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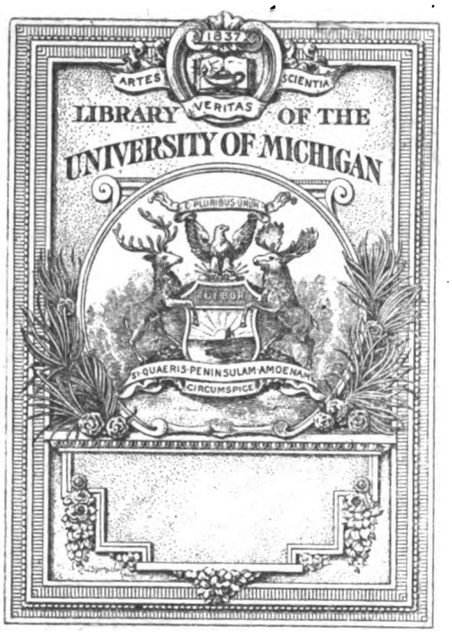

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NOTES.

Cape-to-Cairo Telegraph.—We are pleased to note that the Cape-to-Cairo telegraph has now been laid to a point 50 miles beyond Kasanga, in German East Africa, and about 100 miles beyond the southern end of Lake Tanganyika.

Breakdown of Channel Telegraph Cables.—The Channel cables between England and Boulogne, and also between England and Calais, are both broken, in consequence of the bad weather, and owing to the damage to the telegraph ship "Alert," it is probable there will be some delay in the repairs.

Sixpenny Telegrams in the Colonies.—The introduction of the sixpenny telegraphic rate into New Zealand, we are pleased to note, has resulted in an increase in the number of messages equivalent to 60 per cent., the increased revenue equalling 25 per cent. The Postal Conference which is now sitting in Sydney contemplates the extension of the same system to each of the other colonies, where the existing tariffs are practically prohibitory.

Protection of British Telegraph Lines in Persia.—According to a message from Teheran, the Persian Government is making arrangements for the payment of those British commercial claims which have not yet been settled, and also for putting a stop to the wilful damaging of British telegraph lines in that country. In consequense of a firman which has been issued by the Persian Government, local governors will now be held responsible for any wilful damage done to the telegraph lines in their several districts, unless special measures are taken to protect the same.

Telephone Wayleaves.—An interesting question has been raised at Richmond as to whether a leaseholder is entitled to grant permission to a telephone company to fix a telegraph pole on the property which he holds by reason of a lease. It seems that a tenant of the Vestry of Richmond has given such permission, and that he has been threatened by the Vestry with ejectment unless he causes the Telephone Company to remove the pole in question forthwith. It would seem to us that if the lease is only a short one, the ground landlord has the right to refuse to allow the Telephone Company to place their pole on the land.

Institution of Electrical Engineers.—We are informed that a visit of the students' section of the Institution to the works of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, has been arranged for the 26th inst. Those students who desire to be present on the occasion must inform the hon. secretary of the students' section before Jan. 15. The Birmingham local section of the Institution announce that the inaugural meeting of the section will be held at 8 p.m. on the 23rd inst. in the buildings of the Birmingham University. The president and secretary of the Institution have accepted an invitation to be present on this day, when Dr. Oliver Lodge, the chairman of the section, will deliver his address.

Wireless Telegraphy in Stormy Weather.—Wireless telegraphy has proved itself to be just as capable of use in a gale at sea as in fine weather. During the recent heavy storm the "Princess Clementine," one of the cross-Channel steamers, kept up a constant communication with Ostend on her passage to Dover by means of Marconi's system. Although the waves frequently swept her deck, several messages passed between ship and shore, one being dispatched when the vessel was nearly into Dover. The printed records came out upon the tapes quite clearly without one interruption, in spite of the heavy pitching and rolling of the ship. The test undoubtedly was a severe one, but Marconi's system has showed itself equal to the occasion.

Subterranean Telephones.—Some successful experiments have recently been made by the German telegraph authorities with the new underground telephone cables invented by the Rheydt Cableworks Company. In consequence, it has been decided to gradually replace the present overhead wire system with the new cables, the first line it is proposed to lay being between Düsseldorf and Elberfeld, a distance of about 22 miles. The *modus operandi* is to draw the cable through a wide tube containing air and covered with a thin metal guard, held together with strong wires. Only two other subterranean cables exist in Germany—viz., that between Berlin and Potsdam, and Cologne and Düsseldorf. But these cables are said to have proved unreliable, repairs being frequently necessary.

Australia and Electricity.—What is certainly a colossal scheme for supplying the whole of Sydney, N.S.W., with electric power, not only for lighting, but for transportation and general motive purposes, is reported to be engaging the attention of the Public Works Department at the present time. The Sydney correspondent of the *Express*, who is responsible for the statement, says in his message that the Blue Mountain rivers are to be utilised for the generation of the necessary force, and to provide for water storage on a large scale. The figure named as the estimated total cost of the scheme is something under £1,500,000, the working expenses being put down at £158,000. The correspondent adds that little doubt is entertained that a net profit of half a million sterling will be easily realised.

New Year's Honours.—Among the list published on Jan. 1 of distinguished gentlemen who have been selected by her Majesty the Queen for honours, we are pleased to see the names of Mr. John Aird, M.P., who has been made a baronet, and Mr. Hiram Maxim, upon whom a knighthood has been conferred. These two engineers fitly represent engineering as applied to commercial enterprise and engineering as applied to the manufacture of war materials. In other words, Sir John Aird, Bart., receives his title because of the works of construction which he has carried out in this country and abroad, while Sir Hiram Maxim

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is honoured for the weapons of destruction of which he is the inventor. The last-named gentleman took a prominent part in the early development of electrical engineering, in which subject he still takes considerable interest.

Electrical Engineers Volunteers.—We learn from various quarters that there is a probability of a second detachment of the Electrical Engineers (R.E.) Volunteer Corps being sent to South Africa. The good work done by the contingent which has just returned was so appreciated by the military authorities in South Africa that it is suggested that the corps should supply a second detachment, who would, we understand, be responsible for the continuity of telegraphic communication in the Orange Colony and the Transvaal. If the rumours are correct, no less than 100 men will be required to form the new detachment. This will give an opportunity for the members of the corps who have not yet seen active service, and it seems likely that there will be a considerable chance for remunerative employment in the country being obtained after their period of service under the military authorities is ended.

Prospects for Emigrants.—The Emigrants' Information Office has issued a circular relative to the prospects of emigration at the present time. From this we gather that the demand for mechanics in our Colonies is not large, but in New South Wales, South Australia, Western Australia, and New Zealand there is good employment for farm labourers. At Newcastle, New South Wales, trade has been very brisk of late, and skilled coalminers, as well as turners, blacksmiths, fitters, ironmoulders, etc., are wanted. In Western Australia, owing to the still small population, labour is necessarily limited, but good labourers are required in several of the towns. Free farms are given to settlers. Boilermakers are needed for Christchurch, New Zealand, and several openings have occurred at Dunedin for first-class fitters and turners. Emigrants are warned against going to South Africa in search of work at the present time.

Post Office Telephone Receipts.—A parliamentary paper just issued shows a steady increase in the receipts of the Post Office from the telephone system from 1881 up to the present time. The total receipts in the former year from royalties from licensed companies were £205. In 1882, when, in addition to the royalty receipts, there was a revenue from local exchange and trunk-line business, the total receipts were £8,905, and since then there has been steady increase under all heads, as the following figures show: the total in 1885 was £41,415; in 1890, £69,316; in 1895, £107,174; and in 1900, £360,027. From this it will be seen that the greatest increase—as was only to be expected—took place during the last five years, when the receipts more than trebled themselves. It is interesting to note how the last-named total of £360,027 was made up: £130,272 was in respect of royalties, and £22,338 local exchange business, while the remaining sum of £207,417 came from the trunk-line business.

A Question of Resignation.—A curious incident has arisen in connection with the street-lighting at Fleetwood. It will be remembered that the Fleetwood Urban District Council handed over their electric lighting provisional order to a company under an agreement by which the company were to provide street-lighting at a fixed price. We understand from the Fleetwood papers that there has been somewhat unreasonable delay in the carrying out of this work, and that the Electric Lighting Sub-Committee of the Highways Committee recently discussed the question. In the course of the discussion it was disclosed that all the members of the sub-committee, with the exception of one, were shareholders in the electric lighting company. Unfortunately, that one member has now resigned. It seems to us that the more proper course would have been for the six shareholders to have retired from the sub-committee, on which they were hardly qualified to act while being shareholders of the electric lighting company from whom they were purchasing the current.

Inauguration of Municipal Telephones. — The last day of the old year saw the inauguration of the first system of municipal telephones in England by the Tunbridge Wells Corporation, when communication was successfully established with the public offices and institutions of that town. The scheme undertaken by the Town Council will cost about £10,000, and will provide telephonic service not only in the borough, but throughout the district within a radius of 10 miles. Up to the present moment the Corporation have secured 400 customers, the majority of whom have been subscribers to the National Telephone Company's service. The Tunbridge Wells Council guarantees to provide as efficient a service as the company at a much lower rate, the difference amounting to between £3 and £4 a year, and contemplates, even at this reduced charge, to make a profit, which will be applied to the reduction of local rates. Considerable interest has been manifested in the undertaking by municipal authorities in all parts of the kingdom, for Tunbridge Well shares with Glasgow the distinction of being the first to possess its own telephone service at the beginning of the new century.

Central London Railway.—On Friday last the regular service of trains on the Central London Railway was for the first time interrupted. The breakdown, which caused the traffic to be suspended for over an hour, occurred near the Notting Hill-gate Station. It seems that the break gear on a train near that station had become loosened from the coach, and fallen to such an extent that it touched the middle rail. In this way a short-circuit was caused, which resulted in the interruption of the supply from the main generating station. We learn that the circuit-breaker in the sectional sub-station acted, but it seems from the reports as though it suffered itself in the process. In any case, it took the engineers of the line an hour to get the supply on again from other sub-stations, and after that the regular running proceeded once more. Unfortunately, the breakdown occurred in the morning, when the line ought to have been carrying its heaviest traffic. It must be remembered, however, that the line has already run for five months, and that this is the first time that the regularity of the service has been interrupted. This speaks well for the general supervision of the running plant of a new undertaking.

Consulting Engineers. — In looking through the record of the events of the past year, one cannot but be struck with the fact that a number of the largest towns in this country are reverting to the original practice of having a consulting engineer to supervise the design and erection of their electrical lighting and tramway works. We notice in a daily paper from a provincial town, the name of which we do not propose to give, that the inhabitants of the town are congratulated because their electric lighting department is run without a consulting engineer, and it is inferred, in consequence, that a very large saving has been effected. We agree with the paper that this is the case providing the resident engineer is fully capable of looking after the new work, and has also a sufficiently large staff of expert assistants to enable him to thoroughly supervise the large extensions which are everywhere required at the present day, otherwise it may be found that the overburdening of the resident engineer by work which is directly that of a consulting engineer, may not be to the ultimate interests of the undertakings.

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We are glad, therefore, to note that in the larger towns the real value of independent expert advice, in addition to that which is given by a well-qualified resident engineer, is now more fully appreciated.

The Zeppelin Airship. — At a meeting held at Friedrichshafen recently, Count Zeppelin made some interesting statements concerning the three experimental trials which have taken place of his airship. He claims that the three defects which have been discovered during these experiments can easily be overcome, and that his airship will be able after certain improvements to make long journeys. From trigonometrical observations during the trials he found that a speed of 19 miles an hour was obtained, and he believes that this can be easily increased to 22 miles per hour. The wind velocity on 300 days in a year is less than this, and the inventor points out that during the rest of the time the airship can be used for sailing with the wind. From what we have seen, however, of the vessel in question, we should not much like to make a landing from it when the speed of the wind was considerably more than the speed at which the engines could drive the vessel. The large size of the balloon part of the airship would in high winds be exceedingly difficult to manage when alighting. More extensive trials are to be made with the airship next year, it being estimated that the average cost of an ascent is about £250. Already sufficient funds have been provided to enable 12 more trials to be made.

Hastings Tramways.—The *résumé* of the year's progress at Hastings, as contained in the local papers, shows that the ill-feeling due to the tramway question has not yet fully subsided. In the editorial article now before us on the question, it is suggested that all comments should be suspended until the tramways now about to be constructed by Mr. Murphy are in working order. The advocates of electric tramways in Hastings and St. Leonards have had an uphill fight for a number of years. A great opposition has prevented the tramway company, which has now secured rights for most of the main roads, from running lines along the sea-front. It has been repeatedly urged that the introduction of these tramways on the front would drive away visitors, who at present form the mainstay of the two towns. In our opinion the exact opposite would be the case, as the means of connection between the extreme ends of the sea-front are primitive, and the traffic of heavy omnibuses over the macadam road leaves it in a constant state of bad repair. However, as mentioned above, the opposition was so strong that the sea-coast line had to be given up for some time, and it remains to be seen whether the success of the tramways in other streets will not induce the majority of the Hastings inhabitants to withdraw their opposition to a line along the front. In any case the promoters are to be congratulated even on the partial success they have obtained.

Injury to Eyesight.—Electrical engineers are often told that electric light is very apt to injure the eyesight, and that in consequence it should be used with caution in private houses. The extended use, however, of electric light tends to disprove the idea that any permanent injury is done to the eyes. When the light is installed, those not used to it are rather given to look too closely at the lamps, and the extreme brilliancy of the incandesced filament is then apt to cause temporary ill-effects. The other point which is not often considered, but which is really of the utmost importance, is that with the introduction of electric light higher standards of illumination have been adopted. In consequence of this, the fatigue of the eye when working by artificial light has been very much reduced. We understand that an expert in Russia carried out some experiments in order to ascertain the fatigue of the eye with various methods of illumination, and he claims that a sign of fatigue is the frequent closing of the eye. For instance, by experiments he ascertained that when candle-light was used the eyes were closed inadvertently 6·8 times per minute, in gaslight 2·8, in sunlight 2·2, and in electric light 1·8. We think the general conclusion that one closes one eyes in order to stimulate them when fatigued is correct, but we doubt whether the above figures can be taken to represent the inverse ratio of the fatigue caused when equal illuminated surfaces are being observed.

Sir Robert Ball's Lectures.—The third lecture of the very interesting course, adapted to a juvenile auditory, on "Great Chapters from the Book of Nature," was given by Sir Robert Ball, on Tuesday, at the Royal Institution. Having already dealt with the sun and its enormous heat, and the internal heat of the earth, Sir Robert Ball on Tuesday lectured on "The Evidence from the Stars." At the outset, the lecturer remarked that he would like to connect the noble institution with the beginning of the new century, and in particular with one individual who had given undying fame, not only to the Royal Institution, but to the country to which he belonged. He referred to Michael Faraday, whose memory was perpetuated by the splendid statue seen on the staircase leading to the lecture theatre. Few, indeed, could expect to imitate Faraday's wonderful life-work, but they might, at least, imitate him in that remarkable industry and perseverance which he possessed, and in his devoted love of truth, as also in his love of goodness. Sir Robert Ball exhibited the simple apparatus by which were obtained all the developments of electricity that Faraday's experiments rendered possible—electric railways, wireless telegraphy, telephones, and the like. It was in the Royal Institution, he added, that Faraday's great discoveries were made, and it was at the very table at which he himself stood that those discoveries were announced to the world. The best wish he could extend to the young people who listened to him was that they would try, as far as they could, to imitate the great and noble example which Faraday had afforded by his industry and his devotion to truth.

The Paris Moving Platform.—The moving platform as arranged in connection with the Paris Exhibition interested practically everyone who visited Paris last year. In consequence of this a large number of passengers were carried, and it is advantageous to compare the energy required to move the platform with that taken on the electric railway, which provided communication over practically the same route. We had before us the actual energy required per day when we visited the exhibition, but the owners of the railway and the moving platform would not then give permission for the same to be published. The *Electrical World* of New York, however, has now secured some most interesting diagrams which give the whole power required by the moving platform and by the railway for the period during which the exhibition was opened. It will be remembered that the speed of the moving platform was much less than that of the railway. In fact, the time taken by the electric trains to go completely round was about half that taken by the moving platform. This, of course, is one cause why more energy was required on the railway than on the platform, but in view of the great weight of the platform we are rather surprised at the results obtained. For instance, in August, when both means of communication were in regular work, the platform took about 2,250 kilowatt-hours per day. On the railway the consumption averaged nearly 3,000 kilo-

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watt-hours. As regard the passengers carried, there were 6,694,308 tickets taken on the moving platform and only 2,635,867 on the railway. The above figures will be read with great interest by those engineers who may have an opportunity of installing a moving platform for regular commercial work.

American Fire Rules. — The annual meeting of the Underwriters' National Electric Association was held recently in New York. Delegates attended from all parts of the States, and some important decisions were arrived at with respect to the changes it is proposed to make in the National Electric code of 1901. The proceedings, however, were marked by a tendency of some of the members present to leave two or more alternative courses open in the rules that attracted their greatest attention. The motion to change the limit of low-tension circuits from 300 to 550 volts was carried at the first session. During this session, also, a long discussion took place on the advisability of grounding one of the wires in low-tension circuits, in which numerous authorities were quoted, and prominent electrical engineers spoke in its favour. The resolution was finally adopted to allow the grounding of one wire in every low-potential circuit, but making it optional with the installing engineer. The committee on slow-burning insulation reported on a new style of insulated wire, and recommended its optional use for a year with the present form. The new style reverses the positions of the slow-burning and weather-proof layers. One layer of the latter is placed next to the copper, and two layers of the braid containing the approved slow-burning compound surrounds it. The resolution to make both of these wires comply with the requirements was passed. Good work was reported by the committee on the carrying capacity of aluminium wire, and the results of a long series of tests show that insulated aluminium wire has a safe carrying capacity 84 per cent. that of similarly insulated copper wire of the same size, while bare aluminium wire has only 77 per cent. the capacity of the corresponding size in bare copper. These figures will be incorporated in the new code.

Canal Navigation in Germany.—It seems the management of the Teltow Canal has been seeking to ascertain the opinions of the different authorities concerned as to the advisability of introducing on to the canal an electrical system of towage. The opinions so far obtained declare more or less against the adoption of any exclusive system. It is contended—and with justification, we believe—that it should be left to the individual ship's captain to select that method of towage best suited to his particular requirements. At all events, the steam-tugs which bring the freight boats to the canal should be allowed to navigate the same with their trailers without being compelled to use the electrical towing apparatus belonging to the canal. On the other hand, it should not be forgotten that an electrical towing locomotive such as that introduced experimentally on the Finow Canal offers considerable advantages. For example, it is suggested the transmission line serving the towing locomotives might be employed at the same time to convey electrical energy to the numerous factories, etc., along the canal for lighting and power purposes. It is estimated that this auxiliary load would in time assume very large proportions, especially as the tramways *en route* could also be supplied, and a low charge consequently made for the hire of the towing locomotives. A low charge, it is assumed, would afford sufficient inducement to shipowners to avail themselves of the use of the locomotives. But without the full facts of the case before us it would be useless to attempt to estimate the logic of the conclusion. Of vital importance is the character of the traffic to be dealt with. If barges constitute the main through traffic of the canal, the question arises, would it pay these to dispense with the aid of steam tugs during the comparatively short passage through the canal? It seems to us that to make this worth their while, quicker transit, besides a favourable rate of charge, would have to be guaranteed. For vessels which would proceed under their own steam outside the canal, as well as for barges locally employed, the case is, of course, different.

Spark Telegraphy. — In the early days of Mr. Marconi's experiments on wireless telegraphy, the German Emperor commissioned Prof. Slaby, of the Charlottenburg Polytechnic Academy, to proceed to England and investigate Mr. Marconi's invention. We believe that in this case a report was made to the Emperor, and that the professor demonstrated the success of wireless telegraphy by means of signalling stations in the palace grounds at Potsdam. These experiments were conducted some years ago now, and since that time Prof. Slaby has continued to make investigations on the subject, and has been responsible, together with Count Arco, for a number of improvements. These improvements were explained in a lecture delivered recently in Berlin to 60 eminent scientists. The lecturer was honoured by the presence of his Emperor. The Berlin correspondent of the *Standard* states that the professor commenced his lecture by expressing preference for the term "spark telegraphy" to that of "wireless telegraphy." This was so because an electric spark had hitherto always been necessary for the practical success of the method. He went on to comment on the Marconi system, and condemned for certain reasons the transmitting device used by Marconi. We gather from the report before us that this was condemned because of the comparatively good oscillatory characteristics of the Marconi circuit, which had been adopted to enable the receiving instruments to be timed to the same period as the transmitter. This effect, however, can be increased by a new method discovered by Prof. Slaby, which, it appears, consists of inserting a spiral in the circuit in order to render the waves more persistent. In the lecture in question two receiving instruments were connected with the lightning conductor on the company's chimney. Telegrams were transmitted to and from two stations, one of which is about 8½ miles distant, and the other at Charlottenburg, about 2½ miles distant. After being called, these two stations telegraphed their names simultaneously to the conference hall 10 times as quickly as could be done by the present system, and on ordinary Morse strips. At the conclusion of the lecture, the Emperor expressed his high satisfaction at the great success of the new method, and conversed with the lecturer and others present for more than half an hour, surprising many of them by his thorough knowledge of the system. Valuable evidence of the practical use of wireless telegraphy was provided on Tuesday, when a message was sent from the "Princess Clementine" to Ostend, asking that a tug might proceed to the assistance of the barque "Medora," which had gone on to the Ratal Bank. The exact position of the vessel was given, and a tug was thus able to go to her assistance.

Engine-Builders' Association.—The annual meeting of the Engine-Builders' Association of the United States was held in New York early last month, when the president, Prof. John A. Sweet, in his address, gave the following as the main objects of the association: "The promotion of the interests of the engine trade by the advancement of engineering knowledge and practice, by the cultivation of mutual respect and acquaintance, and the maintenance of a

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high professional standard among members; comparing and standardising methods promoting economy in operation, and the advancement in general of the interests of the trade as a whole." Three papers were read before the association: one by Mr. H. C. Ebert, of the Westinghouse Electric and Manufacturing Company, on "Inter-Relations between Engine and Generator Builders in Connection with Engine Type Units for Power Purposes"; another by Mr. E. T. Armstrong, of the Ball Engine Company, on "Economy Guarantees of High-Speed Simple Engines"; and a third by Mr. H. G. Reist, of the General Electric Company, on "Some of the Requisites of Modern Lighting Generator Sets." We hope to reprint the latter of these in either this issue or the next. From a report of the discussion which followed the reading of the above papers, one gathers that the large engine builders in the States are exceedingly ready to standardising the most important dimensions of their large engines. In this endeavour they have the assistance of the American Association of Mechanical Engineers, and also the American Institution of Electrical Engineers. This latter institution has, of course, at heart the standardisation of large electrical generators, but this cannot be done unless the engines which are to drive them are also standardised by their various makers. The outcome up to the present of the deliberations of a joint committee is an agreement on the subject of speed, but alternating-current sets are acknowledged to be somewhat of a stumbling block owing to the question of frequency. On the question of the overloading capacity of the engine, attention was called to the great discrepancy between the requirements of different engineers. It is often the case that the dimensions of an engine are actually determined by too stringent compliance with the overloading clause of the specification, and that the engine-makers are too often handicapped in tendering by their rigid observance of this, which results in an inferior machine being obtained as far as the ordinary working loads are concerned. It was stated that certain companies have refused to quote when more than 50 per cent. overload was demanded from the engine. We should be exceedingly glad if British manufacturers of engines intended for the driving of large generators would also put their heads together on the matter of standardisation of parts.

The Cauvery Transmission Scheme.—In the issue of our contemporary, the *Indian Engineer*, for Dec. 8, there is the first of a series of two articles on the electric power scheme about to be commenced in connection with the Cauvery Falls. Our contemporary states "that experts all over India are anxiously awaiting the results of the risky experiments which have been undertaken by the Mysore Durbar." The journal goes on to say that it has looked into the case editorially, and that the article before us is a mere statement of the published facts, while the second article is to give the editor's conclusions on the matter. Complaint is made that the reports of experts on the working of the scheme have not been made public, but only extracts from the same. The history of the undertaking seems to be somewhat as follows: The Mysore Durbar entered into agreements with the Madras Government, by which he obtained practically the control of the waterfalls for 30 years in respect of certain annual payments, which did not commence until five years after the date of the concession. Another agreement was made with respect to the sale of electrical energy at the mines in the goldfields, and we understand from the article that the engineers of these gold-mines were consulted before the price of the electrical energy was fixed. The agreements with these mines cover 10 years, and under them the mining companies have to pay £29 per electrical horse-power for the first year and £18 for the succeeding three years. Our contemporary states that in the fifth year the price is to be £24 per electrical horse-power, but we think this must be a misprint for £14, as the price is afterwards reduced for the last five years to £10 per electrical horse-power annum. It is estimated by the engineers that the actual average cost on the mines per horse-power generated by steam is now over £31 per horse-power annum. Expert advice has been obtained from some of the largest electrical companies in America, Switzerland, and Germany, from Captain J. Thomson, of the Board of Trade, London, and from prominent electrical engineers, including Prof. Forbes. We gather that this last expert spoke in most favourable terms of the success of the scheme, although transmission over 90 miles is contemplated. We await with anxiety the succeeding article on the question, which we should think will raise certain points unfavourable to the scheme.

Shop Assistants and the Leeds Tramways.—The question of whether shop assistants should be granted the same privileges as are extended to workmen in regard to fares on the Leeds tramways is just now attracting considerable attention in that city. The matter, of course, is one about which much may be said both for and against. The difficulty is that shop assistants are not "workmen" within the accepted definition of the word. It is no secret that in the majority of cases the so-called workman is in receipt of a higher wage than the shop assistant, and yet he is allowed a reduction in fares to the exclusion of the other. This, on the face of it, does not seem to be quite fair, and apparently this view is shared by those in Leeds who are agitating for a reduction of fares for tradesmen's assistants. Many suggestions for mending the present state of things are forthcoming—one being that on the production of their trade union tickets, or of some badge supplied on registering their names at the tramways office, they should be entitled to travel to their work before 9 a.m. from any part of the city for a maximum fare of 1d., and have the same privilege on the return journey in the evening. But then comes the difficulty—to whom, in the absence of the trade union ticket, are these badges to be issued? It seems to us that the fairest way of dealing with the question would be to grant the suggested reduction of fare to every tradesman's employé earning less than a specified weekly wage and living on his own means, as well as to the working-man. This course ought to meet the requirements of the case, and do away with the absurd idea that only those persons coming within the strict definition of the word "workman" should be allowed to travel on the tramcars to and from their work at the cheaper rate. In the Leeds Press the question has resolved itself into a discussion as to whether or not the tram fares there are cheap. One paper, holding the opinion that the fares are not nearly as cheap as they ought to be, instances a case at Birmingham where what used to be a threepenny ride is now charged one penny for, and it is said the tramway company in consequence are making a larger profit. Many other towns might be instanced, but it is a well-known fact that within the last five or six years tram fares all over the kingdom have been reduced to a fairly close margin. Nevertheless, there is plenty of room for improvement in this direction as regards those employés earning a comparatively small wage, and the shop assistants in Leeds entertain good hopes that before long they will see changes in the present conduct of the local tramways which will not be to their disadvantage.

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THE ELBERFELD STEAM TURBO-ALTERNATOR.

In our issue for Feb. 10, 1899, we gave the preliminary particulars of two large turbo-alternators which Messrs. C. A Parsons and Co., of Heaton Works, Newcastle-on-Tyne, had then secured the order for. These alternators were ordered by the municipal authorities at Elberfeld, on the representation of their consulting engineer, Mr. W. H. Lindley. Each of the machines was designed to run at 1,500 revolutions per minute, and to generate 4,000 volts. The machines being four-pole, the frequency of the alternating current works out at 50 complete periods per second. Through the courtesy of the makers, we have now before us the complete figures of the exhaustive test made upon the first of these machines by Mr. Lindley, in conjunction with the following eminent experts: Prof. M. Schröter, professor of mechanical engineering at the Polytechnicum at Munich; and Dr. H. F. Weber, who holds the important post of professor of physics at the Polytechnicum at Zürich. The test work was carried out at the makers' works at Heaton, where special boilers had to be laid down to provide the necessary steam for the full load and emergency load trials. It is interesting to note that the support for this large turbine, generating up to 1,200 kw., was a wooden framework 13ft. high, representing the permanent foundations on which the turbine is now erected in the engine-room at Elberfeld. Amongst the boilers used for supply were a Babcock and Wilcox water-tube, two marine boilers, and one locomotive boiler. The superheater, arranged with independent firing, was introduced into the main steam-pipe. It was found, however, incapable of giving the degree of superheat mentioned in the contract, but it will be attained regularly at Elberfeld. Owing to the number of boilers used, the steam consumption had to be determined from the condensed water collected from the surface condenser. In the half-load trials, which could be carried out with the Babcock and Wilcox boilers only, a comparison was made between the feed-water supply and the condensed water so collected in the condensers. The quantities were found to agree with very slight differences, which were due to small leakages in the steam-main. The cooling water for the condensers was obtained from a large pond near the works, the water being circulated by means of a pump driven by an electric motor. It is, of course, impossible to indicate steam-turbines in the way it is done with reciprocating engines, but some most interesting observations were made on the steam pressures in various parts of the turbine as the steam was passing through it and expanding. Owing to the method in which these turbines are controlled, the steam pressure in the admission chamber is not constant. In a constant load, however, the variation in this pressure as the successive puffs of steam are admitted by the governors is perfectly regular, and a diagram of the same was obtained by a Dreyer-Rosenkranz indicator obtained from the laboratory at Munich. Steam consumption trials were carried out at loads varying from no load up to 1,200 kw. As the greatest interest, however, centres round the normal load of 1,000 kw., we give below the average figures of the variation in steam pressure obtained through the various parts of the turbine. In the trial in question the pressure at the stop valve was 148lb. absolute. In the steam-chest the maximum pressure as recorded by the above indicator was 122lb. and the lowest 68lb., the mean being 95lb. At the end of the high pressure cylinder the steam pressure had fallen to 7·8lb., which shows how effectively the expansion takes place in these turbines. The inlet pressure on the low-pressure cylinder was 7·4lb., which was reduced at the outlet of the condensers to ¾lb. absolute. With the great variation in load, as is only to be expected, variations were introduced both in the pressure of the steam at the stop valve and also in the superheating. These variations are recorded in the full tables of the tests before us, but a correct paper is also given to show what the consumption would have been in each case if constant values for these quantities had been maintained throughout. These figures are as follows:

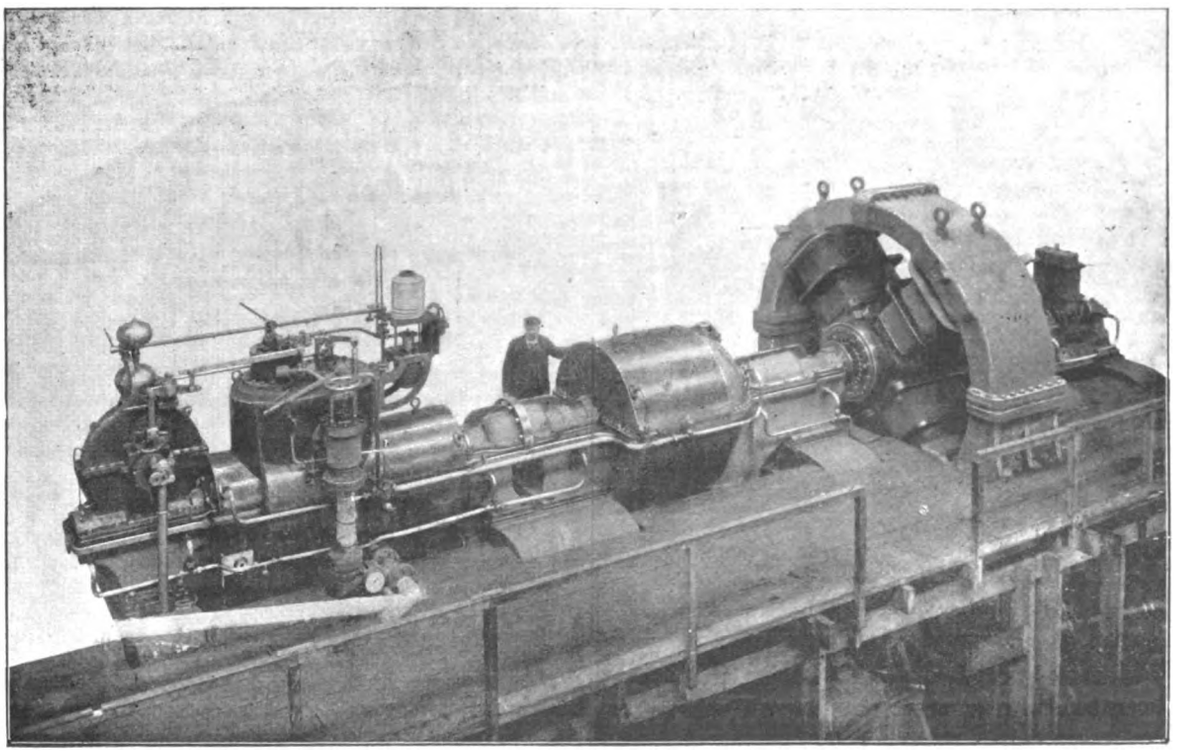

FIG. 1.—Illustration of the 1,000-kw. Parsons Alternator as erected on Wood Platform for Testing.

Load in kilowatts.	Steam consumption per kilowatt-hour in pounds.
1,190 1	19·25
994 8	20·1
745·3	22·2
498 7	25 4
246 5	33·7

When the turbo-alternator was running at no load, but with the excitation on, the steam consumption per hour was found to be 4,050lb., whereas when the excitation was switched off the consumption fell to 2,600lb. per hour. In the above figures the pressure at the stop valve is calculated at 156lb. absolute, with 14·3deg. C. of superheat. A com-

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parison of these results with this guarantee by the manufacturers reveals the fact that at about 400 kw. the consumption obtained is considerably below that guaranteed. Below this output the consumption was slightly more than was expected. In the guarantee, however, 50deg. C. of superheat was mentioned, whereas on the average only 14·3deg. was obtained at the time of the test. For instance, at 1,000 kw. the guaranteed steam consumption was 24·2lb. of steam per kilowatt-hour, whereas, as seen above, the figure obtained on trial was 20·2. The experts also state in their final report that the steam consumption at no load and up to 400 kw. would be decreased when the full superheat was obtained. The next point of interest in the trials is that of the variations of speed between no load and full load with the various types of governors employed. The average variation for this range was found to be about 3·6 per cent. Two methods of governing were tried, one by means of a centrifugal governor and the other with an electrical governor. The test specified was that 25 per cent. of the load should be switched suddenly on or off with a variation of not more than 0·8 per cent. in the speed. Some interesting curves (given in Figs. 2 and 3) were obtained for the centrifugal governor, which showed how closely the control was maintained, in spite of these sudden variations. It was found that this governor regulated the speed with changes of load varying between 16 and 63 per cent. in such a way that the revolutions varied, in round numbers, 1 to 1·9 per cent. immediately after the sudden change of load, whilst the permanent variation in speed amounted to from 0·4 to 1·3 per cent. The potential measured at the same time showed an average variation of 1·3 per cent. of the initial potential when these sudden decreases and increases in the load were made. The working of the electrical governor is illustrated by the curves in Figs. 4 and 5. With respect to these governors, the report states that, according to the tests, the electrical governor during the changes in load, varying between 12 and 62 per cent., regulated the number of revolutions, and thereby the permanent potential, in such a manner that the average variation of the latter remained within 1·1 per cent. of the initial potential. If the magnitude and the suddenness of the changes of load are taken into account, the governors of the steam-turbine submitted to test not merely complied with

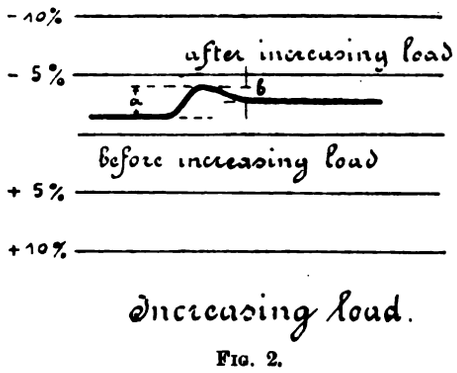

FIG. 2.

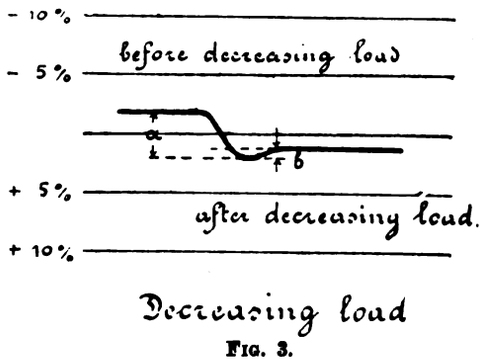

FIG. 3.

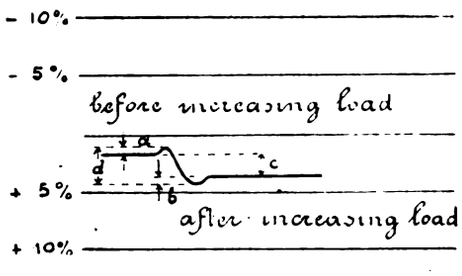

FIG. 4.

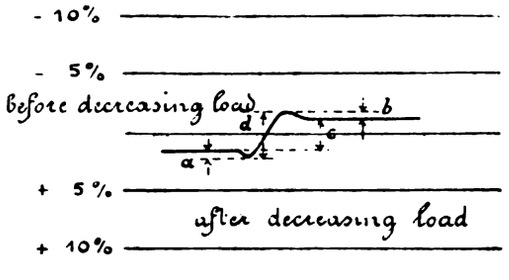

FIG. 5

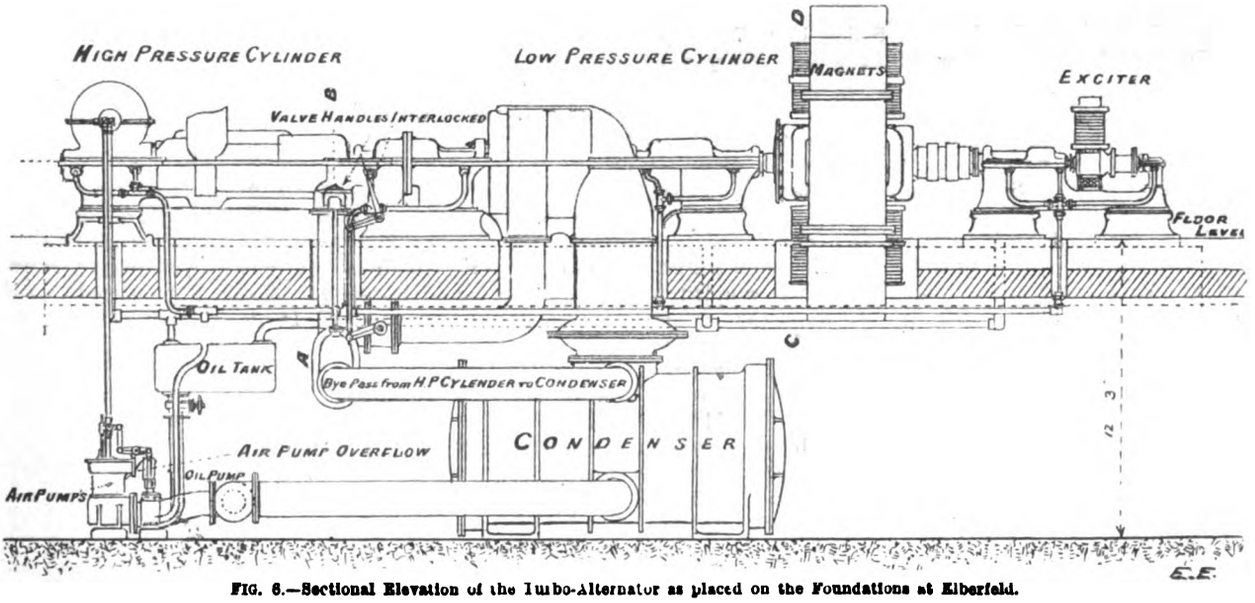

FIG. 6.—Sectional Elevation of the Turbo-Alternator as placed on the Foundations at Elberfeld.

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every reasonable demand, but they may be considered as excellent, and as fully answering their purpose. This conclusion is all the more justified when the shortness of the wave of transition—*i.e.*, the rapidity with which the influence of the sudden decrease and increase in the load upon the number of revolutions of the steam-turbine is overcome by the governing arrangement—is taken into consideration. The bulk of the consumption trials were carried out on a water resistance load as being non-inductive, and on this load the fall of potential between no load and full load was found to be only 1·02 per cent. with the excitation constant. Further tests, however, had to be made, under the terms of the specification, on an inductive load. The maximum load obtained with this inductive resistance in which cos $\phi = 0{\cdot}778$ was 786 kw., and at this load the drop was 345 volts, or 8·8 per cent. of the potential at any load. The report adds that for the full load of 1,000 kw. the existing drop would be 11 per cent., but if the question is looked into we think that it will be found that the drop will be higher than this owing to the increased effect of the demagnetising component of the current. Under the terms of the contract, the drop on inductive load was carried out on a resistance which gave cos $\phi = 0{\cdot}8$, so that it will be seen the makers used more induction than was specified. The temperatures of the various parts of the alternator were taken after a continuous run of six hours, of which the first four hours were at the normal load of 1,000 kw., and the last two hours at an overheat. The temperature rise

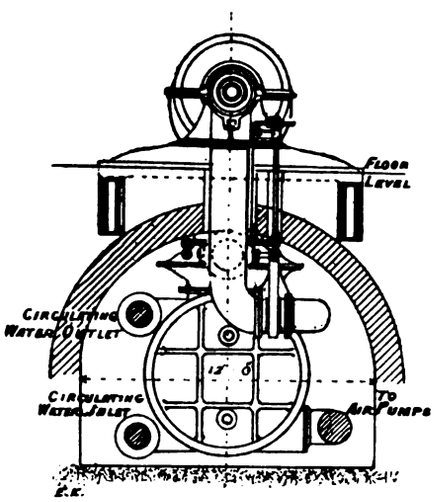

FIG. 7.—Cross-Section through the Condensing Gear.

mentioned in the specification was 50deg. C. or 72deg. F. The only part of the machine which exceeded this was the iron of the armature. An improvement under consideration is to keep down this temperature.

The most interesting part of the trials—*i.e.*, the parallel running—could not be carried out at Heaton owing to want of steam power. Since, however, the first and second alternators have been delivered and erected they have been worked most successfully in parallel with each other and also with the other generating sets in the Elberfeld station, which are Brown-Boveri alternators directly coupled to Sulzer engines. One would expect that the steam-turbines would be mainly adopted for parallel running owing to the evenness of the turning moment. The only doubtful point would rise over the governing, which has been most successfully accomplished by Messrs. Parsons and Co. It will be remembered by our readers that in the ordinary steam-turbines supplied by this firm the speed is not maintained constant from no load to full load, so that they are to be congratulated on the design of their new governors, which so successfully control these large turbines. Congratulations are still more due to them for the extremely small steam consumption which they have obtained at trials, the results of which cannot be questioned, owing to the eminent experts which made them. The increase obtained augurs well for the introduction of large steam-turbines in works designed for the generation of electricity to be distributed in bulk. In this the economy of the prime movers is of the utmost importance, in order that they may successfully compete with large isolated steam-engines in the different works which they hope to supply.

Fig. 6 shows the general arrangement of this turbine, with its condenser and circulating pumps, while Fig. 7 is a cross-section through the same, showing the arch basement containing the condensing plant.

THE LONDON ELECTRIC LIGHTING COMPANIES.

For the last two years we have given in our first issue in January a diagram containing curves which have represented the variation in value of the ordinary shares of the electric lighting companies of London. On referring to our issue for Jan. 5, 1900, our readers will see that these curves of values commenced in the winter of 1895. In 1896 and 1897 there was a regular upward tendency in the market values of practically all these shares, and they reached their highest points about March, 1898. As is frequently the case when a boom in the shares of limited liability companies takes place, the shares of a certain number of these companies were carried up to a point considerably higher than was warranted by the commercial value of the same. As one result of this, the curves show that in every case the market value declined during 1899. We are now giving herewith a table in which comparison is made between the market prices of the various ordinary shares now and that 12 months ago. Owing to the fact that these values have not altered much, we have not prolonged the curves which we gave last year. The closeness of the prices of the shares in certain of the companies to each other makes their clear representation on one diagram almost impossible. It will be seen, however, from the table that only two companies have their ordinary shares at the same price in the market as at the end of 1899. These are the Charing Cross and Strand Company and the St. James and Pall Mall. The first named of these is now making good progress with the mains to supply the City of London, and is commencing to receive income from the same, owing to the fact that the mains can be supplied from the old stations already running. It will be seen that the ordinary shares in the Westminster Supply Company have fallen off 1½ points during the year. This is explained to a large extent by the fact that the company issued a very considerable amount of new ordinary shares. This issue was made at par, the shares being allotted to the holders of ordinary shares *pro rata*. In consequence of this the shareholders received a large profit out of the issue which would otherwise have gone to the company. The ordinary shares which show the largest percentage fall during the year are those of the Blackheath and Greenwich Company and the South London Electric Supply Company. This, we believe, is largely due to the comparative youthfulness of the two companies, which has prevented them so far from paying a dividend on their large capital outlays. This has also restricted the demand for the shares, so that the least selling results in the price going down. The London Electric Supply Company's shares also show a large percentage decrease. It will be remembered that the works of this company at Deptford were closed down during the summer for a complete overhauling, which we trust will enable this pioneering company to again enter a dividend-paying stage. In the tables herewith will also be seen the dividends which were declared early in 1900, which are also contrasted with those declared in 1899. These show that the companies are, with few exceptions, still earning increasing dividends. Amongst the exceptions is the City of London Electric Lighting Company. It will be seen in the next few weeks how far the extra cost of coal during the past year has affected the gross profits of the various companies, in spite of the usual increases in the electrical energy supplied due to connections with new consumers. It must be remembered that, whereas there has up to the present been no increases made in the selling price of electrical energy, the large gas companies have considerably increased the price of gas. We think that the directors of the

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various electric supply companies are quite right in preferring to keep their price down and to use the opportunity so given to attract new consumers, who will naturally not revert to gas when the price of coal again falls, as it shows signs of doing. We trust that during the present year some of the companies will begin to show in their returns the advantage derived from the use of the large new electric supply stations which are being constructed in the outskirts of London. Up to the present, the Metropolitan Supply Company alone has completed its suburban works, but others will commence working during the first year of this century.

TABLE SHOWING THE VARIATION IN THE MARKET VALUE OF THE ORDINARY SHARES OF THE METROPOLITAN ELECTRIC SUPPLY COMPANIES DURING 1900.

Company.	Amount paid on each share.	Market prices. Dec. 29, 1899.	Dec. 28, 1900.	Fall.	Dividend declared. 1899	1900
					%	%
Blackheath and Greenwich	£1	⅜ — ⅞	⅜ — ⅝	¼	—	—
Brompton and Kensington	5	7½ — 8½	7 — 8	½	6	6
Charing Cross and Strand	5	9½ — 10½	9½ — 10½	--	8	9
Chelsea Electricity Supply	5	7½ — 8½	6½ — 7	1¼	6	6
City of London	10	10 — 11	9 — 10	1	6	4
County of London and Brush	10	10 — 11	8½ — 9½	1½	—	4
Kensington and Knightsbridge	5	12 — 13	11½ — 12½	½	10	11
London Electric	3	2¼ — 2⅝	1½ — 2	⅝	—	—
Metropolitan	10	13 — 14	12½ — 13½	½	5	5
Notting Hill	10	15½ — 16½	14½ — 15½	1	6	7
South London	5	4¼ — 4⅝	2½ — 3½	1½	—	—
St. James's and Pall Mall	5	15 — 16	15 — 16	—	14½	14½
Westminster	5	13½ — 14½	12 — 13	1½	12	13

TH' ENGINEER'S SPESHUL.

"Ah, well; it's a poor stomick as can't warm its own grub." The speaker was my old friend Billy Weil, wireman in the St. Ives-Edinburgh district of the Great Calais and Dover Railway Company's telegraph department, and his philosophical remark was prompted by my expression of sympathy with him on account of the hardships his calling entailed upon him.

"Of course," continued Billy, "it's all right gettin' yer dinner on th' bank side in summer, an' havin' a little snooze in th' sun after it. But if yer has to clear away the snow offen a gas-pipe to get a seat, an' yer find yer bottle's frozen solid, it's not so much of a picnic, is it? Get into th' signal boxes for our meals? H'm, 'taint allowed; but what d'yer think? An' we can generally find th' key of th' platelayers' hut if we want it. But sometimes there aint a hut within a mile, an' no cabin either, an' then yer has to do th' best yer can.

"I mind once," continued Billy, reminiscently, "getting my brekfuss in a signal box, an' it wer' nearly a goner for th' signalman and some more on us. He wer' a decent chap wer' Dick Rayson, but a bit nervis when anythin' happened, and not allus sure what wer' best to do when things went wrong. It wer' at Blessenton, up on th' west line, an' three or four on us wer' there repairin' after a breakdown—patchin' (*you know*)—puttin' No. 8 on to old stuff no better'n 16, an' solderin' every blessed binder to keep 'em level. 'Taint a job as yer can get on with quick, an' 'taint no good when done. One hears a lot about Mark Onny and his telegraphin' without wires. Mark mebbe has got it down to that all right, but there's some as could put him up to a thing or two in that way. 'Twere a beastly cold mornin' this as I'm a-tellin' yer about. One of them half foggy, rimey mornin's when yer gets a shower bath under th' wires, an' can see th' cobwebs hangin' between th' wires an' th' insulators, an' when th' vice key sticks to yer hand. We'd been workin' up a height an' none of us wer' sorry when it wer' breakfuss time. Th' nipper wer' up in Dick's box warmin' our bottles an' cans, an' Dick said we might go up an' get our grub as ther' wer' nobody about at that time. An' we told Dick he wer' a good sort, an' we wished ther' wer' more like him. We got our brekfusses all right, an' wer' just startin' a smoke when Dick got th' call "Attention" signal on th' bell from Crammles, which wer' th' next station east, an' that was foller'd by the 'Be ready' for an express."

"Express passenger?"

"Yes."

"'What in thunder's this?' says Dick. 'Ther's no passenger due now!'

"Yer may be sure none of us could tell him, an' so we sat an' waited. By-an'-by Dick got the 'Train on line,' an', sure enough, it wer still an express. Crammles an' Blessenton is only a short section, an' it were'nt long afore we see'd her comin' round th' curve, an' goin' as if th' 'old 'un' had kicked her off for a start.

"'By gum,' says Dick, 'it's the engineer's speshul! Keep yer heeds down, lads, so that they cannot see yer. They'll be off to Lesspett to see about th' accident last night.'

"Ther' had been a run-in at Lesspett th' night afore, through a signalman forgettin' a train at his advance board an' takin' another on behind it. An' sure enough that's what had brought 'em out at 8 o'clock on a cold mornin'.

"'Keep yer heeds down,' shouts Dick again, 'an' dinnot let th' beggars see yer. They'll be as keen as mustard this mornin', an' if yer copped up here I'll be sure to get th' sack.'

"We didn't want to get Dick into trouble, so we crawled down below th' windows 'til we heard her go past an' we thought it wer' all right.

"Just as she went past Dick shouted to th' nipper, 'Keep yer heed down, yer young divvle.' 'Oh Lord!' he continued, 'did yer hear th' bell ringin' on the engine? 'They've seen that young divvle's heed through th' end windows an' they're stoppin'.'

"An they wer'. Th engin' an' carriage had run past the platform end, but they had stopped an' began backin' to th' platform so's they could get out easy. An' we could see'em all on th' end platform of th' carriage ready to get out. An' th' cabin steps wer' on that side. Poor Dick wer' in a bad way with hissel by this time, as we couldn't get out by any road without bein' seen, an' he cursed th' nipper all ends up for gettin' him in such a scrape. An' it wer' reasonable, too, for Dick wer' in a very tight place. He wer' allus a terror, wer' that nipper. Allus gettin' into trouble hissel, or gettin' somebody else into it. An' he wer a clumsy little beggar, too, in every thin' he did. He couldn't hand yer th' tar brush without running it again yer clothes; he never went up a pole but he nearly killed somebody by droppin' his pliers or th' iron out of th handle, and he wer' noways particular where he tossed th' spare solder offen his iron. If his fire-pot weren't out it wer' full of black coal; his solderin' iron wer' nearly cold every time yer got it up th' pole, an' it *never* had a face on it. Th' number of slip joints we had over him wer' awful. As for warmin' yer dinners, he either had 'em cold or burned to a cinder, an' it wer' only necessary to give Joe yer bottle to warm twice before it wanted solderin'. But he wer' noways nervis, weren't Joe. He wer' a demon for climin', an' it made no matter to him whether th' pole wer' rotten or not. He us'ter say as it wer' stiff enough for him if th' earth wire wer' good. An' he got plenty of practice.

"By this time th' big guns wer' out of th' carriage, an' wer' comin' along th' platform in a bunch. Five on 'em. Ther' was th passenger superintendent, th' engineer (he called hissel a civil engineer, but ther' were' nothin' civil about him), th' goods manager, an' the mineral manager. Who wer' th' other one I forget just now. An' they wer' jawin' away among theirselves, as they came along th' platform, thirteen to th' dozen. Dick wer' nearly past hissel now, an' wer' askin' old Bustard, our gaffer, to take

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the blame offen him, as it wer' on our account that he had got into th' hole. He hadn't even sense enough to put up his sticks behind th' special, but left them off. They wer' mighty big guns for such as us to face too, an' we wer' most on us very sorry for oursel's. As soon as our old man Bustard saw what wer' goin' to happen, he jumped up an' went to one of th' battery cupboards (th' batteries wer' under th' instruments in th' top cabin, by good luck), an pulled th' doors off.

"'Look sharp, you chaps, he says. 'Keep down, an get th' doors off, an pull out all th batteries, and mess up the G.P.s all yer know. Some of yer get th' instrument tops off, and pile 'em about on th' floor, Look alive now.'

"We saw what he wer' after without any more talkin', an' th' batteries came out, an' th' instrument covers came off quicker'n you could say knife. An' we had th' floor lookin' like a warehouse in no time a'most. By this time th' big 'uns wer' comin' up th' cabin steps, an' just as th' door opened, old man Bustard told me to go downstairs and look for a wire he wanted tracin'; an' he told th' nipper to get a platelayer's key and see about th' earth wires that wer' on th' rails. An' he took good care that they should hear what he wer' sayin' as they came in. Me an' th' nipper went out as th' five on 'em came in. Th' passenger super wer' th' man concerned with th' job, an' old man Bustard told me after that he asked Dick what we wer' doing there, an', without waitin' for an answer, he asked our gaffer what he wer' up to.

"'Renewin' th' cabin G.P.'s, sir,' says Bustard, as bold as yer please, an' he waved his hands to th' batteries an' instrument tops stan'in' about on the floor. He then began pullin' at a G.P. in th' cupboard bottom, an' yelled out to me did I see it, an' took no more notice of th' super an' th' others than if they wer'ent there. Old Bustard told me to trace that wire, an' I did, an' kept mighty quiet. He then began to pull the G.P.'s out of th instrument holes, an' connected them up outside, just as he would do if he wer' goin' to put new wires in. An' th' super stood as solemn as an owl, watchin' him an' th' others at it. He never seemed to notice poor Dick, which wer' a good job. An' he never see'd that Dick hadn't put his sticks up behind th' train, which wer' also a good job—for Dick.

"As it happened, Dick got th' 'Be ready' for th' fast goods from Crammles just then, an', of course, he couldn't take it on, because th' engineer's speshul wer' stan in' at th' platform. So Dick plucked up a bit of courage, an' told th' super th' goods wer' stan in at Crammles waitin' for them to get out of th' way. This set the goods manager on th hop at once, as he couldn't abear havin' his trains stopped, because, as everybody knew, it wer' th' goods traffic as made th' divvi. Th' passenger super wer' a keen chap, an' he seemed to think that ther' wer' a screw loose somewhere. But the blessed cabin floor wer' filled with th' batteries an' instrument tops, an' our chaps seemed to be so awfully busy that he couldn't put his finger on it. He pawed around an' sniffed a good bit, an' seemed to have an idea as he wer' bein' done, but he couldn't find th' 'nigger.' An' our chaps had got th' cabin in a beautiful mess by that time, an' never took th' slightest notice of any of them. They wer' too busy, you see. An' so at last th' super turned to Dick, an' told him we wer' to get out as quick as possible. An' Dick promised that he would see to *that*. The five of them went down the steps an' along th' platform to th' carriage, an' they wer' jawin' among theirsel's all th way. We let 'em get right away an' out of Dick's section afore we started to put th' wires an' things right, as we thought they might be artful enough to come back. After Dick got th' 'Train out of section' for 'em, we soon had things straight an' got to our patchin' again. We never heard a word about it after, an' neither did Dick. His inspector paid him a visit next day, an' had a good look around, but he never said a word. An' Dick wer'ent anxious to open the subject again, as yer may think.

"Old Bustard wer' tellin' me at dinner time that day about what happened in th' cabin after he sent me an' th' nipper out just as I've been tellin' yer now, an' I wer tellin' him how clever an' ready he had been.

"'"Twas a very narrow squeak,' says th' old man.

"'How?' says I; 'they never guessed.

"'What'd *you* a done, says he, 'if they'd asked where yer new G.P. was?

"We hadn t a bit.

DETAILS AND TESTS OF AN OERLIKON 600-H.P. THREE-PHASE MOTOR.

The *Elektrotechnische Zeitschrift* publishes a communication wherein some interesting particulars are given of an asynchronous motor of 600 h.p. running at 75 revolutions per minute, recently turned out at the Oerlikon Maschinenfabrik. The motor in question is destined to drive a water-pump in a German mine, and was specified to develop a normal output of 570 h.p. when running at 75 revolutions per minute, and to have a maximum starting torque of 20 per cent. above the normal. The pump is to be capable of raising 500 gallons of water per minute to a height of about 1,310ft. A governing factor with regard to the design of the motor was the necessity of lowering the same through a shaft 6ft. 4in. by 6ft. 9in. wide the maximum weight to be lowered being limited at the same time to one ton. It was further stipulated that the rotating portion of the motor should provide an appreciable amount of kinetic energy in order to control the action of the pump. This condition involved the adoption of a factor of slip between the fields of rotor and stator greater than 2 per cent. So far as the electrical engineer is concerned, the difficulty in constructing a synchronous motors for such a low speed lies in the avoidance of undue magnetic leakage, which tends to increase largely with the number of poles round a comparatively small circumference, and the considerable air-gap required with large diameters for mechanical reasons. A generator was ordered to be supplied at the same time with the motor. This was to develop 840 h.p. when direct coupled to a steam-engine running at 90 revolutions per minute. The principal load on the generator was to be the motor. Hence it was possible to choose a periodicity limiting the number of poles necessary for the motor, while at the same time giving a sufficiency of poles to the generator.

The adoption of a large diameter for the generator was deemed necessary in order to attain the stipulated flywheel action. Had the number of poles in the generator been proportioned too low, this would have necessitated inconveniently large dimensions for the pole cores and magnet coils. Having regard to these considerations, the periodicity of 22½ was adopted, which gives the generator 30 and the motor 36 poles. The terminal potential is 1,900 volts. The armature of the generator has a diameter of 15ft. 9in., the air-gap being 0·395in. The magnet wheel weighs 16¾ tons, and has a radius of gyration of 7ft. 3in. The diameter of the motor rotor is 9ft. 7in., and the air-gap between the fixed and rotating parts 0·08in. The finished rotor weighs about eight tons, and has a radius of gyration of about 5ft. The winding of the stator consists of 162 coils of copper wire, embedded in 324 tunnels lined with micanite tubing, while the rotor carries 216 coils, wound in 432 surface slots also lined with micanite. Each coil is composed of 29 bare copper wires of 3·6mm. diameter connected in parallel. The whole winding has only 54 soldered connections, as every four coils is composed of a contiguous length of wire. The three ends of the winding of the rotor are connected, on the one hand, to three short-circuited terminals, and, on the other, to three cast-iron slip rings, upon which latter three brushes are set, and serve to conduct the induced current to a large adjustable rheostat. By means of this rheostat the motor can be started up on full load with the normal current and with the generator going at full speed. So soon as the motor has attained its normal speed, a short-circuiting arrangement is actuated by means of a handwheel and transmission gear until the windings of the motor are short-circuited, whereupon the brushes are raised. Since the generator is required to supply energy to small motors in addition to the big machine described, the starting of the latter could not proceed on a short-circuited armature simultaneously with the starting of the generator as in previous

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practice. In order to lower the motor through the narrow shaft to its working position, both the stator and rotor had to be constructed in two portions. Having regard to this, a special scheme of winding has been adopted for both parts, whereby a division of the winding is rendered possible by the disconnection of a few soldered joints without opening the wound coils. The free sides of the coils are alternately bent over in three levels for the three winding phases, so that the total length of winding for each phase is exactly equal. As regards the mechanical construction of the motor, special importance was attached to the rigidity of the stationary and revolving systems relative to the acting magnetic forces which arise in consequence of a certain unavoidable eccentricity of the rotor. This rigidity had to be obtained within the limited over-all dimensions allowed by the width of the shaft. The frame of the motor is stiffened by means of two cast-iron six-armed spiders, which are mounted concentric with the main shaft on the bearings at either side of the rotor, and may be rotated with the frame after loosening three bolts. Each section of laminated core in the stationary system is secured to the frame by 54 bolts of $\frac{3}{4}$in. diameter. With the rotor purposely mounted in an eccentric position, which involved a variation of ·04in. in the air-gap, no deformation of the latter could be detected even with the maximum magnetic field. The outer diameter of the finished motor is 13ft. and its breadth 2ft. 11in., the extreme distance between the two bearing pedestals being 9ft. 10in. The total weight of the motor amounts to 23$\frac{1}{2}$ tons, of which 7$\frac{1}{4}$ tons is iron plate and 3,080lb. copper. The rotating portion weighs about 11 tons.

In the test-room of the Oerlikon Works the following measurements were made:

Resistance of the winding of one phase of the stator, 0·4 ohm (the stator winding has mesh connections).

Resistance of the winding of one phase of the rotor, 0·016 ohm.

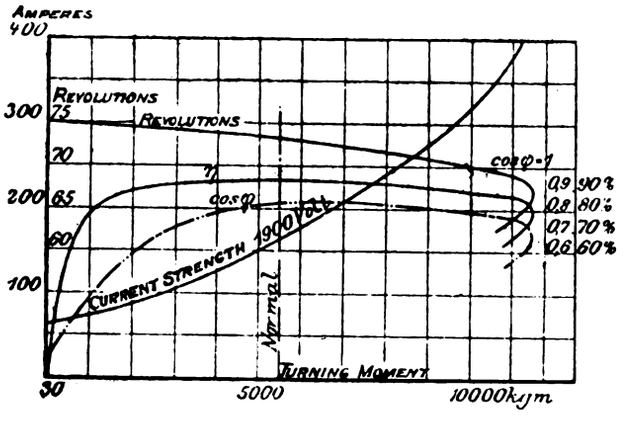
Light running at 75 revolutions per minute, 1,900 volts, 62 amperes, 22·5 periods, 16,000 watts.

Stationary motor and short-circuited rotor windings (short-circuiting current):

390 volts, 110 amperes, 22·5 periods,
600 volts, 200 amperes, 22·5 periods.

Hence we get a leakage coefficient for 190 amperes load current of $\sigma = 0{\cdot}1$.

For larger currents, σ is less. The losses due to friction and ventilation were ascertained to represent about 3,500 watts. The heating of the core with the motor running light amounted to 18deg. above the temperature of the surrounding air.



From these data the accompanying diagrams of the current strength, revolutions, cos ϕ, and the efficiency of the motor at different turning moments under the assumption of a decreasing coefficient of leakage, has been plotted. On the normal load the motor takes about 170 amperes, the corresponding power factor being 0·82 and the efficiency 92 per cent., with 2·7 per cent. slip. The maximum turning moment is 37 foot-tons, which is equal to double the normal.

Having regard to the very low speed and the limited dimensions entailed, these values may be regarded as highly satisfactory. For a motor of the Oerlikon standard type designed for an equal output at 370 revolutions per minute and a periodicity of 50, the corresponding values at the same place and under the same conditions were observed to be as follows:

cos $\phi = 0{\cdot}92$; efficiency = 95 per cent.; slip = 1·5 per cent.

In this case the maximum turning moment amounted to 2$\frac{1}{2}$ times the normal.

CENTRAL-STATION SWITCHBOARD CONNECTIONS.

BY J. A. SEAGER, A.I.E.E.

Among the minor points in central-station design is the arrangement of the cable connections to the switchboard from dynamos, battery, and mains. Although many other considerations claim precedence, it is essential that these leads should be well arranged, as economy both in first cost and in running expenses can be obtained, and, what is more important, mistakes of electricians and wiremen due to complexity of connections must be avoided. Without going much into detail, the following elementary points may be noted. Two different considerations govern the arrangement of high and of low-tension connections. In the first, high insulation at every point is the chief aim of the designer. In the second, dealing with heavy currents, minimum copper resistance and good contact are the important objects. In high-tension work stranded cable is almost invariably used, and in the majority of cases the cable is concentric. The insulating material should preferably not be rubber, as this deteriorates rapidly under such heat conditions as are found in cable trenches in stations. If used, the cable should be vulcanised. Whether the cable be lead sheathed or not depends on whether it is drawn into iron or pot tubes or cleated in a dry trench, or else laid in a trench imperfectly protected from moisture either from drains or escaping steam. The greatest care must be taken to prevent abrasion of the insulating material. Probably the best method for this purpose is to use a glazed stoneware tube, the cable being drawn into this. Next to this comes the employment of iron pipes. It should be remembered that there is a tendency for water to condense in the inside of these tubes and for grit to get in if they are left open, so that the ends should be closed with tarred wood plugs shaped to enclose the cable. The ends of the tube should be cupped outwards to prevent the edge of the tube cutting the insulation when the cable is bent about. If iron pipe is used for alternating-current work, concentric leads are necessary, in order that the eddy currents generated by the "go" current may be eliminated by those of the "return." Iron pipe (which must, of course, be "barffed" or else coated with tar) is cheaper than stoneware. An alternative to iron or stoneware tube is, as mentioned above, a concrete trench. This is generally run along the dynamo ends of the foundations for the plant, and leads to the back of the switchboard or to a cable-room beneath the switch gallery. It is made of sufficient capacity to contain all necessary cables placed well apart from one another, say 5in. from centre to centre, with additional room for future extensions. In small stations cast-iron chequer plates fitting into wrought-iron seats are placed over the trenches. Care should be taken to see that these are watertight, as cleaners have a tendency to slop water very freely about the floors. In larger stations it is found to be better practice to make the trenches large enough for a man to pass through easily without touching wires, and to cover the top of the trench with a brickwork or concrete arch levelled to the floor at the top. It is useful to construct the trench at the same time as the foundations, building into the latter wrought-iron pipes having a gentle curvature leading from the top of the foundations to the trench, suitable for drawing in wire. Inside diameter of pipe to be not less than twice external diameter of cable; least radius of curvature of bend, 3ft. Before and after erection a mandril of hard-wood $\frac{1}{4}$in. less diameter than the internal diameter of the pipe, and, say, 3in. long, should be drawn through the pipe to make sure that there are no burrs, fins, or other

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obstructions. If such exist, they must be removed with a steel tube scraper.

Practice varies as to the arrangement of cables in the trench. If this is liable to wet, lead-covered cable should be used, supported at intervals of about 15ft. on iron brackets affixed to the wall of the trench. Alternatively, wrought-iron pipe may be run along the trench and ordinary insulated cable drawn in. The method of combining trench work and iron piping is rather expensive. If the trench can be guaranteed dry, ordinary insulated cable can be fixed to the walls of the trench by means of wooden or pot cleats. A trench which is likely to receive water should have its bottom sloped down to the centre of the passage, where there should be a gutter with a continuous slope of, say, 1in. in 10 yards, leading to the station sump or to the drains. If corners are necessary in the trench, these should be rounded off wherever possible, as a sharp bend strains the insulation of a cable injuriously. If it is impossible to remove a sharp corner, a slight amount of slack must be allowed in the cable at the corner. Mechanical joints are not always satisfactory in high-tension alternating work, as the slightest slackness causes a dangerous arc. Care should therefore be taken to lead the cables to perfectly accessible positions where the terminals are under easy observation, both on the board and machines. This should be observed in the particular case of concentric feeders. It is common practice to bring the station end of the feeder into the middle branch of a T joint-box, and there connect it to two separate cables leading to terminals on the board. It is essential that all connections in the joint-box should be sweated, and no disconnecting links should be allowed there. These should be placed in full view either on or at the back of the board.

In continuous-current work, where the power is transmitted at a low voltage, the magnitude of the current involves a heavy outlay in copper. To minimise this the runs should be as straight as possible, and the cables should be kept as much to one horizontal plane as convenient. It would be found cheaper, in the case of large outputs, to insert the main machine and feeder switches in the direct horizontal line between 'bus bars and cables, and to work these switches by mechanical levers and link work from the gallery above, rather than to mount the switches on the board, thereby incurring extra expense in vertical runs. For copper cables inside a station connecting machines, battery, etc., to board, a current density of 800 amperes per square inch should be adopted; for screwed or coned contacts about 500 amperes per square inch may be allowed, while a density of 400 amperes only should be taken for planed and scraped surfaces bolted together. Leads from regulating cells in a battery-room are often made of solid copper bar. A usual plan is to bring these away vertically from the cell terminals to about 8ft. above floor level, thus allowing the attendant a clear gangway all round the cells. The bars are then bent horizontal and passed through holes in a horizontal wood beam running parallel to the line of cells, which is in its turn supported either from ground or ceiling. In this way the rods are held up and prevented from touching each other. Where possible, the rods are led to the wall immediately behind the switch gallery, and are connected either to back terminals on the regulating switch or to a terminal board built into the wall. This is to prevent any gaseous acid escaping into the switch-room. Anti-sulphuric enamel is used to cover both the rods and any wood or iron work in the battery-room. Milking leads must, of course, be flexible, and are of ordinary cable. It is found that a grey flintose rubber covering is the best protection for these. Any copper terminals or brasswork in the battery-room, if not enamelled, should be protected by cases having glass fronts and rubber ring joints to exclude the acid spray. Switch gear and instruments should be kept out of the battery-room, unless it is absolutely necessary to have them there.

The use of paint as an element of safety is occasionally overlooked by station engineers. In high-tension stations, all connections at a high voltage should be painted red. All at a lower voltage—*i.e.*, secondary connections—can with advantage be painted blue. If one side of the high-tension system is earthed, the cables on that side should be black. In a low-tension two-wire station, the negative side should be black, while the positive should be painted red. In a three-wire station the outers are red, the middle being black.

It is not overstating the case to say that the major portion of the complexity of a station (as far as the electrical part is concerned) is due to a muddled arrangement of connections. It is not enough to have all connections symmetrically arranged at the opening of the station, although this is essential. Sufficient room must be left in the design to allow for extensions. If alterations to plant are decided upon, the scheme of cable connections should be remodelled till the arrangement is simple. A temporary connection should never be allowed, in consideration of weeks of meritorious service, to become permanent. A cable festooned from pillar to post, tied up with bits of rope, is a sight more common than comely. An engineer who does not keep his cable connections simple and up to date should insist on his wireman taking out an insurance policy.

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 872, Vol. XXVI.)

Chord Windings and Other Devices to Minimise the Armature Reactions.

In May, 1897, Mr. Mordey read a paper before the Institution of Electrical Engineers, in which he made these remarks: "Consider a dynamo designed, so far as the armature is concerned, on ordinary lines, and with a field in the first place sufficient to enable the full volts to be obtained, but no current; the armature conductors being large enough to carry the full current. Such a machine might have a toothed armature, an air-gap only sufficient for clearance, and a short magnetic circuit. It would require very little excitation. Now attempt to load it: reaction sets in, and to check this the gap is increased; then we must add field winding, add length to the magnet in order to provide space for the increased winding, add section to the field magnet in order to convey the leakage magnetism which results from the increased gap, and so on, cumulatively, till finally we have increased the excitation 30 to 50 times, and made the magnet much larger (in length, in section, and in copper than when we started). Practically the whole of this increase is a direct result of armature reaction." Mr. Mordey then took as examples a 150-kw. railway generator with toothed armature, made by the General Electric Company of America, and a smooth-core Edison-Hopkinson dynamo, and showed that in the former case 88·15 per cent. and in the latter 89·8 per cent. of the field excitation was required for the gap, teeth, and compounding, all of which may be said to be required owing to armature reactions. If, then, practically 90 per cent. of the excitation is requisite only to overcome the evils due to armature reactions, the student will not wonder at the fact that much time and thought has been devoted to the discovery of windings and devices which shall minimise to any appreciable extent these reactions, and so enable a cheaper, if not more efficient, machine to be built.

In 1896 Mr. Mordey applied for a patent for certain improvements in dynamo-electric machines, the improvements being the application of a certain chord winding applied to slotted armatures, and in the May of the following year he described his improvements and the various experiments which he had made at the meeting referred to above. Although Mr. Mordey claimed this chord winding, he was not the first who had advocated this type of winding, as several years previously Mr. Swinburne had applied a chord winding to the armatures of smooth-core dynamo, and in both cases it was stated that such a winding would result in a great reduction in the value of the cross-magnetisation.

It is difficult to see how this contention can be upheld. Fig. 32 represents a view of the commutator end of a drum-wound armature with a chord winding, the winding

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being from 1 to 16 and back to 3, thence to 18 and so on, with a pitch of 17. The commutator is shown having 20 sections, and there is one complete coil (of two active inductors) per section. The ends of the inductors are marked with a cross when the current is flowing from the plane of the paper, and with a dot when it is flowing towards the plane of the paper. Suppose, now, the brushes rest upon the sections shown, and that the top brush is positive and the bottom negative, there will be two distinct paths for the current to flow along from the negative to the positive brush—viz :

(1) 38-25-40-27-2 29 4-31-6-33-8-35-10-37-12-39-14.
(2) 21-34-19 32-17-30-15 28-13-26-11-24-9-22-7-20-5-18-3.

Now, if we drop the perpendicular lines A C, B D, and examine the component magnetic exciting turns of the armature, we shall find that the belt of inductors lying between B D and A C are not affected by this short winding, and that, consequently, the cross-induction will be as strong as previously ; but in the belt of inductors lying between A B and C D we find the current is carried in opposite directions by adjacent inductors, and hence the magnetic effect is neutralised. This will, however, only directly affect the back induction, which will now be destroyed. Indirectly this may have some effect upon the cross-induction, as the field under the trailing horn will now be correspondingly strengthened. But this result can be obtained by the addition of the compounding turns upon

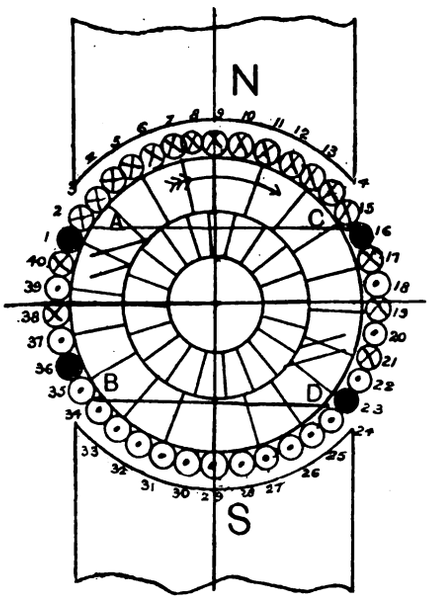

FIG. 32.

the field winding. These compounding coils are necessarily an extra expense, and the more so as with chord winding there is a slight saving in the copper of the armature coils, as the end conductors are slightly less in length ; on the other hand, this saving in copper has only been attained at the cost of considerable loss in commutating power.

Consider again Fig. 32 ; the coils 1-16-23-36 are shown without any cross or dot, as these are under the influence of the brush, and so short-circuited. Let us take the complete coil, 1-16, and deal with the two inductors separately. The current has been circulating round this in a left-handed whorl, and the inductor No. 1 has been under the influence of S pole and inductor 16 under that of a N pole, which is what is necessary ; but now the current is about to change in direction, both inductors ought to pass under the influence of the other pole. But this is not the case, and, whereas while the inductor 1 is in the correct position for commutation to take place, inductor 16 is not ; and if we assume that an inductor in the position of No. 9 will generate in unit time an E.M.F. of x volts, then inductor 16 will be in a position to generate 0·34 x volts, tending to maintain a current flowing in the left-handed whorl, and during the process of commutation this adverse E M.F. has to be overcome. Let us say that an armature revolving in the direction shown in Fig. 32 is running on its chord. If, now, the direction of rotation be reversed, the armature will be running from its chord, and matters will be quite different.

Fig. 33 shows the armature running in the opposite direction, and the brushes are shown pushed up to near the leading horns. The numbers of the coils are the same as in the previous figure, so that the brushes short-circuit the coils 1-16 and 23-36, but these coils are now shown under the opposite polar horn, which has become the leading horn. If the inductor No. 1 is in the position for sparkless commutation, the inductor No. 16 will have passed the position by the amount the chord differs from a diameter, in this case 40deg., and consequently will be in a dense field, and in this case there will be induced in this inductor, considered by itself, an E.M.F. of ·98 x volts, owing to the forward induction, and tending to generate a current in the same direction as in the coils of the series it is about to join ; and consequently as soon as the coil is short-circuited a very heavy reversed current will flow in the coil, the only obstacle to its immediately rising to its full value being the self-induction of the coil, and the strong E.M.F. induced in No. 16 will to a great extent overcome this, and there will, as we have seen when dealing with the armature reactions, be disastrous sparking. The remedy for this will be to decrease the lead of the brushes, and herein a saving will be effected ; but the adjustment will now become very fine, and a small variation in the load will necessitate an alteration in the lead.

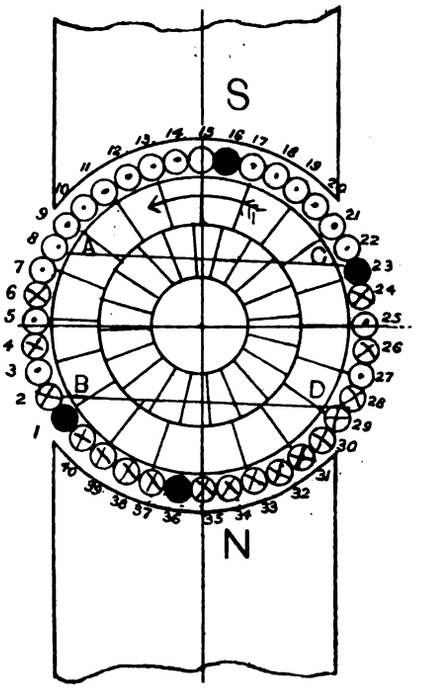

FIG. 33.

The net results, then, of the chord winding appear to be that it effects a diminution in the back induction, but does not materially alter the cross-induction ; when the armature is running on its chord an increased lead is required for the brushes ; when it is running from its chord the lead will be less. So much for the theory. The writer had the opportunity some time ago of trying a chord winding on a multipolar dynamo with a parallel-wound armature designed for a low E M.F. and a current of some 1,500 amperes ; he found that when running from its chord the lead was less than when running in the opposite direction, but that it was very sensitive to fluctuations in the output, and if the lead were not altered and the sparking allowed to continue, the commutator soon became roughed to a great extent. Upon the ordinary winding being adopted, the dynamo ran equally well in either direction. The writer has also come across some motors arranged to run in either direction which were wound with a chord winding, and which had to be taken out, owing to the fact that the sparking was excessive when running in one direction, although their behaviour was all that was desired when revolving the opposite way. The writer has seen motors with a chord

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winding which have run without undue sparking in either direction, but the probability is that they would have run better had they not been wound with a chord. The student must always remember that if at any time it is decided to try a chord winding, the chord must never be less than the arc of the polar span, and that the shorter the chord the more accentuated will be the evil effects pointed out above. When the armature is running from its chord, we have seen that the lead will be considerably less than would be the case with an ordinary type of winding, and the inductor No. 1 will probably at full load only be a very little in advance of the neutral line, and consequently only just within the fringe of the lines of force due to the leading horn. The density of these lines will

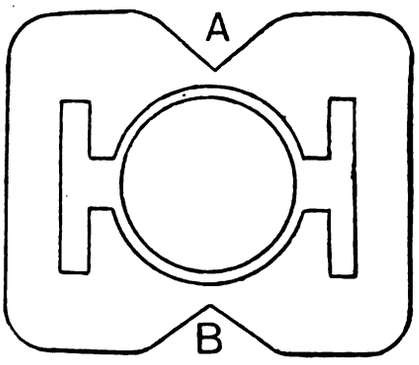

FIG. 34.

be very low, and so will be easily affected by small alterations in exciting power of either the cross ampere-turns of the armature or of the field coils, while the inductor No. 16 will be well within the polar span, and any alteration in the induction due to the cross magnetisation will have little or no effect upon it; and herein probably lies the reason for the sensitiveness of the dynamo to fluctuations in the load when running from its chord, as a very small increase in the current may so alter the disposition of the field that while inductor No. 1 was well within the fringe of the forward induction to begin with, the increase in the current has altered the induction of the leading horn to such an extent that it is now in a neutral field, while at the same time the increased current to be commutated requires that the short-circuited coil be in a *stronger*, not a weaker, field. Whereas when running on its chord neither inductor is fully within the polar span, and in so much the winding more closely approximates to that of the diametrical or ordinary type.

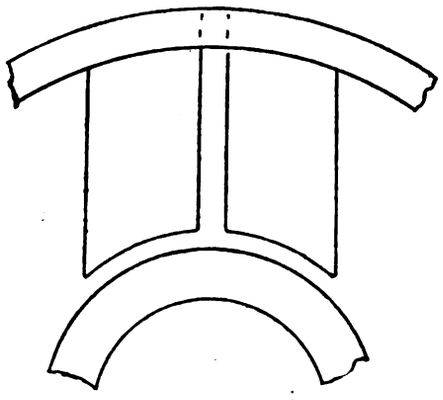

FIG. 35.

Fig. 34, which is copied from the report of Mr. Swinburne's paper on "The Theory of Armature Recreation," in vol. xix. of the *Proceedings* of the Institution of Electrical Engineers, illustrates one of the first attempts to minimise the cross-induction. It will be seen that while there is an ample path for the forward induction, the cross-induction is throttled by the cutting away of the iron of the poles at A and B; and that therefore the lines of force due to the cross-induction have all to flow through the two narrow necks, which will, if the proportions be properly adjusted, soon become saturated, when the reluctance of this path will be enormously increased for additional lines of force, and the evil effects of cross-induction will to a great extent be overcome.

With the great increase in the manufacture of multipolar dynamos, this device became more popular for checking the cross-induction. While it is desirable to increase the reluctance of the path of the cross-induction to the greatest extent, that of the forward induction must be kept as low as possible, otherwise increased excitation will be required for the forward induction. The device shown in Fig. 34 suggested that with multipolar machines, while the yoke should be cast solid, the magnets should be built up of laminated wrought-iron plates, the lamination being at right angles to the flow of the cross-induction. A great deal could be effected by this means, as we have already, when treating of the magnetic circuit, seen the increased reluctance which would be created in a magnetic circuit by reason of badly-made joints. With smooth-core armatures the point of greatest reluctance is in the long air-gap required for space in which to wind the armature coils, but when we come to slotted armatures it is necessary in order to obtain the best results to reduce the length of the gap to the smallest dimensions possible. This naturally increases the cross-induction, and it is found that with a small air-gap the lamination of the magnets is not sufficient, even though the number of laminations be greatly increased, a procedure which entails additional expense. The necessary increased reluctance was then obtained by making the yoke and magnets in one steel casting, and casting a slot down the centre of the magnets at right angles to the flow of the cross-induction, as shown in Fig. 35. Some makers continue this slot right through the yoke, only leaving sufficient metal at the two sides to support the casting; other makers only carry the slot up to the point where the magnets join the yoke. It will not do to make this slot too wide, otherwise the field is too much weakened at the centre of the polar embrace, so that little more can be obtained than naturally exists with a smooth-core armature, since the width of the slot is approximately twice that of the air-gap with a smooth core; but even to gain this amount is to minimise to a great extent the disadvantages that a slotted armature brings in its train.

(To be continued.)

ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.*

BY W. DUDDELL, WH SC., ASSOCIATE.

(Concluded from page 918, Vol. XXVI.)

The alternating current through the condenser circuit may be as large as from three to five amperes R.M.S. value, and the direct current in the main circuit also varies considerably, depending on the amount of resistance in the circuit. This condenser current is sufficient to show experiments with alternating currents which do not require much power, and is very convenient in many cases for lecture purposes, as the frequency, and any changes in it, are at once evident from the pitch of the note given out by the arc. Magnetic space telegraphy can easily be demonstrated on a small scale by using the self-induction coil as the transmitting circuit. [Experiment.] Several arcs can be used in series when more power is required in the condenser circuit than can be obtained from one arc alone. For the convenience of those who may wish to repeat these experiments I append a table of good working conditions for open and enclosed arcs. The exact figures need not be strictly adhered to, as the musical arc will work over a wide range of conditions. It may, perhaps, be well to mention that only condensers suitable for high voltages should be used, as although the P.D. arc is only 50 volts, the P.D. condenser rises to several hundred volts.

TABLE OF DATA OF MUSICAL ARCS.

Carbons both solid.	Open arc. Conradty.		Enclosed arc. Electra.
Diameter	9mm.	.....	13mm.
Arc length	1·5mm.	.....	1·0mm.
Arc current	3·5 amperes	.....	5 amperes
Resistance in series R	42 ohms	.....	about 28 ohms
Self-induction of L	$5·3 \times 10^{-3}$ h.	.....	$5·3 \times 10^{-3}$ h.
Resistance of L and leads	0·41 ohm	.....	0·41 ohm.
Capacity of condenser F	1·1 to 5·4 mf.	.....	1·1 to 5·4 mf.
R.M.S. current through condenser when capacity = 5·4 mf.	3 amperes	.....	4·5 amperes

* Paper read before the Institution of Electrical Engineers.

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Metal Electrodes Switch Contacts.—In connection with the above experiments the attempt was made to replace the carbons by metal electrodes, when I found that on trying to shunt the metal arc with a condenser it went out, no self-induction except that of the leads being used. [Experiment.] Of course, whether the arc is extinguished or not depends on the capacity used to shunt it, and on the other conditions of the circuit; thus in the present case, with a three-ampere arc between 6mm. diameter copper electrodes and a resistance in series of from 50 to 60 ohms, it was found that the arc was always extinguished when shunted with a condenser having a capacity from 0·6 to 5·4 microfarads, though with the smaller condenser 0·6 microfarad and longer arc lengths the extinguishing was not quite so certain. Condensers larger than 5·4 microfarads were not tried, though I have no doubt that they would prove even more effective. This experiment is very instructive as showing how very soon the metal arc becomes practically non-conducting after the current through it is interrupted, for if we consider that the current through the arc is reduced to zero at the instant of first connecting the condenser, and remains zero unless the arc relights, then the time required for the 0·6 microfarad condenser to charge up to $\left(1-\frac{1}{\epsilon}\right)$, or 63 per cent. of the supply voltage—*i.e.*, 126 volts—is about 1/27000 second. So that we may consider that if the current through the metal arc is interrupted for about 1/27000 second, even applying about three to four times the normal voltage*, will not cause it to relight. This is very different from the case of the arc between cored carbons, for it is well known that the current through a 10-ampere cored arc may be interrupted by opening a switch in series with it for, say, a quarter-second,

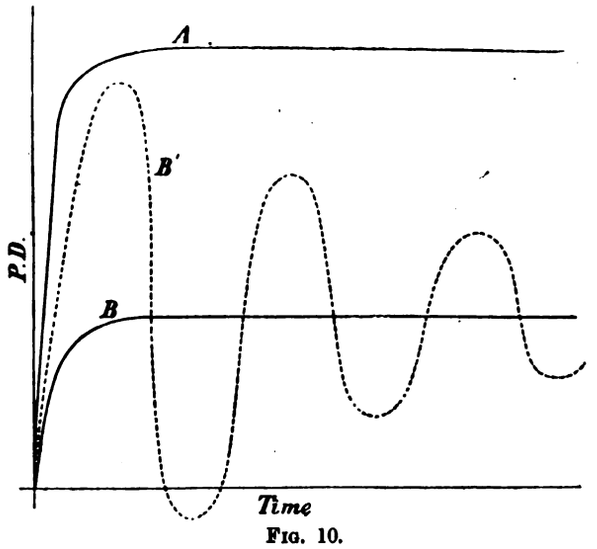

FIG. 10.

and yet the arc will relight on closing the switch again, owing to the high conductivity of the vapour left when the arc is extinguished. The comparison is, however, not quite a fair one, as it might be expected that with the larger current — viz., 10 amperes—used with the cored arc more conducting vapour would exist than with the three amperes used for the metal arc, and that it would, therefore, take longer for the vapour column of a 10-ampere arc to cool down and attain a high resistance than that of a three-ampere arc. In order to make a fair comparison, the metal electrodes were replaced by cored carbons and a three-ampere arc obtained under as nearly as possible the same conditions as the copper arc. This cored carbon arc could not be extinguished even on shunting it with the largest condenser—viz., 5·4-microfarad [Experiment] and it was found necessary, in order to make the cored arc go out on shunting, to reduce the current through it to below one ampere, but with such a small current the arc is rather unstable and liable to go out even when not disturbed in any way. Two solid carbons were also tried, and the effects were found to be intermediate between the cored arc and the metal arc, as a two-ampere solid arc could just be put out by shunting with the 5·4-microfarad condenser, whereas the three-ampere metal arc always went out on being shunted with a condenser of as small a capacity as 0·6 microfarad, as already stated. The correct method of finding out whether the arc will relight in any given case after it has been extinguished on suddenly reducing the current through it is the following: Let A (Fig. 10) be a curve which might be drawn between the P.D. which will have to be set up between the electrodes to relight the arc and the time that has elapsed since the arc was extinguished; and B the curve that connects the actual rise in P.D. between the electrodes—*i.e.*, between the condenser terminals—and the same time. Then the condition for the arc to relight is that the curve B touches or cuts the curve A. Unfortunately, we do not know much about the curve A between P.D. required to relight the arc and time except that it starts from the P.D. at which the arc was burning at the instant it was extinguished, and attains a final constant value equal to the P.D. required to spark across between the electrodes. We can, however, form some idea of the steepness of the curve A at the commencement, for we know that, if the arc fails to relight, the curve A lies between the ordinate at the time of connecting the condenser and the curve B—that is, the ordinate at time nought. The shape of this latter curve, which represents the P.D. between the terminals of the condenser during charge, can be calculated from the known data of the circuit. Thus, with the copper arc mentioned above, which is just extinguished by shunting with a condenser of 0·6 microfarad capacity, E.M.F. in circuit being 200 volts, resistance 56 ohms, and self-induction of leads neglected, the curve B will start with an initial steepness of about 6×10^6 volts per second. In spite of this very rapid rise of curve B, it will generally fail to intersect the curve A for the three-ampere copper arc, so that the apparent resistance of the copper arc seems to increase at a very high rate after the current through it is stopped. With cored carbon electrodes the arc under similar conditions could not be extinguished by shunting with 5·4 microfarads, so that since the initial steepness of the curve B was one-ninth, or about 7×10^6 volts per second, this curve always intersected the curve A for cored carbons. Further, I think that the curves would still intersect—that is, the cored arc would relight if the initial steepness of B had been even many times smaller—so that the rate of increase of apparent resistance of the cored arc after interruption of the current is many times smaller than with the copper arc. In what has been said above, I have neglected the unknown self-induction of the leads, so that the figures given must be considered as only rough approximations. The extreme rapidity with which it is necessary to increase the P.D. between the terminals of the metal

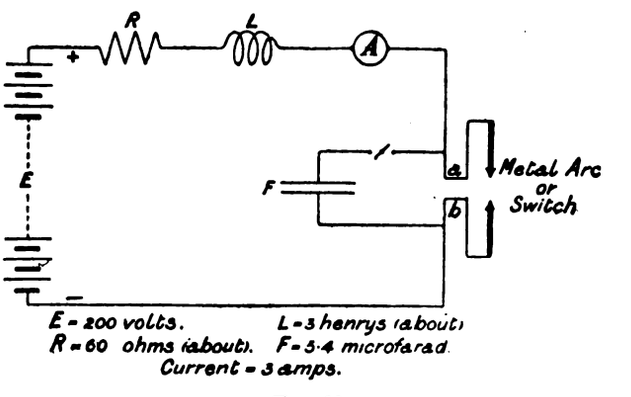

FIG. 11.

arc in order that it may relight again after the current through it has been stopped, explains the fact that it seems impossible to maintain an alternate-current arc between metal electrodes at ordinary frequencies and P.D.'s of even several hundred volts; and that it requires a P.D. as high as 2,000 volts to maintain a metal arc as found by Herr Arons. If the non-inductive resistance in series with the arc be replaced by a highly inductive one, as shown in Fig. 11, the curve B will be altered in shape, and with the conditions inserted under Fig. 11 the charge of the condenser will be oscillatory (as shown by B', Fig. 10), the maximum P.D. attained, if the arc fails to relight at all, being many times as high as the E.M.F. of the source of supply. Although the arc is put out on shunting with a condenser, it does not follow that it may not have really relit and gone out again several times, corresponding with each swing of the condenser, before it is finally left extinguished owing to the dying away of the oscillations; and this is probably what occurs when the curve A is not very steep, as in the case of cored carbons. In this case the maximum rise in P.D. will be limited by the shape of the curve A and by the amplitude of the oscillations being rapidly damped, due to conduction through the arc. This high rise in P.D.—caused by the sudden annulling of the current through the self-induction when the metal arc is extinguished on shunting it with a condenser—is very serious, as the following experiment shows. A three-ampere arc between two copper electrodes 6mm. diameter, the conditions of the circuit being those given under Fig. 10, was shunted with a condenser 5·4 microfarads capacity. This caused the arc to go out and so high a rise in P.D. to be produced that the insulation of the leads broke down, a spark passing from *a* to *b*, accompanied by a report. [Experiment.] When, however, I substituted carbons for the copper electrodes, no report was heard, nor was any serious rise in P.D. noticed.

* Direct-current metal arcs as above usually require a P.D. roughly about 30 volts.

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[Experiment.] The next experiment tried was to connect the condenser permanently as a shunt to the metal electrodes, and then to attempt to strike the arc, the circuit being arranged as in Fig. 11. I found that it was impossible to strike an arc between metal (Cu., Fe., Al., and Brass) electrodes if the capacity of the condenser, F (Fig. 11) exceeded 0·1 microfarad—even although an E.M.F. of 2,000 volts was used—and that on separating the electrodes the sudden interruption of the current through the self-induction set up oscillations in the circuit and a high rise in P.D. between the terminals of the condenser similar to that produced when the metal arc was extinguished by shunting with a condenser, as explained above. The condition that determines the possibility of striking the arc is similar to the condition that governs the relighting of the arc after the current through it has been reduced to zero, as explained above. For corresponding with each position of the electrodes as they separate there is a certain P.D. required to start the arc, and if the relation between the position of the electrodes and time be known, then a curve between P.D. required to start the arc and time can be plotted similar to curve A, Fig. 10 above, and the intersection or otherwise of this curve with the curve B determines whether the arc will strike or not. The practical interest in this subject of the striking of the arc lies in the fact that when the attempt is made to interrupt a steady direct current flowing through an inductive circuit by means of a switch with metal contacts, an attempt is really made at the first instant to strike a metal arc between the contacts, and if these contacts be shunted by a condenser which prevents the arc from forming, a high rise in P.D. will occur. If, however, the arc was allowed to form, the time during which the break takes place would be lengthened, and no such great rise of P.D. would be produced. This rise in P.D. has been mathematically investigated by Mr. Johnson on the assumption that the arc does not form, and putting the data given under Fig. 11 into his equation, I find that the rise in P.D. is just over 2,000 volts as compared with 200 volts, the E.M.F. in the circuit. It is therefore of importance, when it is required to prevent these rises in P.D., on breaking the circuit to so choose the substance of the switch contacts that the arc shall not be prevented from forming or be suddenly extinguished by the action of the condenser—that is to say, that arcing at the switch contacts should rather be encouraged than otherwise—of course, always supposing that no special method such as a non-inductive resistance shunting the switch be provided to dissipate the energy stored in the self-induction. The following experiments illustrate the importance of the nature of the switch contacts and of the condenser which shunts them. The circuit used was that shown in Fig. 11, the arc being replaced by a switch with brass contacts, and the data of the circuit being those given below the figure. When the condenser, F, was disconnected, and the insulation between a and b was made to consist of a single thickness of paper, I found that the circuit might be made and broken by means of the switch, either quickly or slowly, without the paper between a and b being pierced. [Experiment.] After reconnecting the condenser, F, however, every time the switch was opened the paper was pierced, and even three thicknesses of the paper could not withstand the rise in P.D. that occurred. [Experiment.] The steady P.D. required to pierce one thickness of the paper was found by a separate experiment to be about 550 volts, and that required to pierce three thicknesses about 1,500 volts, so that without the condenser shunting the switch the rise in P.D. on breaking the inductive circuit was under 500 volts, but with the condenser as a shunt to the switch was over 1,500 volts, showing that the metal arc must have been almost completely suppressed, as the maximum value of the P.D. calculated above on the assumption of no arc forming at all was only just over 2,000 volts. The influence of the nature of the contacts of the switch on the rise in P.D. which occurs when the switch is shunted by a condenser is very marked; thus with the metals copper and brass, serious rises in P.D. were always found to occur, with solid carbons as contacts the rise was much less, and with cored-carbon contacts was inappreciable. [Experiment.] Breaking the circuit between metal contacts under tap water, or shunting the metal contacts while in air by wires dipping into water, also prevented any serious rise in P.D. It was also found that resistance or self-induction introduced into the connections between the condenser and the contacts greatly reduced the rise in P.D. on opening the switch. I attempted to use an electrostatic voltmeter to measure the rise in P.D. instead of the rough method of the piercing of paper, but although the voltmeter was sufficiently sensitive to read steady P.D.'s much below that required to pierce the paper, it failed to indicate the rises in P.D. This is probably due to the short time the rise in P.D. lasts. There are two practical cases in which capacity shunts the switch contacts to which I will refer. The first is the ordinary induction coil, in which the circuit is the same as Fig. 11, the switch being replaced by the contact maker. In this case a high rise in P.D. is required, so that the nature of the contact points should be such that the arc can be completely extinguished by as small a condenser as possible; for the rise in P.D., if the arc is completely extinguished, will be the higher the smaller the capacity of the condenser. It is evident, therefore, that carbon would be very unsuitable for the contacts of an induction coil. This has lately been shown to be the case by the experiments of Mr. Beattie, who finds that with a slow break the maximum length of spark obtainable between the terminals of the secondary, using platinum contacts, is nearly 2½ times that obtainable when carbon contacts are used, the current interrupted at the break being the same in both cases. I think that if cored carbons had been used, a much greater disparity in the spark length would have been found. [Experiment.] The second case is that of a switch or circuit breaker connected with a concentric cable so that the capacity shunting the contacts is supplied by the distributed capacity of the cable. Whether this distributed capacity in practical cases will have the same effect as a condenser shunting the contacts, as suggested by Mr. Johnson, is, I think, a matter for further experiment. If it has, then serious rises in P.D. are to be apprehended on interrupting a direct current, though an inductive circuit, by means of metal contacts, the capacity of the cable forming a shunt to the contacts. Assuming this to be true for direct currents, may not some of the breakdowns of concentric cables supplying power by means of alternating current be also due to the sudden quenching of the arc at metal contacts, and not to the fact that the current is an alternating one? I suppose, of course, that the attempt to interrupt the current is made at some point in the period when the current is large.

Before concluding this paper, I wish to express my indebtedness to Prof. Ayrton and Mr. Mather, of the Central Technical College, not only for allowing me to carry out the experiments in the laboratories of the college, but also for the valuable assistance and advice they have given me during the course of the experiments. I also wish to express my thanks to the many students who have helped me from time to time, and especially to Messrs. Brown, Watson, and Fithian.

Conclusions.

If the current be suddenly increased through a direct-current arc between two solid carbons, the P.D. and current increase together for less than about 1/5000 second, and at the end of this very short time the P.D. decreases with an increase of current in the ordinary way.

If the current through a direct-current arc varies by as little as 3 per cent. from the mean, and if the frequency of these superimposed variations is even as high as 4,300 $\sim$ per second, a variation in the light emitted by both the + crater and the vapour column can be detected.

A rapid periodic variation of the order of 1 part in 10,000 from the mean current will alter the vapour column of the arc sufficiently to produce sound-waves; and a variation of 1 part in 100 will produce sound-waves even at frequencies as high as 30,000 $\sim$ per second.

The arc is affected by such small changes of outside conditions as sound-waves produce.

The direct-current arc can be used both as a telephone receiver and transmitter.

In the direct-current humming arc the P.D., current, and light emitted vary periodically, the frequency of these variations being the same as that of the rotation of the arc as a whole, and of the pitch of the sound emitted.

In the direct-current hissing arc the P.D., current, and light emitted vary very irregularly, the larger and slower variations corresponding with a rotation of the arc as a whole, and the smaller and more rapid to the hissing proper—*i.e.*, the oxygen of the air obtaining access to the crater surface, as demonstrated by Mrs. Ayrton.

Under certain conditions the direct-current solid arc will emit a musical note when shunted by a self-induction in series with a condenser.

When emitting the musical note the direct-current arc transforms direct-current energy into alternate-current energy, the frequency of the latter being determined by the self-induction, capacity, and effective resistance of the oscillating circuit. The pitch of the note emitted may be used as a means of comparing self-inductions and capacities.

If a direct-current arc be shunted with a condenser of several microfarads capacity, the arc will generally be extinguished if the electrodes are of metal, and not if they are of cored carbon, the resistance in series with the arc being non-inductive.

If the resistance in series with the arc be highly inductive, then, when the metal arc is extinguished by shunting it with a condenser, a violent rise in P.D. occurs between the terminals of the arc.

The rise in P.D. that occurs when an inductive circuit is broken by means of a switch, the contacts of which are shunted by a condenser, is much higher if their contacts are of metal than if they are of cored carbons, owing to the condenser extinguishing the metal arc formed at the contacts more

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suddenly than the arc formed when carbon contacts are separated.

Appendix I.

On the Resistance of the Cores of Cored Carbons.

I do not remember having seen it pointed out that the much greater stability of arcs between cored carbons than of those between solid carbons cannot be very well due to the high conductivity of the material of the core, while in place in the carbon, for the cores have generally a higher specific resistance than the solid carbon which surrounds them, as the following experiment shows: Three carbons were taken—two cored and one solid—of the same nominal diameter (11mm.), and a current of 9·9 amperes was passed through them. The drop of volts was measured along a length of 20cm. of each after they had attained a steady temperature. Each of the three carbons then had a hole 3·16mm. diameter drilled through it so as to completely remove the cores of the cored carbons and the centre of the solid carbon, and the drop of volts was remeasured as before. The results are given in the table below, from which it appears that drilling a hole in the solid carbon increased its resistance 7·8 per cent., whereas drilling the same sized hole (which removed the core and a small amount of the solid carbon) in a cored carbon of the same make only increased its resistance by 2·1 per cent. Allowing for the fact that a small quantity of solid carbon was removed along with the core in drilling, the specific resistance of the core, of one make of cored carbon, was about 16 times that of the surrounding solid carbon, and in the other the specific resistance of the core was practically infinite.

Make of carbons.	Apostle solid.	Apostle cored.	Brush cored.
	mm.	mm.	mm.
Mean diameter	10·97	10·95	10·70
Mean diameter of core	—	2·84	2·82
Drop of volts along 20cm. before drilling	1·71	1·74	1·52
Drop of volts along 20cm. after drilling	1·84	1·77	1·56
Per cent. increase of resistance due to drilling	7·8	2·1	2·4
Ratio $\frac{\text{Specific resistance of core}}{\text{Specific resistance of surrounding solid carbon.}}$	about	∞	16

Appendix II.

On the Conditions which Govern the Conversion of Direct Current into Alternating Current in the Musical Arc. (See Fig. 9.)

Let E and C be the E.M.F. and current through the cells, when there is no oscillatory current through the condenser circuit.

Let V and A be the P.D. and current through the arc under the same conditions.

Let R be the resistance in series with the arc, including that of the cells.

Let r be the resistance of the condenser circuit.

Let δV be a small change in the P.D. arc which produces a current δi through the condenser circuit for a time δt, and let δV, and consequently δi, be assumed to change sign at the end of each interval of time δt.

Let δA and δC be the corresponding changes in A and C, E being assumed constant.

The energy supplied to the condenser circuit—

during one interval $\delta t = (V + \delta V)(+\delta i)\,\delta t$,

,, next ,, $\delta t = (V - \delta V)(-\delta i)\,\delta t$.

Total during one complete period $2\,\delta t = 2\,\delta i\,\delta V\,\delta t$.

Energy dissipated in ohmic losses during $2\,\delta t = r(\delta i)^2\,2\,\delta t$.

In order that, during each complex period $2\,\delta t$ energy may be supplied to the condenser circuit, we must have

$$\delta i\,\delta V \text{ positive.}$$

And in order that this supply shall make up for the ohmic losses, we must have

$$\delta i\,\delta V > r(\delta i)^2.$$

Now,
$$\delta i = -\delta C = -\delta A$$

and
$$C = \frac{E - V}{R}$$

$$\therefore C\,\delta = \frac{-\delta V}{R}$$

and
$$\delta i = -\frac{\delta V}{R} - \delta A = -\left(\frac{1}{R} + \frac{\delta A}{\delta V}\right)\delta V$$

$$\delta i\,\delta V = -\left(\frac{1}{R} + \frac{\delta A}{\delta V}\right)(\delta V)^2$$

$\therefore$ for a supply of energy to condenser circuit $\frac{\delta V}{\delta A}$ must be negative and numerically less than R.

Supposing $\frac{\delta V}{\delta A}$ negative, then in practice the second condition is always fulfilled, or $\frac{\delta V}{\delta A} + R$ would be negative and the whole circuit unstable.

Next, the condition that sufficient energy be supplied to make up for the ohmic losses gives

$$\delta i\,\delta V > r(\delta i)^2$$

and as $\delta i\,\delta V$ is positive,

$$r\frac{\delta i}{\delta V} < 1$$

$$-r\left(\frac{1}{R} + \frac{\delta A}{\delta V}\right) < 1$$

$\therefore$ to obtain best supply of energy to condenser circuit we require R very large and r very small.

Suppose $\frac{1}{R}$ may be neglected compared with $\frac{\delta A}{\delta V}$, then condition becomes

$$-\frac{\delta V}{\delta A} > r.$$

Thus it is possible if $\frac{\delta V}{\delta A}$ is negative and numerically greater than r, for the condenser circuit to receive sufficient energy during each very small complete oscillation to compensate for the energy dissipated in ohmic losses during the oscillation. For larger oscillations, similar but more complicated expressions will probably be required.

CATALOGUES.

The Electrical Company, Limited, are now issuing a list of 24 pages entirely devoted to switches, wall sockets, and connecting plugs. We are particularly struck with the number of standard types which this firm has of switches for electric lighting installations. The most of these are of the Royal type, and they are constructed for wood casing and armoured casing, low voltage and high voltage, and for indoor use and outdoor use in almost innumerable forms. The design of the switch makes it easily applicable to either one way, two-way, or three-way switching. The switch is manufactured for voltages as high as 1,000, while the more usual type finds application on circuits up to 550 volts, and is specially applicable to tramway working. The Royal switch, as adopted for outdoor use, is completely encased in a porcelain covering, so that it can be mounted on the wooden poles of an overhead system of distribution. The other accessories in the catalogue show evidence of careful design, and the customers of the firm will find the diagrams of connections, which are given at the end of the list, of great service when connecting up the switch gear for particular purposes.

The British Thomson-Houston Company, Limited, have sent us their pamphlet No. 82, which is a well-illustrated description of the electric tramways they have laid down at Sheffield.

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FORTHCOMING EVENTS.

Tuesday, Jan. 8.

Royal Institution of Great Britain.—At 3 p.m., lecture on "The Shooting Stars," by Sir Robert Ball.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers for discussion are: "Glasgow Bridge," by Mr. Benjamin Hall Blyth, M.A; "Railway Bridge over the Fitzroy River, at Rockhampton, Queensland," by Mr. Walter James Doak, B.E.; and "The Niagara Falls and Clifton Steel Arch Bridge," by Mr. Leffert Lefferts Buck.

Wednesday, Jan. 9.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., ordinary general meeting. Paper on "The Utilisation of Water Power for Electrical Purposes," by Mr. R. Fredk. Yorke, illustrated by models.

Society of Arts.—Juvenile afternoon lecture by Mr. E. Walter Maunder, superintendent of the Solar Department, Greenwich Observatory, on "Eclipses."

Thursday, Jan. 10.

Institution of Electrical Engineers.—At 8 p.m., ordinary general meeting. Paper on "Capacity in Alternate-Current Working," by Mr. W. M. Mordey; and if time permit, "The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure," by Mr. John B. C. Kershaw, F.I.C.

Friday, Jan. 11.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Address by Mr. Wilfrid Airy, B.A., on "Geodesy."

Saturday, Jan. 12.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., "The Education of a Shipbuilder," by Prof. J. Harrard Biles.

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THEN.

Those who have dived deeply into the literature of any particular subject will have noticed how persistent through long years are phrases and paragraphs. Up to a score or so years ago text-books on electricity were merely new editions of what had gone before; whole sentences—nay, whole pages remained practically the same in words and in position through a century of writers. During the past twenty years we have had a new electrical literature. It may be interesting to consider briefly the state of the subject at the beginning of the last century, and every reader can then make a comparison with the state at its close. The words used by Cavallo in 1782 are as true now as then. After a reference to the discovery of the Leyden jar, he says: "Discoveries crowded upon discoveries, improvements upon improvements, and the science ever since that time went on with so rapid a course, and is now spreading so amazingly fast, that it seems as if the subject would soon be exhausted, and electricians arrive at an end of their researches; but, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving his attention, and promising further discoveries, perhaps equal or more important than those already made." Cavallo's knowledge was confined to static electricity. There were cylindrical and plate machines, Leyden jars and vacuum tubes, and a few modest phenomena therefrom. There seemed to be no idea of pressure or potential, or circuits or lines of force. The magnetic phenomenon accompanying the electric was for the future. That the rapidity of conduction varied was known, but Ohm had not promulgated his law, and practical instruments of measurement were unknown. Grey had experimented, but telegraphy was for another century. The knowledge about electric light was confined to phenomena of static machines and vacuum tubes. The new century was quite early to see imported among the tools of the electrician modest pieces of carbon. There is not one single example of even approximate measurement in any of the books of the eighteenth century we have seen. Yet Cavallo was amazed at what was known. No doubt in pamphlets and in papers before learned societies were foreshadowed the views published by Walker in his "Familiar Philosophy" in 1799. He had real ideas about the magnetic circuit and magnetic flux, as also about electric circuits, for much experimental work had been done between 1782, the time of Cavalls, and 1799, the time of Walker. At the latter period men had come to recognise that signals were possible through miles of wire conductor. Walker came to the conclusion: "We cannot judge of electric motion by its shocks, but by its progress through very long conducting substances." He was right in this, but wrong when he argued that electricity had weight. Of electricity he says: "Though, Proteus-like, it eludes our grasp, plays with our curiosity, tempts enquiry by fallacious appearances, and attacks our weakness under so many per-

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plexing subtleties, yet it is impossible not to believe it the soul of the material world, and the paragon of elements." Galvani made his classic experiment with the frog in 1791, and the ensuing controversy as to causes led to Volta's discovery of the pile and battery. But, although the experiments were commenced at that time, the real results and applications belong to the last century. And what was there commercial in applied electricity at the beginning of the nineteenth century? The lightning conductor, due to Franklin—that was all. The difference between "then" and "now," the wonderful advances during the past century, may be indicated by asking a similar question: What is there commercially practical at the end of the nineteenth century? Surely it must by the historian be termed the electrical age. It began with practically nothing electrical; it ends with practically everything.

THE FORTHCOMING EXHIBITION IN DUSSELDORF.

Very little information is available with regard to the engineering exhibition which is to be held in Düsseldorf, but we understand that preparations in connection therewith have been progressing steadily for some time past. The space to be devoted to the purpose of the exhibition is a large tract of partly reclaimed ground. An enormous quantity of material has been transferred from one bank of the Rhine to the other in the course of the river-diverting and channel-deepening operations which have been going on in the locality, and this material has served incidentally to transform what was formerly little better than a vast swamp into a dry, level site eminently adapted for the purposes of the exhibition. As regards the exhibition itself, an attempt will be made to give it an educational value far surpassing anything hitherto attempted. Not only will the finished article be shown, but also its several stages of manufacture, commencing with the raw material. We understand that the manufacture and treatment on the spot of heavy armour-plates and guns will be included as one of the attractions of the exhibition. This is certainly a large order, and would, of course, involve a heavy outlay of capital; but the show being exclusively German, no opportunity is likely to be lost of demonstrating to the world the immense resources of German industry. Having regard to the above-mentioned promised educational value, coupled with the garden-like attributes of Düsseldorf itself, it needs no prophet to foretell a probable success for the exhibition.

YOUNG MEN.

This is not a sermon from a Young Men's Christian Association, but a criticism of a most misleading article in the *Times*. During last year the *Times* published a series of articles upon "American Engineering Progress." These articles deservedly received great attention. They were conceived in a broad spirit. The information was largely first hand and carefully considered, though the conclusions did not always commend themselves to those best acquainted with the matter in this country. At the close of the year two supplementary articles appeared, the second of which dealt with "Educational Influences." In it the author has, in our opinion, gone completely astray. Because engineering progress in the States has been rapid, and because most of the concerns are managed by young men, he infers that the young men are the cause of the progress. They are a result, not a cause; and if the critic lives another twenty years, he will find the average age of managers increased. It might be put as an axiom that all new and progressive industries are managed by young men. How about the electrical industry in this country? It is a new industry, and practically all concerned in it are young men. No doubt in the near future Australia will develop an engineering industry, and the work will naturally be in the hands of young men. The mining industry of the Rand; of Rhodesia is in the hands of young men. Education has little or nothing to do with the matter, and, as for that, Britain has contributed its proportion of youngsters who control important undertakings throughout the world—a good many even to America. The American engineering progress is due to a variety of causes. That it is controlled by young men is due to the fact that it is a young industry. The *Times* writer might have referred to Russia as well as China, but neither analogy would hold good. He might also have enquired how many of these young men were British-born or within one generation of being British-born, and then, perhaps, he would have held a different view as to the British parents' ways in bringing up children. If his reasoning was correct, or even approximately correct, then there ought to be a retiring age for all, even the most successful business men. Without entering into the hundred and one causes, natural and otherwise, that have made the American nation what it is, surely it must have struck any enquirer that the men who have emigrated from Britain, Germany, Scandinavia, Italy, etc., are really picked men, men of a go-ahead type; and if there is anything in heredity, their children will be go-ahead too, and will be educated by their parents somewhat differently than if they had remained in their own native land. We also believe in young men, but we also believe in experience, and have not so little faith in the human products of Great Britain as to imagine they are inferior to any other race under the sun.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE DENSITY FACTOR.

SIR,—In my paper on the "Development of the Density Factor" forwarded to you, I stated that Aberdeen sold only 7·8 units per annum per £1 worth of main laid. I now find that the units given in "Garcke's Manual" as consumed during the year 1899, are for seven months only. While not able to give exact figures, I gather from later published results that Aberdeen really sells over 20

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units per annum per £1 worth of mains laid. I deeply regret the mistake, and will be much obliged if you will kindly make the correction known.—Yours, etc.,

North Shields, Dec. 29, 1900. C. TURNBULL.

THE LATE LORD ARMSTRONG.

In our last issue we briefly announced the death of Lord Armstrong, which took place on Dec. 27 at the great age of 90. Wm. George Armstrong was the son of a prominent merchant of Newcastle-on-Tyne, and was born on Nov. 26, 1810. After a liberal education he was articled to a lawyer in Newcastle, and spent the first 10 years of his professional life in the pursuit of law. His mechanical and scientific tastes, however, were so great that even during this time a considerable portion of his energies were devoted to the investigation of scientific problems. Amongst the first of his notable discoveries was that of the electrification caused in the surrounding air by a jet of steam issuing from a boiler. This phenomenon was discovered and investigated by the late Lord Armstrong in the thirties, and the full description was first published in 1840. Acting on the information found by experiment, a number of hydro-electric machines were built, which formed the most powerful means of generating electricity then known. In order to work successfully, the steam-boiler had to be insulated from the ground, and particular shapes had to be given to the nozzles through which the steam escaped. In these experiments Faraday took a large interest. The next subject which was taken up by the then Mr Armstrong was that of hydraulic engineering. He was first struck, while on a fishing expedition, with the great waste of energy which occurred in the ordinary water-wheel. He then experimented with an hydraulic engine, which was not particularly successful, but this induced him to investigate the applicability of an ordinary cylinder and piston with high-pressure water supply. Having a certain amount of connection with the water authorities in Newcastle-on-Tyne, he succeeded in constructing for use on the town mains the first hydraulic crane. This was placed on the quay side, where it attracted the attention of a large number of engineers. Among those who inspected this soon after it was erected was Mr. Jesse Hartley, of Liverpool, who immediately recommended its adoption at the Albert Dock. The early hydraulic machinery constructed by Armstrong up to 1849 was all worked off town water supply. Applications for the use of hydraulic cranes in places where the water pressure on the mains was not sufficiently high to enable cranes to be constructed economically, led to the development of special systems of hydraulic mains being laid and provided with artificial heads. Air reservoirs were first tried to give the required pressure, combined with a certain amount of storage, but these were soon abandoned in favour of the hydraulic accumulator, which is always used in connection with such work at the present time. The first hydraulic machinery designed by Lord Armstrong was made in some small works which have since developed into the tremendous series of factories now existing at Elswick. The business soon required all the attention of Lord Armstrong, and he consequently gave up his connection with the law. The next subject to which Lord Armstrong devoted his attention was the design of guns, and he may justly be considered as the father of the artillery in use at the present time throughout the world. Up to 1854 there had been few attempts made to strengthen guns in order to enable high muzzle velocity of projectiles to be obtained. He recognised that the ordinary methods of casting guns, or of constructing them out of wrought-iron bars bound together, as had been done, was utterly inadequate when heavy charges of powder had to be used. The first guns made at his works were accordingly strengthened by having rings of iron shrunk on while hot over an inside rifled tube. In this way this tube was, under the ordinary conditions, in compression, and by accurately adjusting the diameters of the various rings a gun was obtained in which all the metal was active in resisting the explosive force when the gun was fired. The whole of the patents for the construction of these guns were given by Lord Armstrong to the country, and he was in 1859 appointed engineer to the War Office, having the rifled ordnance under his special charge. In 1863, however, he resigned this position in order to devote his energies to the development of the firm, into which Captain Noble had then been taken as a partner. We do not propose here to go into the further extensions of this firm, which has been so eminently successful in supplying our own Government and also the governments of other countries with war stores. We prefer to restrict ourselves to the electrical work which Lord Armstrong again took up when, owing to age, he was unable to continue to take such an active part in the control of the large firm with which his name was associated. The experimental work on electricity was carried out in a laboratory constructed by him in his house at Rothbury. An account of the experimental work done there will be found in a book published by him in 1897, entitled "Electric Movement in Air and Water, with Theoretical Inferences." At that time we reviewed the volume in question, which is worthy of the most careful study by all experimenters. In his work he took up experiments which he had commenced in his early career, but had to leave on one side owing to commercial interests. Amongst these was the experiment of having "two wine-glasses filled to the brim with chemically pure water and connecting them by a cotton thread coiled up in one glass, and having its shorter end dipped into the other. The two glasses were joined up to the electric machine, the one containing the coil of thread by a negative wire, and the other by a positive connection. On putting the machine into full action the coiled thread was rapidly drawn out of the negative vessel and deposited in the positive one, leaving for a few moments a rope of water about 3in. in length suspended between the lips of the two glasses.'

This experiment, the author contended, was "strong evidence of two currents flowing simultaneously in opposite directions, the negative being inside the positive." His own summary of the points which he wished to bring forward as the results of experiments are as follows: "(1) An intelligent explanation of the water and cotton experiment has been offered and its teaching indicated; (2) the duality of electricity, apart from quantitative distinction, has been shown to consist largely, if not wholly, in difference of direction, the motion being in the one case outward and forward, and in the other inward and backward, as in the smoke ring; (3) the consolidation of brush lines into main channels of conduction, and the mode in which they coalesce have been clearly illustrated; (4) pictorial illustrations have been exhibited showing electric configuration in various phases, and the persistency of pattern independent of magnitude has been exemplified; (5) the double composition of conducting lines has been displayed by fracture; (6) novel effects due to oscillation and secondary action, as well as to modification of induction, have been exhibited; (7) magnetic or quasi-magnetic effects on common dust have been shown; (8) examples have been presented of the remarkable correspondence between some electric figures and living organised forms."

Although always a busy man, Lord Armstrong took a large interest in scientific and engineering societies, both connected with the Newcastle district and throughout the kingdom. Thus he was president of the British Association in 1863, president of the Institute of Civil Engineers in 1882, and thrice president of the Institute of Mechanical Engineers. He was an hon. LL.D. of Cambridge and hon. D.C.L. of Oxford. An original member of the Iron and Steel Institute, he was in 1891 awarded the Bessemer medal by that body, and the large number of foreign decorations which were bestowed upon him attested the reputation which his work won for him abroad.

The success as an engineer was due not only to the great originality displayed in his inventions, but also to the care with which he worked out the details of the same. The commercial success of the firm was due to the latter cause. It is a curious fact that Lord Armstrong, although an inventor, was a strong opponent to the

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English patent law. Thus while developing the Armstrong gun he conceived, with Sir I. K. Brunel, the idea of constructing a wire gun much on the same lines as they are constructed to-day. It was then found that the idea had been patented by two engineers, and in consequence the matter was dropped. In other words, the firm who was best capable of developing the invention was debarred from so doing, and the perfection of wire guns was retarded for a large number of years. Lord Armstrong urged that the enormous number of patents which were taken out prevented rather than aided progress. His remedy was to abolish the system, although he admitted that certain classes of invention ought to be made subject to royalties to their originators. In Lord Armstrong England loses one of her foremost engineers, and Newcastle-on-Tyne its most prominent citizen.

GROUP-DRIVEN LATHES WITH ELECTRO-MAGNETIC COUPLINGS

The following is an abstract of an article contributed by Mr. J. Löwy to the *Zeitschrift für Elektrotechnik*

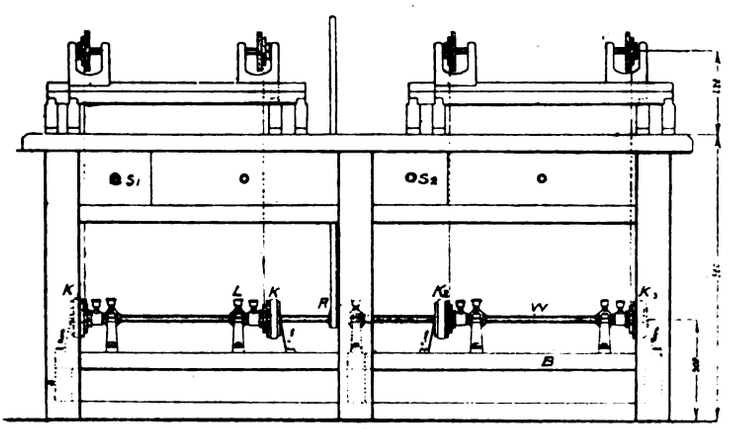

FIG. 1

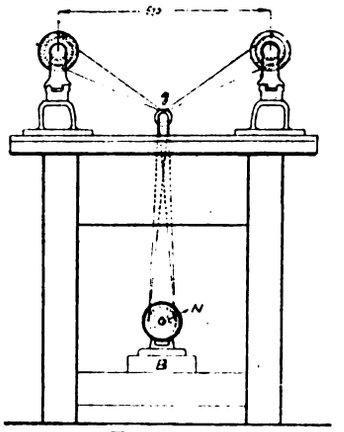

FIG. 3.

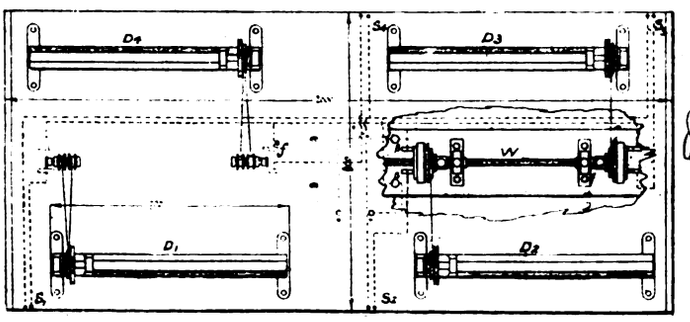

FIG. 2.

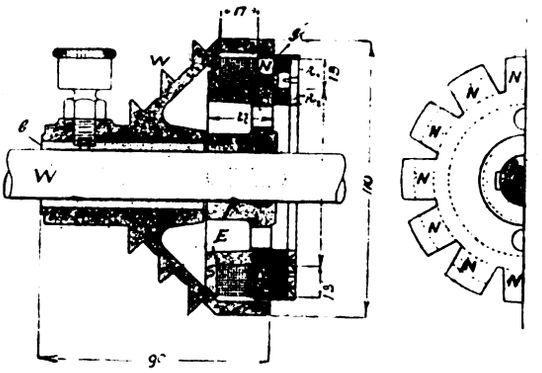

FIG 4.

Having regard to the importance attaching to electricity as a motive power in modern workshops, it may not be without interest to describe an arrangement of lathes which seems especially adapted for engineering works. With respect to the installation described herewith, it was a question of adopting the most compact arrangement possible for four small automatic turning lathes, it being desired at the same time to provide a quick and convenient means whereby the individual lathes could be stopped or started without complicated switching apparatus The problem was solved in the following manner:

The four lathes were mounted on a table as shown in Figs. 1, 2, and 3. Upon the board, B, a shaft, W, is mounted as shown. This shaft is driven from connter-shafting by means of a belt running on the pulley, R; but there is nothing to prevent the lathes being driven by means of a shunt-wound motor if desired, which might be mounted on the board, B, and direct coupled to the shaft, W, the motor, of course, being so designed as to maintain constant speed irrespective of the switching in or out of individual lathes. To the shaft, W, are attached four electromagnetic clutches, K, each arranged as shown in Fig. 4. It will be seen that the electromagnet, E, is keyed to the shaft, W. The winding of this magnet consists of 0·2mm. copper wire. The magnet has 24 poles, marked N and S, and the necessary exciting current is conveyed to its exciting coil in the manner described below. The cast-iron core, E, carries a vulcanite ring, I, to which two contact rings, r_1 r_2, are attached, and on which the two contact springs, *f*, which are connected with an electric circuit, bear as shown in Figs. 1 and 2. The other part of the coupling—namely, that corresponding to the stepped pulley on the lathe—is the pulley, *w*, which is seated on the bush, *b*, with which it is both free to rotate and to move in an axial direction. When the electro-magnet, E, is excited it strongly attracts the pulley, *w*, which arranges itself with its inclined inner surface against the correspondingly bevelled surfaces of the poles, S, whereby it is clutched by the constantly revolving portion, E, and carried round by it. Each exciting coil possesses, inclusive of the contact resistance between the contact springs and slip rings, a resistance of about 430 ohms. After each coil has been brought up to its full working potential, about 85 volts, each coupling takes about 0·2 of an ampere. The attracting force of the electromagnet, E, acting on the pulley, *w*, is so great that the lathe works well on all loads. The method of conveying current to the couplings is shown in Fig. 2. The conducting wires enter below the table from the engine-room through the floor in the workshop, whence they are taken to the points on the board, B, marked + and −. The two wires then go through two fuses, β, to two conductors, which run the length of the board, B, and to which the branch wires connecting to the contact springs are attached. These branch wires are also connected to the switches, *s*, by means of which each lathe may be separately switched in or out. The extreme compactness of the arrangement described will be appreciated.

THE MAGNETIC OBSERVATORY QUESTION.

We have frequently referred in our columns to the question of public interest involved in the interference likely to be set up between electric tramway lines and magnetic observatories. The matter has been strongly

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ventilated in the daily Press, and practically all the writers have been in favour of the electric trams, holding that the magnetic observatories should be moved to observation stations further away from large towns. An article on this subject appeared in the *Times* on Christmas Day, and was answered on the 26th by Prof. A. W. Rucker, who is so eminently connected with pure science and with the question at issue that we take the liberty of reprinting his letter in full. It reads as follows:

Sir,—The communication which appears in your columns to-day on "Electric Trams and Magnetic Observatories" must not be taken as giving an accurate account of the controversy to which it refers.

I begin with the statement that "if the rails were perfect conductors of electricity, or if they were perfectly insulated from the neighbouring ground, there would be no trouble. But neither of these conditions can possibly be fulfilled."

The question is not whether theoretically "perfect" insulation can be attained, but whether what is ordinarily called insulation should be insisted on. Some five or six electric railways and tramways originally accepted a clause compelling them to insulate their return conductors, amongst them being the company which has power to construct tramways in the neighbourhood of Kew. The experimental line which has been constructed at Kensington for the District Railway has an insulated return. It is intended to use a system satisfying the same conditions whenever the Inner Circle is run by electricity. I believe that I am right in saying that the London County Council intend to employ an insulated return for their electric tramways. "Insulation" in the ordinary sense of the term is therefore possible.

The scientific men who have been working in the interests of the observatories have never claimed to dictate how the insulation is to be secured. The double-trolley system, described in your correspondent's letter, was that selected by the adviser of the tramway company. Apparently they did not, at that time, consider it to be "undesirable and impracticable." If it is so, several other methods of obtaining the required insulation are known. They are familiar to the engineer of the District Railway and to the adviser of the London County Council.

When it became evident that electric traction was to be developed on a large scale, the question as to the precautions to be taken to protect observatories was referred to the Board of Trade. This action was made restrospective, and the company which had undertaken to insulate the part of the line for which it had then obtained powers became free to argue against insulation. It is for the Board of Trade to decide whether the cost of insulation is more than the companies should be asked to bear, and I will not discuss it.

When the matter came before the Board of Trade a committee was appointed to investigate the amount of the magnetic disturbances produced by the tramways. In this investigation I took part, and at the special request of the engineers we tested, at Stockton, a plan for protecting observatories which they proposed and which did not involve insulation. Though doubtful as to the success of the plan, we finally assented to it, though the same arguments which proved that it was likely to be successful proved that precautions would have to be taken throughout a larger area than had at first seemed necessary. The stringent suggested regulation as to limiting the potential difference between the rails and the earth to one-fifth of a volt was proposed by the representatives of the tramways, not by us, and in agreeing to it we only accepted a condition which they had expressed their willingness to fulfil. Having first accepted and then abandoned insulation, they have now found, we are informed, that the method of protection which they suggested at Stockton, and the conditions which they proposed on July 20 last and which were accepted by us within a fortnight, cannot be carried out.

I do not wish to blame them for the delay which has thus been caused, but they certainly have no right to blame anybody else. It is not correct to say that the "maximum" (potential difference) was "suggested by Kew." It was suggested by the engineers. As to the alleged fact that the stray currents from the Central London Railway are producing currents in the London United Tramways Company's lines, which ought to affect Kew, I do not, of course, dispute the fact that measurements have been made to which the engineers of the company have, in good faith, given this interpretation. I will only say that I do not accept the result until I have had an opportunity of criticising the details of the experiment. The Kew authorities have offered every facility for experiments to test the matter and for the inspection of their records, but on every occasion on which a definite date has been fixed the interview has been postponed at the request of the representatives of the companies.

Finally, your correspondent displays a tender care for the interest of Greenwich, which is convenient when Kew is, for the moment, the more seriously assailed. I have been for some years both a visitor of Greenwich Observatory and a member of the committee by which Kew has been controlled, and I must decline to discuss their relative importance as magnetic observatories.

It is sufficient to say that the work carried on at the two places has not been identical, and that the special work of Kew must either be destroyed or transported to some other place. Your correspondent states that it is impossible to produce "perfect insulation," which is either not *ad rem* or means that it is impossible to produce insulation sufficiently perfect for the protection of observatories.

If this is so, Greenwich is seriously threatened, in spite of the fact that the London County Council are prepared to insulate their tramways. Whether other companies which may construct lines within a dangerous distance of Greenwich will adopt the same plan I do not know, but I am quite sure that under existing circumstances it would be unwise to spend money on increasing the magnetic work of Greenwich.

If the Board of Trade decides that it cannot adequately protect the Kew Observatory, the only feasible plan is to remove the more delicate part of the work to some isolated spot where "stray currents" are not to be feared.

Such a removal would be expensive, and the annual expenditure involved in maintaining a separate staff, and in keeping up a second establishment in an out-of-the-way place, will add seriously to current expenses. For this the electric tramways ought to pay compensation.

The defence of Kew is the defence of a branch of science to further which the most enlightened countries in the world are willing to found observatories, and to send expensive expeditions to the arctic and antarctic regions. It is also the defence of the British maker of magnetic instruments, which cannot be tested in disturbed situations.

It is absurd to represent a defence of this sort as mere blind opposition to a great and growing industry, which I, for one, believe will be of the greatest use to town and country alike. The question is not whether electric traction shall be developed, but whether a small fraction of future dividends is to be spent in compensation for the injuries done to science and to a small but highly skilled trade, which wants all the support it can get if it is not to be killed by German competition.—I am, Sir, your obedient servant,

Dec. 25. ARTHUR W. RUCKER.

The new facts added by the above letter to the public knowledge of the negotiations between the magnetic observatory defenders and the London United Tramway Company should be carefully read by all electrical engineers and by the public.

ELECTRIC TRACTION ON THE DISTRICT RAILWAY.

Another step in the right direction in regard to the proposed conversion of the Underground Railway from steam to electric motive power has been taken by Mr. J. S. Forbes, the chairman of the Metropolitan District Railway Company. Under date Jan. 1 he has issued a circular urging that at the extraordinary meeting of the company, to be held on the 7th inst, the sanction of the shareholders should be given to the raising of the moneys already authorised by Parliament for effecting the object described. The circular in question runs as follows:

"Sir or Madam,—With reference to the legal notice already advertised, the meeting is called under circumstances of a novel and exceptional character.

"1. The position of the company havin been most adversely affected during the last few years by severe omnibus competition is now even more seriously imperilled by the opening of the Central London Railway. That company has adopted, as already appears, the rather hazardous policy of uniformity of class and fare, disregarding all experience of railways in and around London as to the necessity of separate classes of carriages and corresponding differences of fare.

"2. Concurrently with these influences, the prejudice long since arising to the District line, owing to the condition of the atmosphere in the tunnels and stations, has been greatly emphasised by the impossibility of maintaining that rigid attitude as to the character of coal consumed by the engines of the several companies using the railway which was possible, and in a certain degree effectual, so long as Welsh smokeless coal was plentiful and cheap. As things are now, the position is much altered for the worse, and there can be no doubt as to the consequent serious prejudice to the income of the company.

"3. All experience points to the one possible remedy, which is the substituting of electrical for the existing locomotive traction on the lines of the company within the metropolitan area. Under the superintendence of Sir John Wolfe Barry,

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K.C.B., and Sir William H. Preece, experiments have been carried out, with results which confirm the view that with electrical traction the atmospheric evils will disappear entirely, whilst a more economical and effective working of the trains may be secured.

"Acting upon this conclusion, the Metropolitan and District Companies jointly have invited and received suggestions and tenders for the electrical working of the Inner Circle lines from the most important firms connected with that industry. These are now undergoing careful examination on behalf of the companies, with the view of selecting whichever may appear most effectual and advantageous. It is already made clear that the conversion of the railways into electric lines can be effected at a very moderate outlay, and in a comparatively short period of time.

"(4) In view, therefore, of the adverse change in circumstances above referred to, the Board have thought it their duty to call upon the shareholders to allow them to raise the moneys already authorised by Parliament for effecting the object described. Every holder of the company's capital, whether it be debenture, guarantee, preference, or ordinary, is vitally interested in this matter, and the Board rely upon such a measure of support as will enable them to exercise the parliamentary powers already granted.

"A form of proxy is enclosed herewith, which should be signed and posted to the secretary so that he may receive it not later 12 noon on Saturday, the 5th inst.—Yours faithfully,

"J. S. Forbes, chairman."

The resolution to be submitted to the meeting on the 7th inst. is in this form: "To sanction the raising of the additional capital of £500,000 authorised by the Metropolitan District Railway Act, 1897, by the creation and issue of new ordinary shares or stock or new preference shares or stock, or wholly or partially by one or more of those modes respectively, and to authorise the creation and issue of £166,000 debenture stock, being the extent of the borrowing powers authorised by the Metropolitan District Railway Act, 1897, in respect of such additional capital, and to authorise the creation and issue of such new shares, stock, and debenture stock, at such time, in such amounts and manner, on such terms, and subject to such conditions as the meeting shall think fit."

In connection with this matter, an important statement has been made by an official of the British Westinghouse Electric and Manufacturing Company to the effect that the company's Bill for providing the electric motors, carriages, etc., for the conversion of the Metropolitan and District Companies' lines from steam to electric traction will be proceeded with, although no intimation has been given by the railway companies to the public that a contract has been made with the Westinghouse Company or any other firm. The representative of the firm did not say whether his company had received a contract, but he intimated that the public must judge of that matter for itself. The company's Bill is lodged in the Private Bill Office, and is a very comprehensive one, providing for the entire reconstruction of the underground and the suspension of the railway service during that reconstruction. It also confers power on the two railway companies to compel all other companies having running powers to use electric motors for haulage work.

CHELTENHAM ELECTRICITY WORKS.

The accounts of the Cheltenham electricity works made up to March 31, 1900, have just been issued. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. The prices charged are from 3¾d. to 6d. per unit, on a sliding scale based on consumption per kilowatt maximum demand, for private lighting; 3d. per unit for private supply for power, etc., and for the public incandescent lamps; £19. 10s. each per arc for the first 150, £17. 10s. each per arc for the next 50, and £15 each per arc for all in excess of 200:

Revenue Account.

Dr.	Generation of Electricity.	£ s. d.
Coal and other fuel	£1,789 16 1	
Oil, waste, stores, etc.	348 9 8	
Salaries and wages	1,103 8 0	
Repairs and maintenance to buildings	21 19 4	
Ditto machinery	119 17 1	
Carbons and miscellaneous	31 16 0	
		3,415 6 2
Distribution of Electricity.		
Salaries and wages	82 15 10	
Repairs and maintenance—Mains and services	61 13 1	
Ditto house connections	242 10 1	
Ditto sub-stations	45 9 4	
		432 8 4
Public Lamps.		
Salaries and wages	391 17 6	
Carbons, renewals, etc.	319 19 7	
		711 17 1
Rents	25 0 0	
Rates and taxes	114 13 8	
		139 13 8
Management Expenses.		
Salaries and wages—Engineer	199 14 9	
Ditto clerks	202 19 5	
Ditto collector	10 0 0	
Stationery and printing	83 15 4	
General charges	94 19 0	
		591 8 6
Law expenses		15 12 3
Special charges—insurances		30 11 0
		5,336 17 0
Less goods sold, etc.		357 1 1
		4,979 15 11
Amount carried to net revenue account		3,272 7 4
		£8,252 3 3
Cr.		£ s. d.
Electric energy at 6d. per unit £2,255. 17s. 2d.; less cash discounts, £57. 18s. 2d.		2,197 19 0
Electric energy at 5½d. per unit. £2,274. 13s. 3d.; less cash discounts, £148. 8s. 1d.		2,126 5 2
Electric energy at 5d. per unit, £114. 2s 11d.; less cash discounts, £5. 14s. 1d.		108 8 10
Electric energy at 4d. per unit, £383. 12s. 7d.; less cash discounts, £24. 16s. 11d.		358 15 8
Electric energy at 3d. per unit		102 15 3
Electric energy sold by contract		48 0 0
		4,942 3 11
Less rebates		382 5 9
		4,559 18 2
Public lighting		3,688 14 1
Meter rents		3 11 0
		£8,252 3 3

General Balance Sheet.

Liabilities.	£ s. d.
Capital account—loans received	85 191 0 0
Sundry creditors: capital account, £2,651. 11s. 6d.; revenue account, £682. 1s. 9d	3 333 13 3
Interest on debentures	572 5 8
Loan repayment (£17,200 loan) provision account	219 2 9
Sinking fund provision account	1,179 12 3
Cash due to treasurer: capital account £3,125. 0s. 2d.; revenue account, £6,535. 2s. 9d; outstanding cheque, £7. 14s. 7d.	9 667 17 6
Suspense account capital, £8. 2s. 11d.; revenue, 6s. 8d	8 9 7
Amount of sinking fund	5,384 7 2
	£105,556 8 2
Assets.	£ s. d.
Capital account—amount expended for works	90,839 5 9
Stores in hand: coal, £21. 15s. 10d.; oil, waste, etc., £151. 3s. 3d.; carbons, £383. 13s. 9d.	556 12 10
Sundry debtors for energy to March 31, 1900	1 253 18 9
Other debtors—goods sold, etc.	443 15 4
Balance at debit of net revenue account	6,993 18 4
Electrical engineer's advance account	77 10 0
Suspense account—revenue	7 0 0
Sinking fund investments, £5,030; borough treasurer (cash at bank), £354. 7s. 2d	5 384 7 2
	£105 556 8 2

Statement of Electricity Generated, Sold, etc.

Units generated in B T. units		714 504
Units sold { Public lamps	309,175	
Units sold { Private consumers	232,209	541,384
Units used in works sub stations, etc.		38 558
Units accounted for		134 562
Maximum load (kilowatts)		450
Capacity of plant (kilowatts)		800

Number of public lamps: arc, 212; incandescent, 18.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a complete list of the applications for provisional orders deposited with the Board of Trade for the parliamentary session of 1901 under the provisions of the Electric Lighting Acts, 1882 to 1890.

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Title of Order and Description of Area.	Name of Promoters.
Aberavon Electric Lighting Order.—The Borough of Aberavon.	The Corporation.
Abertillery Electric Lighting Order.—The Urban District of Abertillery.	The Urban District Council.
Alfreton Electric Lighting Order.—The Urban District of Alfreton.	The Urban District Council.
Alnwick Electric Lighting Order.—The Urban District of Alnwick.	The Northern Counties Electricity Supply Company.
Annfield Plain Electric Lighting Order. The Urban District of Annfield Plain.	The Northern Counties Electricity Supply Company.
Ashton-in-Makerfield Electric Lighting Order.—The Urban District of Ashton-in-Makerfield.	The Urban District Council.
Aspull Electric Lighting Order.—The Urban District of Aspull.	The Urban District Council.
Atherton Electric Lighting Order.—The Urban District of Atherton.	The Urban District Council.
Barry Electric Lighting Order.—The Urban District of Barry.	The Urban District Council.
Benfieldside Electric Lighting Order.—The Urban District of Benfieldside.	The Northern Counties Electricity Supply Company.
Benwell and Fenham Electric Lighting Order.—The Urban District of Benwell and Fenham.	The Urban District Council.
Beverley (Corporation) Electric Lighting Order.—The Municipal Borough of Beverley.	The Corporation.
Birstall Electric Lighting Order.—The Urban District of Birstall.	The Urban District Council.
Blackrock (County Dublin) Electric Lighting Order.—The Urban District of Blackrock.	The Urban District Council.
Briton Ferry Electric Lighting Order. The Urban District of Briton Ferry.	The Urban District Council.
Bromsgrove Electric Lighting Order. The Urban District of Bromsgrove, a portion of the Parish of Stoke Prior (Finstall) in the Rural District of Bromsgrove and a portion of the Parish of Bromsgrove, in the Urban District of North Bromsgrove.	George Gordon Brodie, Charles Steer, and William Whitehouse, Esqs.
Burgess Hill Electric Lighting Order. The Urban District of Burgess Hill.	The Urban District Council.
Cannock Electric Lighting Order.—The Urban District of Cannock.	The Urban District Council.
Carnarvon and District Electric Lighting Order.—The Borough of Carnarvon and the Rural District of Gwyrfai (except such part of that district as is situate in the Island of Anglesea).	Edward Whittred Iltyd Peterson, Esq.
Chesham Electric Lighting Order.—The Urban District of Chesham.	The Urban District Council.
Cheshunt Electric Lighting Order.—The Urban District of Cheshunt.	The Urban District Council.
Clydebank Electric Lighting Order.—The Burgh of Clydebank.	The Commissioners of the Burgh.
Consett Electric Lighting Order.—The Urban District of Consett.	The Northern Counties Electricity Supply Company.
Crieff Electric Lighting Order.—The Burgh of Crieff.	The Commissioners of the Burgh.
Crompton Electric Lighting Order.—The Urban District of Crompton.	The Urban District Council.
Dalkeith Electric Lighting Order.—The Burgh of Dalkeith.	Messrs. Crompton and Co., Limited.
Dollar Electric Lighting Order.—The Burgh of Dollar.	Messrs. Crompton and Co., Limited.
Dorchester Corporation Electric Lighting Order.—The Borough of Dorchester.	The Corporation.
Dorking Electric Lighting Order.—The Urban District of Dorking.	The County of Surrey Electrical Power Distribution Company, Limited.
Dungannon Electric Lighting Order.—The Urban District of Dungannon.	The Urban District Council.
East Cowes Electric Lighting Order.—The Urban District of East Cowes.	The Isle of Wight Electric Light and Power Company, Limited.
Ebbw Vale Electric Lighting Order.—The Urban District of Ebbw Vale.	The Urban District Council.
Falkirk Electric Lighting Order.—The Burgh of Falkirk.	The Commissioners of the Burgh.
Faversham Electric Lighting Order.—The Borough of Faversham.	The Corporation.
Felling Electric Lighting Order.—The Urban District of Felling.	The Urban District Council.
Foots Cray Electric Lighting Order.—The Contributory Place of Foots Cray and portion of the Urban District of Chislehurst.	The Rural District Council of Bromley (Kent).
Friern Barnet Electric Lighting Order. The Urban District of Friern Barnet.	The Urban District Council.
Frome Electric Lighting Order.—The Urban District of Frome and portion of the Parish of Selwood in the Rural District of Frome.	The Urban District Council.
Galashiels Electric Lighting Order.—The Burgh of Galashiels.	The Corporation.
Goole Electric Lighting Order.—The Urban District of Goole.	The Urban District Council.
Gourock Electric Supply Order.—The Burgh of Gourock.	The Commissioners of the Burgh.
Hampton Electric Lighting Order.—The Urban District of Hampton.	The Urban District Council.
Handsworth Electric Lighting Order.—The Urban District of Handsworth.	The Northern Counties Electricity Supply Company.
Hindley Electric Lighting Order.—The Urban District of Hindley.	The Urban District Council.
Hoddesdon Electric Lighting Order.—The Urban District of Hoddesdon.	The Urban District Council.
Honley Electric Lighting Order.—The Urban District of Honley.	The Urban District Council.
Ilkley Electric Lighting Order.—The Urban District of Ilkley and the Townships of Middleton and Denton, in the Rural District of Wharfedale.	Alfred Horswill Gibbings, Esq.
Ince-in-Makerfield Electric Lighting Order.—The Urban District of Ince-in-Makerfield.	The Urban District Council.
Isle of Thanet (Rural) Electric Lighting Order.—The Parishes of Garlinge, Northdown, and St. Peter Extra, in the Rural District of the Isle of Thanet.	The Isle of Thanet Electric Tramways and Lighting Company, Limited.
Jedburgh Electric Lighting Order.—The Burgh of Jedburgh.	Messrs. Crompton and Co., Limited.
Kildare Electric Lighting Order.—The Town of Kildare and certain adjacent Townlands in the Parish and Electoral Division of Kildare.	The Naas, No. 1, Rural District Council.
Lichfield Corporation Electric Lighting Order.—The City and County of the City of Lichfield.	The Corporation.
Llandaff and Dinas Powis Electric Lighting Order.—The Rural District of Llandaff and Dinas Powis.	The Rural District Council.
Llangollen Electric Lighting Order.—The Urban District of Llangollen.	The Urban District Council.
THE COUNTY OF LONDON.	
Deptford Electric Lighting Order.—The Metropolitan Borough of Deptford.	The County of London and Brush Provincial Electric Lighting Company, Limited.
Lewisham and Penge Electric Lighting Order.—Portion of the Metropolitan Borough of Lewisham and the Urban District of Penge.	The Lewisham and District Electric Supply Company, Limited.
Marylebone Electric Lighting Order.—The Metropolitan Borough of St. Marylebone.	The Marylebone Electric Supply Company, Limited.
St. Marylebone Electric Lighting Order.—The Metropolitan Borough of St. Marylebone.	The Corporation.
Stoke Newington Electric Lighting Order.—The Metropolitan Borough of Stoke Newington.	The North Metropolitan Electrical Power Distribution Company, Limited.
Lyndhurst Electric Lighting Order.—The Parish of Lyndhurst.	The Lyndhurst Electric Lighting and Traction Company, Limited.
Macclesfield Electric Lighting Order.—The Borough of Macclesfield.	The Corporation.
Macclesfield Electric Lighting Order.—The Borough of Macclesfield.	The Electrical Power Distribution Company, Limited.
Melrose Electric Lighting Order.—The Burgh of Melrose.	Messrs. Crompton and Co., Limited.
Midland Electric Power Distribution and Lighting (Extension) Order.—The Urban Districts of Perry Barr, Tettenhall, Lye and Wollescote, and Stourbridge, and the Parish of Great Barr, in the Walsall Rural District.	The Midland Electric Corporation for Power Distribution, Limited.
Mitcham Electric Lighting Order.—The Parish of Mitcham.	The Rural District Council of Croydon.
Mountain Ash Electric Lighting Order.—The Urban District of Mountain Ash.	The Urban District Council.
Neath Corporation Electric Lighting Order.—The Borough of Neath.	The Corporation.
Neath Rural District Electric Lighting Order.—The Rural District of Neath.	The Rural District Council.
Neath, Briton Ferry, and Aberavon Electric Lighting Order.—The Municipal Boroughs of Neath and Aberavon, the Urban District of Briton Ferry, and portion of the Rural District of Neath.	The Electrical Power Distribution Company, Limited.
Newbury Electric Lighting Order.—The Borough of Newbury.	The Urban Electric Supply Company, Limited.
New Hunstanton Electric Lighting Order.—The Urban District of New Hunstanton.	The Urban District Council.
Northfleet Electric Lighting Order.—The Urban District of Northfleet.	The Urban District Council.

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Title of Order and Description of Area.	Name of Promoters.
Northwood and Ruislip Electric Lighting Order.—The Parish of Ruislip, in the Rural District of Uxbridge, and portions of the parishes of Watford (Rural) and Rickmansworth (Rural), in the Rural District of Watford.	The Northwood Electric Light and Power Company, Limited.
Norton Electric Lighting Order.—The Urban District of Norton.	The Northern Counties Electricity Supply Company.
Oban Electric Lighting Order.—The Burgh of Oban.	The Commissioners of the Burgh.
Pickering Electric Lighting Order.—The Urban District of Pickering.	The Northern Counties Electricity Supply Company.
Pokesdown Electric Lighting Order.—The Urban District of Pokesdown.	The Bournemouth and Poole Electricity Supply Company, Limited.
Pontypridd Electric Lighting Order.—The Urban District of Pontypridd.	The Urban District Council.
Pudsey Electric Lighting Order.—The Borough of Pudsey.	The Corporation.
Rhondda Electric Lighting Order.—The Urban District of Rhondda.	The Urban District Council.
Rickmansworth Electric Lighting Order.—The Urban District of Rickmansworth.	The North Metropolitan Electrical Power Distribution Company, Limited.
Ripon Electric Lighting Order.—The City of Ripon.	The Corporation.
Rishton, Great Harwood, and Clayton-le-Moors Electric Lighting Order.—The Urban Districts of Rishton, Great Harwood, and Clayton-le-Moors.	Charles Chadwell, Esq.
Ross Electric Lighting Order.—The Urban District of Ross.	John Parker, Esq.
Roundhay and District Electric Lighting Order.—The Township of Roundhay, in the Rural District of Leeds.	The Roundhay and District Electric Lighting Company, Limited.
Royton Electric Lighting Order.—The Urban District of Royton.	The Urban District Council.
St. Austell Electric Lighting Order.—The Town and Parish of St. Austell and the Urban and Rural Districts of St. Austell.	The St. Austell and District Electric Lighting and Power Company, Limited.
Shildon Electric Lighting Order.—The Urban District of Shildon and East Thickley.	The Northern Counties Electricity Supply Company.
Sittingbourne Electric Lighting Order. The Urban Districts of Sittingbourne and Milton-next-Sittingbourne.	The County of Kent Electrical Power Distribution Company, Limited.
Skipton Electric Lighting Order.—The Urban District of Skipton.	The Urban District Council.
Standish-with Langtree Electric Lighting Order.—The Urban District of Standish with-Langtree.	The Urban District Council.
Stratford-upon-Avon Electric Lighting Order.—The Borough of Stratford-upon-Avon.	The Corporation.
Teddington Electric Lighting Order.—The Urban District of Teddington.	The Urban District Council.
Teddington, Hampton, Hampton Wick, and Ham Electric Lighting Order.—The Urban Districts of Teddington, Hampton, Hampton Wick, and Ham.	The Richmond (Surrey) Electric Light and Power Company, Limited.
Thornhill Electric Lighting Order.—The Urban District of Thornhill.	The Northern Counties Electricity Supply Company.
Todmorden Electric Lighting Order.—The Borough of Todmorden.	The Corporation.
Tredegar Electric Lighting Order.—The Urban District of Tredegar.	The Urban District Council.
Trowbridge Electric Lighting Order.—The Urban District of Trowbridge.	The Urban District Council.
Ware Urban Electric Lighting Order. The Urban District of Ware.	The Urban District Council.
Warwick Electric Lighting Order.—The Borough of Warwick.	The British Electric Traction Company, Limited.
Waterford Electric Lighting Order.—The Borough of Waterford.	The Corporation.
Wellingborough (Public Purposes) Electric Lighting Order.—The Urban District of Wellingborough.	The Urban District Council.
Wellington (Salop) Electric Lighting Order.—The Urban District of Wellington (Salop).	The Urban District Council.
Whitley and Monkseaton Electric Lighting Order.—The Urban District of Whitley and Monkseaton.	Alan George Robson, Athol Wilson Dixon, and Joseph Alexander Jeckell, Esqs.
Widnes Electric Lighting Order.—The Borough of Widnes.	The Corporation.
Wisbech Corporation Electric Lighting Order.—The Borough of Wisbech.	The Corporation.
Workington Corporation Electric Lighting Order.—The Borough of Workington.	The Corporation.
Worsley Electric Supply Order.—The Urban District of Worsley.	The Urban District Council.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

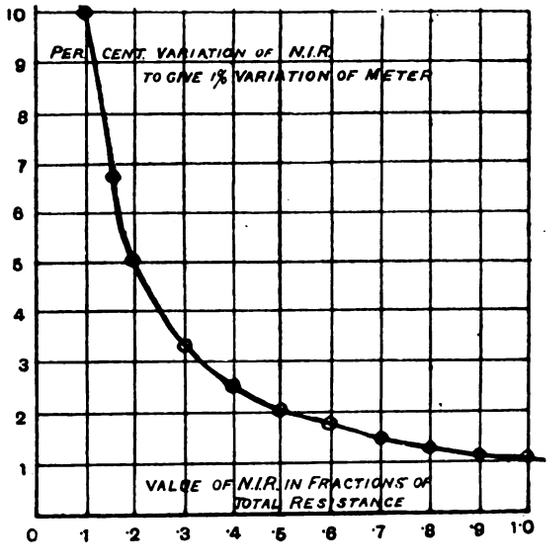
339. Describe what you consider to be the best arrangement of staff for a combined traction and lighting station with a maximum output of 1,500 kw.—A. B.

340. Is there any advantage in driving gas-engines by specially prepared gas instead of by ordinary gas used for lighting purposes? Compare the two methods.—T. C.

ANSWERS.

Question No. 333.—How can the Thomson-Houston and similar meters be adjusted without either breaking the seals on the controlling magnets or altering the position of the coils?

Best Answer to No. 333 *(awarded* 10*s.)*.—The only way to adjust wattmeters of this class without breaking the magnet seals or altering the position of the coils, is by altering the resistance of the shunt circuit. In the Thomson meter this is best done by adding or removing wire from the non-inductive resistance contained in an envelope at the back of the meter. The wire on this resistance in all sizes of meters has a resistance of 18·2 ohms per yard, and as this resistance forms a certain fixed portion of the shunt circuit of the meter, the amount to be added to or taken from (added to if the meter is fast) can easily be calculated for a given percentage error of the



meter. For example, a 100-volt 10-ampere T.-H. meter has a total shunt resistance of 3,195 ohms, and of this the non-inductive resistance takes 2,400 ohms, or practically is 0·75 of the whole. Therefore, to make a 1 per cent. difference in the meter, the N.I.R. must be altered by 1·33 per cent. A very convenient way of adjusting this resistance is to have one of the pressure mains fitted with an ordinary tie-clip, and after measuring off what is thought to be the right amount of wire, bare it, and clip in tie-clip and test the meter again. This saves time, as there is no need to cut off the wire and make a soldered joint until the right place is found. The bare trial places can easily be insulated with a bit of silk tape and shellac.

The following table gives the average proportion which

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the N.I.R. forms of the whole shunt resistance in the most generally used sizes of T.-H. meters:

Size of meter. Volts.	Amperes.	Value of N.I.R. in terms of total resistance.
100	10	0 752
,,	25	0 748
,,	50	0·653
,,	75	0 675
200	5	0·870
,,	10	0 889
,,	25	0 887
,,	50	0 840
,,	75	0 853

In all other motor meters, and in the Aron wattmeter, there is a coil or bobbin of wire which takes the place of the N.I.R. of the T.-H. meter, and which in the same way forms a certain proportion of the total shunt resistance. The following curve, showing the percentage alteration to be made in this coil to give 1 per cent. variation of the meter when the coil forms certain fractions of the total shunt resistance, may therefore be found useful.—H. R. M.

Answer to No. 333 (*awarded* 5*s.*).—The conditions of this question are rather exacting, and are in opposition to the usual practices of adjusting Thomson-Houston meters. The first and most important method of altering the speed of a Thomson-Houston meter with a given load is by moving the magnets, M M. If the speed is to be increased,

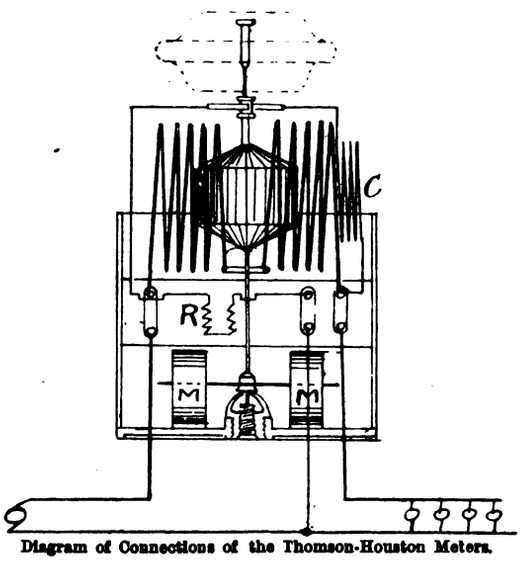
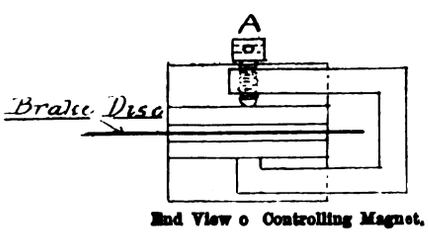


Diagram of Connections of the Thomson-Houston Meters.

they are moved towards the centre of the disc, and contrary if a reduction of speed is required. This cannot be accomplished without breaking the seals, so this method is not possible. The question also stipulates that the position of coils is not to be altered, which will refer to coil C, the compounding or starting coil, whose function is to assist at starting and light loads. The resistance coil, R, in series with the armature and starting coil could be increased or decreased in resistance so that more and less current would flow through the armature, and so regulate the speed, but this seems also to be contrary to the conditions of the question. The brush friction could be increased a little, which would tend to reduce the speed at low loads, but against this we should have the trouble of sparking. The only solution which suggests itself is to have a small short-circuiting device for one of the magnets (see sketch), whose



End View o Controlling Magnet.

position could be adjusted by means of the screw, A; by altering the position of this on the magnet a certain range of adjustment could be obtained. If the speed was increased too much by having the screw, A, down on the magnet, small brass washers could be inserted between A and magnet. By this method the speed of the meter could be increased to any amount, but it seems to be impossible to reduce the speed without breaking the conditions of the question. In the writer's experience, new Thomson-Houston meters run slow at low loads, which gradually adjusts itself on circuit; after a time there is a tendency to run fast as the magnets lose their magnetism.—W. A. J.

Answer to No. 333 (*awarded* 5*s.*).—The necessary adjustments to correct an inaccurate Thomson-Houston meter depends on the form of the error in the meter curve. This may show a nearly constant + or − error, or more probably a larger error at small currents than at other parts of the curve. The law of the meter may be investigated as follows:

Let A = series coil or main circuit current;
V = potential difference on shunt;
w = speed of armature;
a = constant depending on windings, etc., of series coil;
b = constant depending on windings, etc., of armature;
c = constant depending on windings, etc., of starting coils;
r = constant depending on friction of bearings, brushes, and train;
f = constant depending on brake field.

Then Driving torque $= a\,b\,A\,V + c\,b\,V^2$;
Retarding torque $= f^2\,w + r$.

For steady motion, $a\,b\,A\,V + c\,b\,V^2 = f^2\,w + r$.

Now, if the bearing and brush friction is exactly compensated for by the starting coil torque,

$$c\,b\,V^2 = r \text{ and } a\,b\,A\,V = f^2\,w;$$

or,
$$A\,V = \frac{f^2\,w}{a\,b}.$$

Thus the speed of the meter is directly proportional to the energy put through it. If the error is not uniform, it is probably because $b\,c\,V^2$ is not equal to r. If the meter under-registers at small currents, the pivot should be examined, cleaned, and oiled if necessary, and the commutator cleaned and brushes examined to see that they are not bearing too heavily. These should be adjusted so that the meter will not run on the shunt even when subjected to vibration, but will start well with ·2 ampere. Finally, the starting coils should be examined to see that they are correctly joined up to *assist* the series field.

If the meter over-registers at low currents, the brushes should be tightened in order to increase r, as the retarding torque is obviously too small in this case. Great care is necessary to see that the small nuts holding the brushes are left quite tight, as otherwise they very soon work loose and may allow a brush to lose contact with the commutator, thus stopping the meter. Finally, to correct a uniform error without transgressing the conditions laid down in the question, all that is necessary is to increase or decrease the shunt resistance (by a percentage equal to the percentage error) by winding wire on or off the inductionless resistance to be found at the back of the meter. This resistance for a 100-volt meter is of about 30,000 ohms value. Thus if a meter were 5 per cent. high, it would be necessary to increase the *total* shunt circuit resistance by 5 per cent. By suitably combining the above adjustments it is possible to get a practically straight line law from about ·5 ampere upwards in the case of a five-ampere meter.—E. M.

Question No. 334.—An output of 2,500 h.p. has to be transmitted from a power station to a chemical works two miles away. The load is a continuous one night and day. The works generate three-phase alternating current, with 2,000 volts between adjacent wires, and the pressure at the chemical works is required to be 200 volts. Investigate what is the most economical voltage for transmission with underground cables.

Answer to No. 334 (*awarded* 7*s.* 6*d.*).—A three-phase system with 2,000 volts between adjacent wires gives 1,150 volts, approximately, difference of E.M.F. in any one phase. There are practically only two methods of

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transmitting the power to be considered. The one would be to transmit at the generated voltage and transform down from that to the required 200 volts. This involves a heavy outlay in the first case for mains capable of carrying the large current at 1,150 volts pressure. The other way would be to instal transformers at the generating end, to raise the pressure to, say, 15,000 volts, and then to transform down again to the required pressure. Thus we have, on the one hand, the difference in cost between mains to carry 1,300 amperes at 1,150 volts, and those for 100 amperes at 15,000 volts. To set against this we have the cost of a bank of transformers at the generating end and an extra cost for transformers at the receiving end. So far we have only mentioned initial capital outlay, but there is another factor of great importance, particularly as the load is a constant one. This is the unavoidable loss in transmission. In the case of direct transmission we have the C^2R losses in the mains and the transformer iron and other losses at the consuming end of the system. With the step-up transformers we have an extra transformer loss at the generating end, and probably higher transformer loss at the other end, owing to the higher ratio of transformation. The C^2R loss in the mains would be probably equal in both cases. We must also consider that by raising the pressure we are running a greater risk of breakdown than is incurred by transmission at generated pressure. These are the main points upon which the question must be decided. In the absence of knowledge of local conditions, it is difficult to give even approximate figures. If overhead transmission be available, the cost of mains for the two systems is almost in direct proportion to the weight of copper—*i.e.*, an inverse proportion to the voltage employed.

With underground transmission the higher tension used would involve proportionately higher insulation on the cable. In both cases we should use a common return, and, hence, have four wires, making a total length of cable of eight miles. Assuming the cost of lead-covered armoured cable to carry 1,300 amperes at, say, £850 per 1,000 yards, we have a total cost of cable of something like £12,000. The extra high-tension cable for 100 amperes might cost £170 per 1,000 yards, or practically one-fifth of the cost of the other. We have something over £9,500 as the difference in first cost of the underground cable, and we must balance this against the cost of high-tension transformers for 1,800 kw. to step up from 2,000 to 15,000 volts. As the transformers are always worked at maximum efficiency, they ought to give out 97 per cent. of the power received by them.

With overhead transmission the difference in first cost of wires would be still more pronounced. The figures given are probably rather wide of what would be actually obtained, if one knew more of the conditions and probable cost of laying underground mains as compared with the erection of overhead conductors. From the assumptions made above, however, the advantage would seem to lie decidedly in favour of transformers and high-voltage transmission.—F. H. C.

Answer to No. 334 (*awarded* 7*s.* 6*d.*).—There are two methods to be considered: (1) to transmit at 2,000 volts and so save the cost of transformers; (2) to transform up and transmit at the most economical voltage, and so save in the cost of the line and in efficiency of transmission.

It is necessary to find the most economical line for case 1, and the most economical voltage and line for case 2. Lord Kelvin has shown that the most economical line is such that the annual cost of the energy waste in it is equal to the interest on the money spent on it. As a rule, such lines are carried overhead, and it is only necessary to consider the weight of copper; but in this case the cost of insulation may exceed that of copper, and as the weight of insulation is not proportional to the weight of copper, the question becomes rather complicated. It is impossible to apply Lord Kelvin's formula, but by a series of curves an exact solution can be arrived at; 2,500 h.p. equals 1,860 kw., or 620 kw. per circuit, and at 2,000 volts this means 310 amperes in each cable. One penny per kilowatt-hour will probably be not unreasonable for a continuously loaded station like this, giving £36. 10*s.* for 1 kw. for one year. We will assume rate of interest to be 5 per cent.

Case 1.—If we plot two curves with the same axes, one showing the interest on the cost of six miles of cable of various sectional areas and the other showing the watts lost in six miles of the same cables at 310 amperes, these two curves will cross, and at the point where they cross we have, by Lord Kelvin's law stated above, the maximum economy. Fig. 1 shows these curves. The prices of the

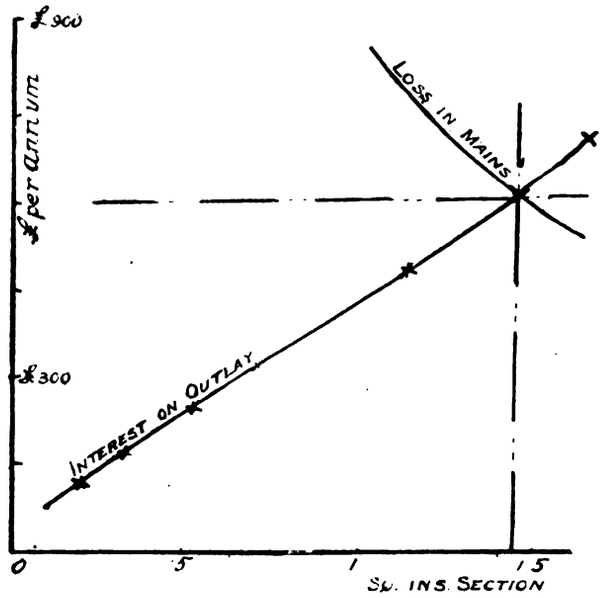

Fig. 1

cables are, and also of those considered later were, taken from a cable catalogue, but in some cases where the catalogue did not go far enough they were estimated by considering the sectional area of the copper and of the insulation. The cable is insulated with rubber whose radial thickness in inches is $^1/_{20}$ of the working pressure in volts, taped, vulcanised, braided, and soaked in preservative compound. If cable is one square inch area, resistance of six miles equals ·0255 ohm and waste equals 24·5 kw., cost per annum equals £893. For all other sections the cost per annum is inversely proportional to the area, and is represented by a rectangular hyperbola. We see from Fig. 1 that the best cable is one of 1·4 square inch section, and that the interest and the energy lost would each be equal to £600 per annum.

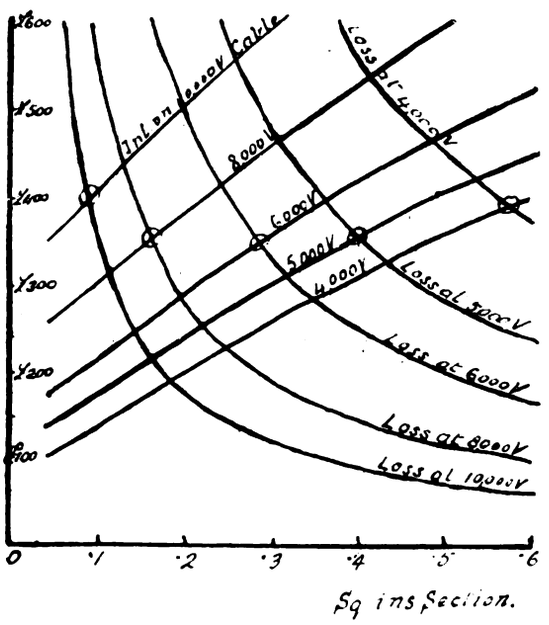

Fig. 2.

Case 2.—We must now plot curves showing the interest on six miles of cable of various sections for 4,000, 5,000, 6,000, 8,000, and 10,000 volts respectively, and also curves showing the annual cost of energy lost when transmitting at these voltages. Fig. 2 shows these curves. The crossing point of each pair of curves shows the best size of cable

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for that voltage and the total annual cost. We see at once that there is not much to choose between 5,000, 6,000, and 8,000 volts, but that 4,000 and 10,000 are much more costly. So far we have assumed that the cost of laying is independent of the weight of the cable; but as this is not quite correct, 8,000 will be the most suitable voltage. The figure shows that the total cost will be £680 per annum, but to this we must add the loss in the transformer. Allowing 1 per cent., this also works out at £680. Transmission at 2,000 volts is therefore more economical by the cost of the transformer, plus £160 per annum, less a small amount for increased cost of laying the heavy mains.—J. W.

[N.B.—The above answer proceeds on the right line, but the limits are not well chosen. The transformer losses would be more than 1 per cent. The chief points, however, are that 5 per cent. interest is not sufficient to allow in company work, and that for a 24 hours' load the cost of energy is under 1d. per unit.—ED. *E. E.*]

LEGAL INTELLIGENCE.

THE CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED, AND THE CORPORATION OF KING'S LYNN.

The award in the arbitration between the Chloride Electrical Storage Syndicate, Limited, and the Corporation of King's Lynn, which was heard on Dec. 4 last, has now been made. The arbitrator has ordered the Corporation to pay the syndicate the sum of £100, and also to pay their costs and the costs of the arbitrator. The amount claimed by the syndicate was £301. 1s. 7d., the principal part of which represented labour expended in erecting the storage batteries at the electric lighting station of the Corporation, it being claimed by the syndicate that they were entitled to charge for all labour under the daywork scale in the schedule of quantities, in addition to the prices quoted for material; the contention of the Corporation was that such prices included all necessary labour. The arbitration was appointed by the president of the Institute of Civil Engineers on the application of the syndicate, the Corporation appearing under protest on the ground that the matter was not one within the jurisdiction of the arbitrator, but one on which the decision of their engineer was intended by the contract to be final.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC STREET TRAMWAYS.

On Monday the statutory general meeting of the shareholders of the Company was held at the Hotel Cecil, Strand, W.C., under the presidency of Sir J. Kenneth Mackenzie, Bart., the chairman.

The **Chairman** said the directors had called a statutory meeting of this Company so soon after allotment, and so well within the four months allowed by the Companies Acts, in order that they might lay before the shareholders its exact position, notify them of the important concessions they had been able to obtain from the vendors, and give them some brief idea of its prospects. The prospectus differed from the generality of such documents, and was somewhat florid in its tone generally. But it called the attention of the public to the advantages of electric traction generally; it pictured the happy condition of affairs which would result when electric tramways became general in this country; it called attention to the various patents that the Company owned, and the multitude of improvements that would result were they to be adopted generally. Undoubtedly a great future lay before the Company. It must walk before it could run, and for the present it must feel its way till it stood firmly upon its legs. An important matter to mention was that Mr. Thomas Parker had consented to accept the fee of £300 per year as consulting engineer to the Company, instead of the £500 per annum provided by the first contract made with him, and also to forego the sum equal to one-tenth of the dividends paid to the shareholders by way of commission over and above his salary. Mr. Parker thought he could be of much more service to the Company by having a freer hand as consulting engineer for the Midlands district than by remaining on the Board as a director only, and he would thus continue to act for the Company in the same way as would Sir William Preece and Major Cardew, their consulting engineers and electricians. The vendor company had now consented to allow the shares received by them in part payment of the purchase money to be deferred as regarded dividends until a dividend of 5 per cent. had been paid upon the shares publicly subscribed and paid for; and, furthermore, they had agreed to allow the Company to retain £70,000 shares in its hands, and which would only be released to the vendors *pari passu* as and when the remainder of the Company's capital was issued. This was a very important concession to have obtained. He had connected himself with the largest new electrical railway schemes now before Parliament in order to influence business for the Company, and if everything went well the concern would make a good thing out of that. In conclusion, the Chairman moved that the agreement with Mr. Parker, referred to in the notice convening the meeting, be approved and ratified by this Company.

Mr. Huth seconded the motion, which was unanimously agreed to.

Mr. Lockyer said he and certain other shareholders had taken shares in the Company on the strength of the name of Sir William Preece, but he had since found out that Sir William Preece had very little to do with the Company. He then read a letter from Major Cardew addressed to Sir Kenneth Mackenzie, in which he denied that his firm, Preece and Cardew, had any official connection with the Company.

The **Chairman**, in reply, said that the public subscriptions to the Company brought in nearly £70,000, and the shares taken by the vendors brought the total to nearly £270,000. With regard to what Mr. Lockyer had said, he did not think that gentleman was quite right in reading a private letter from his old friend Major Cardew to himself. Major Cardew, it was true, wrote him that letter, but he (the chairman) called on him the following day and the matter was explained. The Company did receive a proper letter from the firm of Preece and Cardew agreeing to act as their consulting engineers. After the question was raised in the manner shown by the letter read, he and Major Cardew had a long talk over it, in which he pointed out that the appointment of that firm as consulting engineers placed no responsibility upon them in regard to the prospectus; it was simply an intimation that the Company's work would be placed in their hands. There was a perfect understanding on the subject when he left.

A meeting of the Founders Syndicate, Limited, was then held, when **Sir Kenneth Mackenzie** who again presided, remarked that the shareholders were practically the same as in the company whose meeting had just been held, and there was no further intimation to lay before them at present.

The proceedings then terminated.

LONDON ELECTRIC OMNIBUS.

The fourth ordinary general meeting of the Company has been postponed for a week owing to a sufficient number of shareholders to constitute a quorum not being present on Monday last, the day originally fixed for the meeting. In moving the adjournment of the meeting on Monday, the **Chairman** (Lieutenant-Colonel T. T. Turnbull) said a number of replies had been received to the circular sent out by the Board, and it was probably owing to that fact that more shareholders had not attended.

The circular in question stated that the directors were of opinion that electricity as applied to street traction, except as regarded tramways, had not been sufficiently developed to warrant their advising the shareholders to experiment further with it. The automobile car had become an accomplished fact. The directors had every reason to believe that a type of street car, to carry 14 passengers, could be procured, which would be more suitable for London streets, at an inclusive price of not more than £450 each, 20 of such street cars being considered a sufficient number with which to start business. The order for these cars would be conditional on the makers' guarantee, and a running test of one or two of the cars for at least 30 full working days consecutively being satisfactory. If a sufficient number of the shareholders assented to the suggested scheme, the directors would propose that this Company should be wound up voluntarily with a view to reconstruction, and that a new company should be formed to acquire and work the undertaking of the present Company, the capital of the new company to be £100,000, divided into 100 shares of £1 each, credited with 15s. paid up thereon. The members of the present Company would be entitled to receive in respect of each fully-paid share now held by them one share in the new company, credited with 15s. paid up thereon, the sum of 2s. 6d. per share in the new company to be forthwith called up, and the balance of 2s. 6d. per share to be called up as and when required.

MAXIM ELECTRICAL AND ENGINEERING EXPORT.

The second annual general meeting of this Company was held on Monday at the offices of the Company, 65, 66, and 67, Grace-street, E.C.

Mr. Jules de Meray (the chairman), who presided, said there was a very valuable addendum to the certified accounts by the auditors under the heading of open contracts, showing profits on orders in hand with which they started the new year of £3,704. 12s 7d., which would be realised in the course of the next few months. Since the closing of accounts on Nov. 30 the activity in their engineering department had been such that they had received firm orders for the sum of £3,930, and they had sent in their tenders for £21,510 worth of work, and as a good deal of these tenders were for goods of their own specialities, they must secure a fair share of them. The Chairman then referred to another department of their business, which, for simplification, they termed "Wheeleries." These productions had been received with favour. They had supplied them to the Board of Trade, Government railways in Australia and New Zealand, and orders were in hand for New South Wales. There were excellent chances of an important trade in that direction. They had only shipped 6,368 lamps, but that number might have been largely increased if the Hiram S. Maxim Corporation had been ready for them. He was informed that the Hiram S. Maxim Corporation were now prepared to give them

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prompt delivery of a very superior lamp. They were sending out a trial shipment to an Australian corporation with a tender and a cable code for them to order 10,000 lamps per annum for three years, which they hoped to secure, while they were in treaty with several agents at different ports to take from 5,000 to 30,000 lamps per annum. In the coming year this would be done, and an important business would result. In addition to the Maxim incandescent lamp, they had in active progress the production of an arc lamp that for price, efficiency, and simplicity would beat anything hitherto known to the electric world—it was a combination of two American and one English patents, and their emissary was now in the States arranging for the amalgamation of those patent rights, while some 1,500 lamps were in active manufacture in this country. He expected that they would soon put an arc lamp on the market that would be a potential revolution, and must secure the bulk of the arc lamp trade.

UNITED RIVER PLATE TELEPHONE.

The directors of the United River Plate Telephone Company, Limited, announce an interim dividend on the ordinary shares at the rate of 5 per cent. per annum for the half-year ended Sept. 30.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN

Asuncion (Paraguay).—The Municipality invite tenders for the installation of the electric light in the town. Tenders by Jan. 15, 1901.

Colne.—The Electrical Committee invite tenders for various plant. Tenders by Jan. 19. Details in our advertisement columns.

Derby.—The Tramways Committee will shortly advertise for plans for new offices to be erected in Victoria-street, premiums to be offered to local architects.

Oldham.—The Electricity Committee invite tenders for supply, delivery, and erection of engines and dynamos. Tenders by Jan. 29. Details in our advertisement columns.

Madrid.—The Department for Agriculture, etc., invite tenders for the installation and working for 60 years of an electric tramway from Inespete to Fogas and Boranova. Tenders by Jan. 7, 1901.

Southampton.—The Corporation invite tenders for the overhead electrical equipment of about 1¾ miles of tramway route. Tenders by Jan. 7 1901. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for eight 66 passenger tramcar bodies, motors, undertrucks, controllers, etc. Tenders by Jan. 10. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of telephone apparatus in connection with the Glasgow Corporation tramways. Tenders by Jan. 18, 1901. Details in our advertisement columns.

Barcelona.—Tenders will be received for the construction of the electric tramways until 1 p.m. on Jan. 7 at Department of Agriculture and Public Works, Madrid. Specifications may be seen at this office.

Ayamonte.—Tenders for an electric installation for public lighting will be received by the Municipality of Ayamonte (Province Huelva, Spain) by Jan. 12. Specifications may be seen at this office.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of steam dynamos, battery-charging motor, booster, and balancer. Tenders by Jan. 7. Details in our advertisement columns.

Canterbury.—The Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 30. Details in our advertisement columns.

Fulham.—The Council invite tenders for materials and goods required in connection with their electric light and dust destructor station at Townmead-road, Fulham. Tenders by Jan. 9. Details in our advertisement columns.

Rathmines.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 10, 1901. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Farnworth (Lancs.).—The Urban District Council invite tenders for steel girder tramrails, fishplates, etc. Drawings may be seen from the engineer, Mr. W. J. Lomax, A.M.I.C.E., 11, Fold-street, Bolton. Tenders by Jan. 8, 1901.

Whitby.—The Urban District Council invite tenders for erection of an electric light station and destructor. General conditions, etc., can be obtained on and after Jan. 1 from the Clerk at the offices of the Council, Whitby. Tenders by Jan. 8.

Belfast.—The Harbour Commissioners invite tenders for 10 tramway trucks, each capable of carrying a weight of 10 tons on a 3ft. gauge. Further information may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by Jan. 7.

Sheffield.—The Tramways Committee invite tenders for a slow-speed vertical engine for driving a 1,000-kw. tramway generator. Specification, etc., may be obtained from Mr. A. L. C. Fell, M.I.E.E., general manager, Town Hall. Tenders by Jan. 21.

Leeds.—The Lighting Committee invite tenders for the construction of two underground transformer chambers. Specifications, etc., may be obtained from Mr. H Dickinson, manager of the department, 1, Whitehall-road, Leeds. Tenders by Jan. 14.

Manchester.—The Corporation invite tenders for electrical fittings, conductors, etc., at their hydraulic pumping station, Pott-street, Ancoats. Particulars may be obtained from the Secretary, Waterworks Offices, Town Hall, Manchester. Tenders by Jan. 8.

Turin (Italy).—The Public Works and Artillery Department in this town require tenders for 20 tons of copper ingots, to be delivered within 40 days of acceptance of tender. The provisional deposit is £1,840, the final deposit being 10 per cent. of the total. Tenders by Jan. 7.

Rotherham.—Tenders are invited for the supply of electricity meters of sizes for maximum currents of 5, 10, 20, 25, and 35 amperes. The supply pressure is 230 volts, continuous current. Tenders should be sent to Mr. H. Hampton Copnall, town clerk, Council Hall, Rotherham, by Jan. 19, 1901.

Nuneaton.—The Nuneaton and Chilvers Coton Urban District Council invite tenders for erection of a new electric lighting station, comprising engine-house, boiler-house, accommodation-room, etc. Drawings, etc., may be obtained from Mr. J. S. Pickering, A.M.I.C.E., engineer and surveyor, Council Offices, Nuneaton. Tenders by Jan. 8.

Poplar.—The Borough Council invite tenders for the supply of an electric crane to lift a maximum load of five tons, with a return block, the electricity supply being continuous current at 460 volts. Specification, etc., may be obtained from the Borough Electrical Engineer, at the Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by Jan. 16, 1901.

Salford.—The River Irwell Conservancy Committee invite tenders for about 500 yards of tramway, 2ft. gauge, including curves, points, crossings, etc.; a hoist for tram wagons, to drawings; rolled-steel joists for tram bridges; two tram portable turntables, all to be delivered at the sewage works, Weaste. Particulars may be obtained at the Borough Engineer's Office, Town Hall, Salford. Tenders by Jan. 16.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Alteerig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 15, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, New Hampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston-street, Cleveland-road, and Bilston-road to the borough boundary, amounting to a route length of about 4½ miles, mainly double track. General conditions, etc., may be seen at the office of Mr. J. W. Bradley, M.I.M.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Jan. 15.

RESULTS OF TENDERS.

Crewe.—The tender of Dorman and Smith has been accepted for 500 lamp columns.

Kilmarnock.—The Public Library Committee have accepted the tender of Messrs. Anderson and Munro, Glasgow, at £621, for the electric lighting of the Dick Institute.

Derby.—Ferranti, Limited, have secured the contract for an engine and alternator at £6,000. This amount is included in the sum of £35,000 already granted by the Council.

Bristol.—The Electrical Committee have accepted the tender of Siemens Bros. and Co. Limited, for two Siemens-Willans steam-engines and dynamos, having an output of 165 kw. each, for the sum of £4,390. 16s. 6d.

Maidstone.—The Council have settled the contract with Wallis and Sons for the buildings, amounting to £7,226. 11s. 6d., and also the agreement between the Corporation and Stevens and Barker, with reference to their engagement as engineers for putting down the installation for the electric light, and for carrying out the scheme sanctioned by the Local Government Board.

Stockport.—The Tramways Committee have accepted the following tenders: Leeds Steelworks, Limited, rails, fishplates, tiebars, bolts and nuts, £15,902; Hadfield and Co., Hecla Works, Sheffield, points and crossings, £3,407; British Insulated Wire Company, Prescot, overhead equipment and rail bonds, £6,980; Macartney, McElroy, and Co., 165, St. Vincent-street, Glasgow, laying permanent way, etc., £5,795.

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BUSINESS NOTES.

TRACTION.

Huddersfield.—On Thursday last week a successful trial of a tramcar on the Corporation electric tramways, now nearing completion, was made.

Oldham.—The Town Council, after a lengthy discussion on Wednesday, refused to accept the Tramways Committee's recommendations of tenders.

Portsmouth.—The tramways company on Monday night formally handed over their undertaking to the Corporation, and the Town Council now run the cars.

City and South London Extensions.—The Bills of the Islington and Euston Railway Company (proposed capital £420,000), provide for an extension to Euston of the City and South London Railway from their authorised extension to Islington.

Nottingham.—After a delay of more than two months the Market-place-to-Sherwood section of the new electric tramways was opened for public use on Tuesday morning, and, in spite of the inclement weather, the cars were very extensively patronised.

Paris.—The companies which placed 60 electric landaus on the streets of Paris just before the opening of the Exhibition have decided to withdraw them from the streets A number of accumulators were tried, but in every case the cost of the carriages is said to have exceeded the receipts.

Chester.—At the last meeting of the Town Council the municipalisation and further development of the tramways was discussed at length and the whole matter is to be placed before the ratepayers in the shape of a printed leaflet, which the mayor and the town clerk are about to prepare.

Blackburn.—Two years ago the Corporation adopted the electric system, and reduced fares 100 per cent. The receipts that year were over £4,000 more than in the previous year, representing an increase of 2,000,000 passengers. Last year showed an increase over 1899 of £2,500 in receipts and 600,000 in passengers.

Dundee.—The east end, Blackness road, and extended Perth-road section will be opened together about the end of January. The time at which workmen's fares on the Lochee route are in force has been extended, making reduced fares available from four o'clock in the afternoon (instead of from five o'clock) until half-past six.

Broughton.—The Parish Council have approved of the Wrexham Electric Company's application to Parliament for extension of time in connection with the tramway. A proposal that the clerk write Wrexham Electric Company *re* terms for lighting the parish with electric light was discussed last week, but allowed to stand over till a future occasion.

Burnley.—The Tramway Committee of the Corporation have agreed to retain Mr. George Hopkins, C.E., as valuer of the tramway company's undertaking on behalf of the Corporation. The committee will offer the same terms to Reedley Hallows Parish Council for the reconstruction and electrical equipment of the line within their district as have already been arranged with regard to Padiham.

Motors.—The motor industry, we hear, is satisfactorily growing, and next year will probably witness an enormous development. One Coventry firm is reported to have orders in its motor department worth £10,000. At the same time, both English and American papers record a great falling off in the cycle trade, and one of the large tracks near London has been closed for want of patronage.

Putney.—The anti-tramway agitation still continues. A deputation from ratepayers and inhabitants of Putney, which was received last week by the Wandsworth Borough Council, opposed the proposed construction of tramways in the parish on the ground that at present the parish was well served by omnibuses. The Mayor promised careful consideration for the petition, which was signed by 1,190 names.

Perth.—The Special Tramways Purchase Committee have resolved to recommend to the Police Commissioners that the offer of £20,000 made for the purchase of the tramways is a very reasonable one; that it should not be increased; and that in the event of its non-acceptance notice be given to the tramway company to acquire the whole undertaking in terms of the Commissioners' powers to that effect.

The Mumbles.—The British Electric Traction Company have formed plans for laying out the vacant land in Mumbles village. Between the main road and the Dunns Station there will be a short street of lock-up shops, with cafés overhead. From the Dunns Station, running parallel with the railway to Southend, the company propose to lay down a promenade, inside of which and facing the sea will be erected a terrace of villas.

Salford.—The Tramways Committee's proposal to establish a circular system in the centre of the town, with cars running every 2½ minutes and collecting and depositing passengers at the starting points of the various routes, caused much discussion at Wednesday's meeting of the Town Council. An amendment disapproving of the scheme was defeated. It was stated that by these means an expenditure of £400,000 on street widenings would be avoided.

Derby.—The Tramways Committee of the Corporation are negotiating for the purchase of property in Full-street and Silk Mill-lane. It is suggested in regard to the proposed electric trams that a meeting of the tradesmen and property owners in St. Peter's-street should be called to consider the question of double lines along the street. It is urged that they would be most dangerous to the public who may be driving through the streets or alighting for shopping.

The Spen Valley Tramway Scheme.—The Gomersal District Council are preparing notices with a view of exercising their right to purchase so much of the undertaking of the Dewsbury, Batley, and Birstal Tramways Company as lies within their district, in accordance with the agreement between the Council and the company to transfer the same to the electric traction company in connection with their scheme of tramways for the Spen Valley and district.

Halifax.—The Tramways Committee have decided to advance the salary of Mr. F. Spencer, tramways manager, by £50 per annum on Feb. 1 next, with a further advance of £50 on Feb. 1, 1902, subject to his entering into an agreement to remain in the service of the Corporation for a period of two years from Feb. 1 next, the Corporation to have the right to use the patents obtained by him without payment of royalty or other charges, and all witnesses' fees received by him to be paid to the Corporation.

Gateshead.—Following the near completion of the tramway lines in Gateshead, a beginning was made on Sunday with the erection of the pillars for the support of the wires. The route chosen for the first erections was Sunderland-road, and the pillars are to be set up on either side of the road. A large staff of workmen worked without interruption until nightfall, when scores of holes had been excavated for the pillars. The next day a travelling hoisting crane was brought into use, and a number of pillars set up.

Bradford.—The receipts on the various lines of the city tramways during the week ended Dec. 30 were: Bolton, £153, or 11·83d. per mile run; Horton, £323. or 13·35d. per mile; Lidget Green, £169, or 13·57d. per mile; Whetley Hill, £226, or 19·88d. per mile; Thornton, £98, or 9·56d. per mile; and Stanningley, £89, or 12·07d. per mile. The receipts per mile run for the various lines from or subsequent to April 1 last have been: Bolton, 11·17d.; Horton, 11·77d.; Lidget Green, 11·53d.; Whetley Hill, 17·4d.; Thornton, 8·64d.; and Stanningley, 9·02d.

Cleckheaton.—The District Council's electricity scheme includes provision for supplying motive power for the electric tramway to be laid by the British Electric Traction Company between Cleckheaton and Dewsbury, so far as it affects the Council's district. The estimated annual expenditure, including loan charges and working expenses, is £1,462, and it is calculated that there will remain a small profit on a supply of 36 000 units for lighting and ordinary power purposes, at an average charge of 5·5d. per unit, and 100,160 units for tramway purposes at 1½d. per unit.

Tramways in the Lake District.—The report of the committee appointed by property owners and others to oppose the scheme of the British Electric Traction Company, Limited, to lay down electric tramways in the Lake District states that the application of the Electric Traction Company has been withdrawn. The secretary has been instructed by the committee to hold in abeyance all preparations connected with the dispute, but to collect information as to procedure and precedents in similar cases, and to invite all persons interested to join the guarantee fund, which now amounts to over £1,300.

Yeadon.—At Wednesday's meeting of the District Council the proposals of the Yorkshire Electric Power Syndicate were discussed. A letter was read from Messrs. Gibbings and Baker, the engineers to the syndicate, pointing out the area proposed to be included in the application to Parliament, and communications were also received from three or four local authorities in reply to the Yeadon Council's query as to whether they were willing to attend a joint meeting to discuss the matter. It was decided to defer further consideration of the subject until replies from all the councils in the Wharfedale Union were received.

Wrexham Tramways.—The National Electric Traction Company, Limited, were summoned on Monday by the Wrexham Town Council for failing to keep their tramway in proper condition. Since the case was last before the court notice has been served by the traction company asking that all matters in difference between the parties should be referred to an arbitrator appointed by the Board of Trade. The Town Council now asked that the summons be amended so that the Board of Trade could be approached. The magistrates decided to adjourn the case for a month in order that the road authority could invoke the aid of the Board of Trade.

Bury.—The additional tramways which it is proposed to construct under the Corporation's new Tramways Bill, are expected to cost £132,000, the additional electricity works require another £39,000, and the street improvements £114,000. There are 25 new sections of tramways proposed to be laid, but all are short lengths, and cover only about nine miles altogether. The only portions outside the borough are the districts of Tottington, Unsworth, and Whitefield. The Corporation takes power to carry light and heavy goods on the tramways, goods even exceeding eight tons in weight. The Corporation also seek powers to supply electrical energy outside the borough.

Bradford.—The directors of the Keighley Tramways Company and a committee of the Corporation have arrived at a provisional agreement for the sale of the tramway undertaking and plant to the Corporation. The agreement only requires the approval of the shareholders, and an early meeting will be called for obtaining that consent. It is understood that the directors refused a sum equal to 8s. for every £1 share, and that the amount they have accepted is a little over £8,000, or about 10s. per share. The company has never paid any dividend. The full sale price will not be available for the shareholders, for there is a debt on the under-

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taking. It is expected that the Corporation will introduce electric cars as soon as possible.

Leeds.—The receipts of the Corporation tramways during 1900 totalled £168,005. 11s. 6d, as against £123,937. 0s. 6d. for the previous year, or an increase of £44,068. 11s. The gradual extension of the electric light system is responsible for the swelling of the receipts, and the figures conclusively prove that wherever improved facilities for travelling are provided the public will take advantage of them. Within the past year electricity has supplanted horse and steam haulage on different routes, and the committee have instructed the engineers to get out specifications for the electrical equipment of the few remaining sections. It is expected that tenders will be accepted early in spring, and the work completed before the close of the year.

South London.—In a letter to the *Daily Chronicle*, "Suburban" remarks on the County Council's project of a line through Denmark-hill, Grove-lane, and East Dulwich, that it should be opposed on these following grounds: (1) the route is hilly and circuitous; (2) it throws the burden of additional traffic upon the already congested Camberwell and Walworth roads; and (3) it involves the destruction of many pretty gardens, and of a very great number of trees, and altogether mars the beauty of an interesting suburb. The writer makes an alternative suggestion to extend the South London Electric Railway from the Elephant and Castle to Camberwell-green, and thence to East Dulwich, thus affording quick and direct access to all parts of London, and making use of an already existing system of communication.

Middlesbrough.—A curious dispute arose at the last Town Council meeting. It will be remembered that the Council wrote to the Board of Trade complaining of the action of the inspector in not waiting for the Corporation representatives when he made his inspection. A reply was received stating that the lifeguards or fenders now fitted to the cars were inspected by Colonel von Donop, and that the Board understand that the tramway company propose to try a fender of a new type. A copy of Colonel von Donop's memorandum was added, in which he said that he had no previous intimation of any deputation having wished to see him at Middlesbrough. The engineer and others asserted that they had informed the inspector upon his arrival that a deputation was waiting for him at the town hall. There must be some mistake somewhere.

Objectionable Passengers.—The *Globe* on Saturday, discussing the subject now attracting attention in Liverpool of unpleasant and insanitary people in tramcars and omnibuses, says: "The conductor has the right, which he very often exercises, of preventing an intoxicated person from entering tram or 'bus, and there is no reason why he should not exert his power in cases where a would-be passenger is clearly and beyond all question unfit to mix with respectable people. Such a step would at any rate rid the public of the intolerable part of this nuisance. In cases where a person is only moderately insanitary, and might be inclined to argue the point with the conductor, the public can look for no protection." The same thing holds good where a man is drunk and tries to argue the point, no matter whether he is moderately or immoderately so.

Dudley.—A rather serious accident has occurred on the tramway. A car while going at full speed down a steep gradient left the metals, swerved round, struck and broke a pole, knocked down part of a wall, and was only prevented from toppling over by coming against another pole. The overhead wires were brought down and the traffic suspended for some hours. At the Town Council meeting last week it was said that the accident was due to overcrowding. It appears that the car descended the steep portion of the hill safely, but directly the front wheels had passed the stationary points at the foot of the incline, where there is a passing place, it suddenly left the metals. There was a fairly good number of passengers in the car at the time, and they were all badly shaken, whilst five of them were more or less seriously injured, the motorman narrowly escaping being killed.

New Branch.—Messrs. Robert W. Blackwell and Co., Limited, engineers and contractors of London, Liverpool, Manchester, Paris, Brussels, and New York, and who have made a speciality of electric traction and power transmission, have just opened a branch at 7, St. Mary-street, Cardiff. We learn that engines have lately been installed by this company in the power stations at Sheffield, Middlesbrough Glasgow, Bristol, Dublin, Cork; for the Isle of Thanet Light Railway, the London United Tramways, and London's latest and most useful railway, the Central London, and a combined lighting and power plant was recently completed by the firm at Ellesmere Port, Cheshire. Some 250,000 h.p. of steam-engines have been installed by them within the last few years. The local management has been entrusted to Mr. B. Phillips-Smith, who has until lately been in charge of one of the principal departments at the head office in London.

Cardiff.—On Tuesday the Mayor of Cardiff (Councillor Andrews), who is also chairman of the Tramways Committee, started the work on the new municipal tramways, which, it is hoped, will be ready for electric traction at the end of 1901. The work of excavating was begun last week in Cathedral road, and at noon on Tuesday the Mayor laid the first rail and fixed the first electric bond. The laying of the track is in the hands of the borough engineer (Mr. Harpur), and the bonding and other electric equipment come within the province of the electrical engineer (Mr. A. Ellis). A start has also been made with the laying of the main cable trench in connection with Cardiff's electric system at Pengam Bridge on the Newport road. When the weather improves about 50 men will be employed on this part of the work. A Tramways Sub-Committee of five will shortly visit various towns where electric cars are now running, and also the works of well-known makers where cars are being built, in order to present a report and recommendations to the Council.

Lancaster.—There are 34 applications for the post of electrical engineer for the borough to take charge of the electric light works and to superintend the installation of the new tramway scheme. The salary offered is £300 per annum. The following were selected to meet the committee: Mr. E. A. Browning, London; Mr. A. R. Dayson Plymouth; and Mr. W. A. Tester, Western Counties. On Wednesday a long discussion arose regarding the proposed appointment. At a previous meeting it had been decided that the engineer to be appointed should act under the surveyor until Mr. Fraser returned. An effort was now made to get the resolution rescinded so as to allow the committee to appoint an engineer to have full charge. It was stated that the selected candidates had refused to accept appointment under another official. The Mayor ruled that the standing order precluded the rescinding of the resolution, and the matter was left over to the next Council meeting, when notice would be given.

Aberdeen.—At the last meeting of the Tramways Committee, a letter was read from the M'Elroy-Grunow Electric Railway System Company, New York, stating that they accepted the conditions in the contract signed by the Council to lay down an experimental line to the beach. A communication was also submitted from Messrs. Johnson, Lundell, and Co., Limited, asking if they would be permitted to lay down an experimental line. A good deal of discussion took place over the matter, and the opinion was expressed by several members that, seeing that they had already agreed to one experimental line, another would complicate matters, and that they were in this further difficulty that they had no street on which they could allow the company to experiment in which there was a cable, and on which they had parliamentary powers to allow the company to lay down a line. It was therefore agreed not to comply with the request meantime. It was stated also that an experimental line by Johnson, Lundell, and Co., Limited, would be laid down in all probability in some English town, and that the committee would have an opportunity of inspecting it.

Wigan.—Under the omnibus Bill deposited for next session, Parliament will be asked to extend the Corporation's powers to supply electricity, at present confined to public and private purposes, so as to enable the Corporation to supply electrical energy for traction purposes to 'any authority, company, or person owning or working light railways or tramways within or without the borough." These powers are, of course, restricted by a provision prohibiting the Corporation from supplying energy in any district in which any local authority, company, or person "are already authorised to supply energy by provisional order, unless such local authority, company, or person consent thereto in writing." Power is also sought to enable the Corporation to sell or let fittings and apparatus "for all purposes for which electrical energy can or may be used," and provision is also made to empower the Corporation to sell electricity in bulk to any local authority adjoining the area supplied by the Corporation. The Bill also empowers the Corporation to construct five sections of tramways of an aggregate length of 5¼ miles, and to borrow for the construction of these lines £65 950.

Palermo.—Mr. de Garston, in his report on the trade and commerce of Sicily, speaks of electric trams and light in Palermo. He says: "The laying down of the electric tramway to replace the present horse service has proceeded satisfactorily during the latter half of 1899, and will be a great improvement to Palermo; not only are the existing tramway lines to be transformed, but new lines will be laid, notably a specially constructed and worked track from La Rocca to Monreale, which will be exceedingly handy for the numerous tourists and visitors who annually flock to visit the magnificent cathedral. The tramway company, in order to obtain the necessary sanction for the extension of its lines, found it expedient to offer a premium of 1,000,000 lire (£40,000) to the municipality of Palermo as an incentive for certain concessions, which were not, however, accorded. Large workshops have been established at the Arenella, a suburb of this city, for the construction of the tramcars by a local firm, and these are furnished with excellent modern machinery, the cars turned out being apparently in every respect satisfactory. The Via Macqueda, one of the principal thoroughfares intersecting this city, is now lighted by electricity, which is supplied by the works of the tramway company; private consumers are also furnished by the same company. The price, however, is still apparently too high for electricity to be generally introduced into private households, and, moreover, there does not seem to be any likelihood of the cost being lowered."—*Morning Post.*

LIGHTING AND GENERAL.

Dunstable.—The Town Council have agreed to apply for a provisional order for electric lighting purposes.

Galashiels.—The Town Council have decided to apply for an electric lighting provisional order.

Dudley.—The Town Council propose to renew their application for sanction to borrow the money for free wiring.

Dundee.—We understand that the Town Council are making experiments with a view of lighting the tops of their tramcars.

Gateshead.—The Urban District Council have received an amended estimate of the cost of electric lighting from Mr. Hamer.

Stockton.—The electric arc lamps in the Stockton High-street were on the 27th ult. turned on for the first time since the formal opening.

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Far-Distance Telephone.—We note that direct telephonic communication will be opened between Brussels and London next February.

Worcester.—The Council have authorised the Electricity Committee to enter upon a scheme for the extension of street-lighting by electricity.

Goole.—The Urban District Council have passed the statutory resolution opposing the application for an electric lighting provisional order.

Grimsby.—On Tuesday Alderman Dobson, chairman of the Lighting Committee, formally switched on the electrical illumination of the station.

Electric Construction Co.—The transfer books for the 4 per cent. perpetual first mortgage debenture stock will be closed until 14th inst. inclusive.

Barnard Castle.—The Rural District Council have decided to take no action with regard to the Cleveland and Durham Electric Power Company's Bill in Parliament.

Cardiff.—Mr. Ellis said at Monday's meeting of the Town Council that a scheme was being arranged for lighting the main thoroughfares in the South Ward by electricity.

Clayton.—The draft provisional order for electric lighting in Clayton, Great Harwood, and Rishton has been referred to a sub-committee with power to engage expert assistance.

Share Market.—Dull and inactive was the note as far as transactions in the electrical market were concerned this week. The quotations suffered in consequence of the Globe disaster.

Huddersfield.—The Incorporated Chamber of Commerce last Friday resolved to reply to the Walsall Chamber of Commerce that the local telephone service was "good, but too expensive."

Rotherham.—The price to be charged for electric current will probably be fixed at 5d. per unit. The cable from Doncaster road is to be extended to the corner of Parkfield-road in Clifton-lane.

Italy.—The Municipality of Catanzaro have just petitioned the Government for a commission to lay down and work an electrical tramway from the railway station of Catanzaro Sala to Catanzaro Città.

London Gazette.—A first and final dividend of 5s. 7$\frac{1}{2}$d. per pound has been declared *re* G. H. Bentley, 63, Cross-lane, Earlestown, Lancaster, payable at 71, Cross lane, Earlestown, Lancaster, on Jan 16.

East Grinstead.—The Urban District Council have decided to spend £25 in employing an expert for his opinion on the practicability and commercial prospects of an electric light undertaking in the town.

Gillingham.—The District Council are approaching the electric light company with a view of acquiring the works and rights of the company. Chatham and Rochester are proceeding in the same direction.

Wrexham.—At the Town Council meeting last Friday it was decided to obtain an estimate for erecting the necessary bells, wires, and switches for electric calls for about six firemen's houses within the borough.

Ilkley.—The application of a syndicate for an electric lighting order is to be opposed, and if necessary the Council will apply for an order and bring forward a scheme of their own. An electrical expert is to be engaged.

Lincoln.—Permission for the erection of various telephone poles had been asked of the City Council, but this has been withheld until the advisability or otherwise of the introduction of municipal telephones has been determined.

Electric and General Investment Co.—Warrants for the dividends on the 6 per cent. cumulative preference shares, and the interim dividend of 10 per cent. on the ordinary shares of this Company, have been duly posted.

St. Pancras.—The Borough Council have authorised an expenditure of £29,390 for the laying of additional electric feeding mains into King's Cross, Highgate-road, and Prince of Wales-road districts. The works are to be carried out forthwith.

Personal.—We learn that Mr. Philip Dawson, managing director of Messrs. Robert W. Blackwell and Co., Limited, has just left for the United States in order to enquire into the subject of electric traction on metropolitan and interurban lines.

Notting Hill.—The Notting Hill Electric Lighting Company's Bill seeks for powers to acquire properties in Napier-road and Holland-mews, Kensington, for the purpose of providing an additional generating station. No additional capital will be created.

Maidstone.—An additional 150-kw. steam dynamo and extra boiler is to be put on order forthwith, owing to the strong probability of being required next winter. The cost will amount to £2,299. 17s. 6d., which has been estimated for and included in the loan sanctioned.

Sale.—The Nelson Corporation invite offers for the sale of a storage battery, E.P.S. central-station K-type, consisting of 62 solid lead box cells of 132 plates in each, also six Faure-King cells, with all plates and lead strip connections complete. Full particulars appear in another column.

City of London Union.—The electric light installation at the Board's offices, at 61, Bartholomew-close, is now completed, and the Board-room was on Tuesday illuminated with electricity for the first time. The standards and chandeliers are gilded, and each bears the City coat-of-arms.

Greenock.—Bailie Cook last week formally opened an installation of electric light in the town hall saloon, cloakrooms, and ladies' rooms. Between 200 and 300 lamps, each equivalent to 8 c.p., have been placed in the saloon, and the carriageway leading to the town hall has also been lit up.

Barnstaple.—The Electric Lighting Committee, after having discussed the report of the engineer (Mr. Adams), have asked him to prepare a further report providing for the public lighting of the borough outside the compulsory area so far as the inhabited and frequented portions of such area extended.

Spain.—The Compagnie Thomson Houston de la Méditerranée, which has its seat in Brussels, has just increased its capital from £400,000 to £800,000 with the object of extending its operations in Spain, where probably a branch will be established. The shares, which are nominally of £20, were issued at £24.

Partnership.—We note that the business which has been carried on for the past 11 years at 36, Dale street, Liverpool, by Mr. Lester Taylor and Mr. Archie Kelly will in future be continued by them in partnership with Mr Walter J. Hide, and under the style of Lester Taylor, Kelly, and Hide.

Peter Spence and Sons.—We are informed that, for family reasons, this business has been converted into a limited company under the style of Peter Spence and Sons, Limited The whole interest of the firm will remain vested in the partners and their families, and there will be no change in the management.

Wigan.—The Corporation have decided to promote in the next session of Parliament a Bill for the following purposes: to construct tramways along the following routes—(1) Wigan lane, Wigan, and Wigan-road and High-street, in Standish; (2) Woodhouse-lane, Wigan, and Standish Lower-road, Standish; (3) Millgate, Scholes, and Whelley, Wigan; (4) New Market-street, Frog-lane, and Woodhouse-lane, Wigan; (5) Caroline-street, Chapel-lane, Bradford street, and Bradford-place, Wigan; and also to empower the Corporation to construct street improvements in the districts named and to supply electricity in bulk beyond the limits of the borough.

Appointments Vacant.—A mechanical foreman is wanted, for the service of the Government of India, to take charge of the repair and manufacture of telegraph instruments in the telegraph workshops, Calcutta.—The Tramways Committee of the Huddersfield Corporation invite applications for the appointment of lineman.—The Tramways Committee of the Manchester Corporation require the services of a competent electrical engineer to act as the chief engineer of the tramways department. Salary, £400 per annum.—A smart draughtsman is wanted as evening instructor in the drawing office of the Northampton Institute, Clerkenwell, E.C. Full particulars of these vacancies appear in our advertisement columns.

Power Schemes.—Amongst this session's power schemes are again to be found, with a capital of two million pounds sterling each, the Electric Power (Yorkshire) Company, for the purpose of supplying electricity to authorised undertakers and to persons requiring a supply for power within a portion of the West Riding of the county of York, and the South Yorkshire Electric Power Company. The area within which this company proposes to carry on business is set out at great length in a schedule attached to the Bill, but by express enactment the company is prohibited from exercising any powers in Bradford, Leeds, and Sheffield, and, except for the purpose of obtaining convenient access to some other district, a similar restriction is placed upon the company in Halifax, Huddersfield, Wakefield, Dewsbury, Batley, Morley, Brighouse, Keighley, Doncaster, Barnsley, Rotherham, and Todmorden.

Stock Exchange.—The Stock Exchange Committee have appointed special settling days as under: Jan. 9—Blackheath and Greenwich District Electric Light Company, Limited, provisional certificates for £100,000 4$\frac{1}{2}$ per cent. first debenture stock; Motor Manufacturing Company, Limited, 246,432 shares of £1 each fully paid, Nos. 1 to 246,432. Jan. 15—London United Tramways, Limited, provisional certificates for £328,444 4 per cent. first mortgage debenture stock. They have also ordered the undermentioned securities to be quoted in the official list: Blackheath and Greenwich District Electric Light Company, Limited, provisional certificates for £100,000 4$\frac{1}{2}$ per cent. first debenture stock; London United Tramways, Limited, provisional certificates for £328 744 4 per cent. first mortgage debenture stock; Kensington and Knightsbridge Electric Lighting Company, Limited, and the Notting Hill Electric Lighting Company, Limited, £73,009 4 per cent. debenture stock; Metropolitan Electric Supply Company, Limited, further issue of 13,769 shares of £10 each, £5 paid, Nos. 85,001 to 98,769.

Worthing.—The Council adopted the following report on Wednesday: "The committee, as authorised by the Council at its last meeting, considered the question of obtaining information as to the cost and practicability of constructing electric tramways in the borough, and resolved to insert advertisements in the usual trade papers inviting offers from any person, firm, or company willing to instal, equip, and maintain a system of electric tramways in the borough, with power to the Corporation to acquire the same at any specified date upon agreed terms, such offers to specify the price to be paid for current to be supplied from the central station of the Corporation electric lighting works. An offer by Mr. Monkhouse to give a lecture on the use of electricity and electric lighting within the borough was accepted with thanks. The committee also recommended the Council to fix the charge for electrical energy at 6d. per unit for lighting purposes and 3d. per unit for power, with discounts varying from 1 to 25 per cent. when the quantities used amounted to 1,000 units and over per year." The question of the manner of charging was left open for the present.

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Hammersmith.—It is proposed, in order to judge of their effectiveness for lighting a main road, that the gas lamp-posts in Dalling-road and Paddenswick-road be equipped with Loftus lanterns containing two electric incandescent lamps of 16-c.p. each, of similar pattern to those which have been fitted in the Luxemburg-gardens.

Diary.—Messrs. John Walker and Co.'s No. 1 diary for 1901 is a useful and handy article, giving the usual information contained in such productions. The most noticeable feature about the diary, the binding of which is in russian leather, is its completeness, yet small size. It may thus be carried in one's pocket without inconvenience.

Swansea.—The Board of Management of the hospital decided on Thursday, as the Corporation could not guarantee a supply of electrical energy for the laundry within a given time, to ask the National Wiring Company to fix the necessary machinery for a brief period on their guaranteeing the cost of working to be below that of gas engine power.

Ross.—The Ross Urban Council have consented to the application for the draft provisional order promoted by Mr. John Parker, of Hereford, for the supply of electric light for Ross. The company promoting the scheme will have a capital of £8,000, and it is estimated that the cost of the installation will be £7,800. The maximum cost for the current will be 8d. per unit, and the net price 7d.

Recent Floods—Many houses at Sandgate have been flooded, and the tramway service was suspended for some time last week between Sandgate and Hythe owing to the state of the track. On Monday the floods rose at Loughborough to 3ft. between the platforms of the Midland Railway station, and flowing into the Brush Electrical Works caused most serious damage. Fifteen hundred men had to leave work.

Aberdeen.—At the last meeting of the Gas and Electric Lighting Committee of the Town Council it was resolved to support overtures to the Board of Trade which were being made by corporations all over the country in relation to proposed changes in the rules affecting alterations to voltage in connection with the supply of electric light. Accounts were passed amounting to £16,002. 9s. 6d. in connection with the electric department.

Dear Lamps.—In consequence of previous thefts, a strict watch was kept at the Bank Station of the City and South London Railway on Saturday night, and at about 11 o'clock a man was practically caught in the act of taking a lamp, which was valued at 1s. After its removal the staircase was left in total darkness. When given into custody he said, "I was a fool; I stole it to give to a friend of mine in the electric light line.' His folly cost him 40s., or in default 14 days.

Hull.—The second sectional meeting of the employés of the Hull Electric Lighting Committee took place at the Imperial Hotel on Monday, the chairman of the committee (Councillor Skinner) presiding. About 40 of the staff sat down to an excellent tea, and after some humorous remarks by the Chairman, in which he sketched the Hull electrical millennium, and advised closer personal knowledge between the committee and the staff, an enjoyable musical programme was gone through, interspersed with speeches by the mayor, the deputy-chairman, and the engineer. The meeting was most successful throughout, and provides an example worthy of imitation elsewhere.

Metropolitan Electric Supply Co.—In the Metropolitan Electric Supply Company's Bill powers are sought to lay a second distributing system from each of its distributing stations. At the present time the Company is dependent for its supply of electricity on a single line of cables passing from its generating station at Willesden, along the towing path of the Grand Junction Canal to the several areas of supply. The second distributing system now proposed will be separate and distinct from the existing trunk main, and will run by an entirely different route to the various areas of supply, and thus enable the Company to give an extra high pressure and will better secure the continuance of the supply.

"Multum in Parvo."—The Electrical Power Storage Company, Limited, publish, as usual, their combination of blotting pad, diary, account book, etc. A £500 railway accident policy is thrown in. From the price list attached we gather that the company, who received a gold medal at the Paris Exhibition, 1900, sell about 1,000,000 plates per year. Particulars are given of one-hour and two-hour discharge cells and various types of E.P.S batteries. The Faure King cell for autocars is specially mentioned. A number of instruments are catalogued, amongst which a very compact little voltmeter is particularly worthy of note. We are informed that the company have, according to their usual custom, sent a blotting pad and diary for the year 1901 to each of their customers, and that should any have been accidentally omitted the mistake will be rectified on receipt of a postcard.

Islington.—The Borough Council, on the recommendation of the Finance Committee, have agreed to adopt the sum of £6,606, for the loan of which sanction has been obtained, as the estimate of the cost of erecting a water tower and tanks and other works at the electric lighting station. At the meeting to-night it will be proposed that, having regard to the very unsatisfactory condition of the public street lighting in the borough, outside the area lighted by electricity, it be an instruction to the Works Committee to bring up a scheme with an estimate of the cost of improving such lighting either by the introduction of electricity where feasible or by the use of incandescent or other improved gas lighting. The Council will also receive a deputation of tradesmen and residents in the Upper-street desirous of objecting to the proposed subway leading from the Torrens-street station of the City and South London Railway Company into the Royal Agricultural Hall.

City of London Electric Lighting Company's Charges.—The City of London Electric Lighting Company has given notice of an increased scale of charges, which is to take effect from the beginning of the present year; in fact, the scale will really come into operation from the date on which the last meter readings were taken on each consumer's premises in December. It will be remembered that the previous scale of charges were based on a charge of 8d. per unit for the first 12 units consumed per annum per 8-c.p. lamp fixed on the consumer's premises. All electrical energy consumed over and above these 12 units was charged for at 2d. per unit. In the new and revised scale the number of units to be charged at 8d. has been increased to 18. Of these 18 units six per 8 c.p. lamp are supposed to be consumed for each of the two winter quarters, and three units per 8 c.p. lamp for each of the summer quarters, before the reduction to 2d. per unit is made. The company state that the high price of coal has led to the alteration and revision of scales, which revision, we think, will be welcomed by the Charing Cross and City Electric Lighting Company, which is now getting to work. We regret that with the revision of charges the company has not seen its way to work its sliding scale on the basis of maximum demand rather than on lamps fixed. There will be no alteration in the charge for electrical energy supplied to motors, which will remain at 2½d. per unit.

Bournemouth.—Messrs. Lacey, Clirehugh, and Sillar have been asked to advise the Corporation on the purchase of the electric light undertaking. The Mayor, the Chairman of the Lighting Committee, with Messrs. Beckett, Mate, Lane, and Webber, have been appointed a sub-committee to confer with the consulting engineers, and arrange all matters of detail in connection with the purchase. Mr. H. P. Boulnois has held an enquiry into the application of the Town Council for sanction to borrow £12,000 for the purposes of electric lighting. The Town Clerk (Mr. J. Druitt, jun.) explained that the money was required to enable the Corporation to utilise the proposed generating station for the purpose of the electric trams, and to light by electricity the various streets which would be traversed by the trams. The total of the estimate was £12,661, although only £12,000 was asked for, the estimate having been amended since the application was made. The Borough Surveyor and Mr. Lacey (of the firm of Lacey, Clirehugh, and Sillar, electrical advisers) presented plans and described them, and the latter stated that between seven and eight miles of streets would be lighted by electricity. There would be 220 arc lamps, separated from each other at distances varying between 60 and 80 yards, according to the character of the streets, and each arc lamp would have attached to it two incandescents of 16 c.p. each. The arc lamps would be of 2,000 c.p. each.

Bolton.—The electricity department of the Bolton Corporation has undergone some changes of late in connection with its *personnel*, but the staff has now been completed by the appointment just made of Mr. W. J. Wood, of Edinburgh, to the post of chief assistant under Mr. A. A. Day, M.I.E.E., the borough electrical engineer. Mr. Wood's salary will be £110 per annum, with an increase of £20 during the next two years. It is interesting to note that the alleged grievances of the employés in this department, as alleged by the officials of the Trades Council, have been declared by the committee, on enquiry, to be unproved, whilst an intimation has also been given that all complaints of a similar character must be reduced to writing before they are taken in hand by the committee. The annual returns just issued in connection with the department contain the following statistical information: Cost of works, £117,589; quantity of energy sold per annum, 842 792 Board of Trade units; greatest output on one day for lighting, 6,057 units, and for trams 3,970 units; length of cables laid, 61,500 yards; number of consumers, 751; number of 8 c.p. lamps connected, 56,705—total income, £12,098. Tramways: Four routes of 24 miles. Capital expenditure on lines, £124,246; number of car miles run during six months ending Sept. 30, 683,113; passengers carried, 8,575,148; total receipts, £35,762; working expenses, £17,225; and interest and sinking fund, £6,385.

Belfast.—The electrical engineer is early in the field with his annual statement, which reads as follows: "On Dec. 31, 1899, we had an equivalent of 51,500 8-c p. lamps connected to the mains; we have now 73,500 8 c.p. lamps connected, or an increase of 22,000 lamps, 43 per cent., and we have application for a further 10,000 8 c.p. lamps. The output for the year 1899 was 622,500 units sold. I estimate the output for the year 1900 at 875,000 units, or an increase of 40 per cent. The average price obtained for current supplied during 1899 was 4·36d. per unit. Owing to the reduction in price introduced in the beginning of this year, the average price will work out at about 3¾d. per unit. The Free Wiring Company has obtained for us during the year a connection of over 2 000 8 c.p. lamps. The advantages of electrical driving are at last being recognised, and we have now about 120 electric motors aggregating 450 h.p. connected to our mains, and applications for a further 160 h.p. The system of letting out motors on hire is being appreciated by small users of power, and we have about 150 installed, driving various types of machinery, including hoists, sewing machines, linen-finishing machines, printing machines, dairy machines, ventilating fans, grain crushers, etc. The average price obtained for current supplied for motors during the year works out at about 2¼d. per unit, while several long-hour consumers obtained it as low as 1·6d. per unit. I am pleased to be able to state that, notwithstanding the greatly increased cost of coal during the year, our cost of production will not be

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increased, but will actually be reduced owing to other economies being introduced and to the increased output. The maximum load on the station for 1899 was 955 kw., and for 1900 1,307 kw., or an increase of 37 per cent."

District Messenger Company.—The particulars of the Bill which the District Messenger Company, Limited, will seek to carry in the next session of Parliament for conferring upon them further powers with respect to telegraphic and telephonic communications, show that the Company have already expended upwards of £140,000 in establishing and improving a system of electric calls, and have organised a messenger system, but that up to the present no dividend has been paid to the holders of ordinary shares of the Company in respect to such outlay. They were the first to establish any such system, and are the only existing institution within the specified district maintaining a prompt and efficient night and day messenger service. They have paid upwards of £12,500 in royalties to the Post Office, and for the last five years such royalties have exceeded 43 per cent of the Company's net revenue for that period. The conditions imposed by the Postmaster-General under the licenses by which the Company carry on their service are, they contend, unduly onerous, and, unless modified, will render it impossible for them to continue their business. The period for which the existing licenses were granted expires on April 14, 1903, and having regard to the large amount of outlay necessary to maintain and extend the system, it is essential that the Company's rights and powers of carrying on their business should be secured to them for an extended number of years beyond the five years offered by the Postmaster-General. They, therefore, ask that the period should be for 42 years from April 14, 1903; that the royalty then paid to the Postmaster-General should be £5,000 per annum, with an additional £100 for every 1 per cent. over 5 paid in dividends to the ordinary shareholders in any year.

NEW COMPANIES.

The following new companies have been registered:

Walters Motor Syndicate, Limited.—Capital, £5,000. Object: to manufacture motors, launches, etc., and to carry on the business of electricians, etc.

Auto Steam Generator Syndicate, Limited.—Capital, £5,000. Object: to carry on the business of cycle and launch builders, and electricians, etc.

Williamson and Joseph, Limited.—Capital, £4,000 in £1 shares. Object: to acquire the business referred to in an agreement with the Consolidated Telephone Construction and Manufacturing Company, Limited, and to carry on the business of electricians, electrical and general engineers, suppliers of electricity, etc.

Milnerton (Cape Town) Estate and Railway Company, Limited.—Capital, £330 000. Object: to acquire the business of the Milnerton Estates, Limited, of Cape Town, and to acquire, own, maintain, and work any railways, tramways, telegraphs, telephones, and other works and undertakings.

Brisbane Electric Tramways Investment Company, Limited Capital, £75,000 in £5 shares. Objects: to adopt agreements made with W. H. Adams and with the Brisbane Tramways Company, Limited, primarily to carry on the business of light railway and tramway constructors and owners.

Richard Johnson and Nephew, Limited.—Capital, £200,000. Object: to acquire and carry on the business now carried on at Bradford Ironworks, Manchester, and at Alderwasley, near Ambergate, Derbyshire, by H. A. Johnson and E. Johnson under the style of Richard Johnson and Nephew, and to carry on the business of ironmasters, wire drawers, electrical engineers, electric cable manufacturers, etc.

Johnstone, Benjamin and Co., Limited.—Capital, £15,000. Object: to take over the business of electric wire and cable manufacturers and metal merchants now carried on at the Crown Electric Works, Ascham-street, Kentish Town, N.W., by L. Benjamin and E. E. Benjamin as Johnstone, Benjamin, and Co., and to carry on the business of electricians, electrical and mechanical engineers, etc.

London and County Contracts, Limited.—Capital, £5,000. Object: to adopt an agreement with R. Turnbull, and to carry on the business of estate owners, builders, contractors for railways, tramways, and public works, etc.

Universal Telephone and Electrical Company, Limited.—Capital, £10,400. Object: to carry on the business of a telephone, telegraph, and electric light, heat and power company, and, in particular, to establish and maintain telephonic exchanges, telegraphic and telephonic systems and works, etc.

Moorlort Goldfields, Limited.—Capital, £750,000. Object: to acquire certain mines, and to establish and maintain telegraph and telephone systems.

Fleet and District Electricity Company, Limited.—Capital, £5,000, in £1 shares. Objects: to acquire the right to supply electricity in Fleet and district, in the county of Southampton, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity for light, heat, motive power, and otherwise, etc.

J. G. Wagstaff, Limited.—Capital, £25,000. Object: to acquire the business carried on at Dukinfield, Cheshire, known as the Alma Ironworks, and the site thereof, now belonging to J. G. Wagstaff, of Sycamore House, Dukinfield, with the engineering business carried on by him at the said premises, and to carry on the business of ironfounders, mechanical and electrical engineers, etc.

Wolverhampton District Electric Tramways, Limited.—Capital, £200,000. Object: to carry on the business of carriers of passengers and goods, electric engineers, electricians, engineers, contractors, railway, tramway, electric, and other apparatus manufacturers, producers and suppliers of light, heat, and power, etc.

Hudson Economiser Company, Limited.—Capital, £20,000, in £1 shares. Objects: to take over the business of G. and H. Hudson and Co., Limited (incorporated in 1898), together with certain patents relating to an invention for supplying purified and heated feed water to the boilers of non-condensing steam-engines, and for separating oil and other lubricants from the exhaust steam of condensing engines, and to adopt an agreement with the said old company and S. E. Barwick.

Tangye Tool and Electric Company, Limited.—Capital, £100,000. Objects: to acquire the business now carried on by Tangye's Machine Tool Company, Limited; to adopt an agreement with the old company and W. J. Parkins, the proposed liquidator thereof; and to carry on the business of machine and other tool makers, founders, smiths, electrical and general engineers, electricians, motorcar and cycle manufacturers, telephone, bell, phonograph, lamp, and dynamo manufacturers, etc.

Cambridge and Newmarket Autocar Company, Limited.—Capital £2,000. Objects: to acquire the business carried on by H. A. Bedwell, G. C. Bedwell, E. C. Crisswell, and F. W. H. Hutchinson at Cambridge as the New Town and Newmarket Motor Company, and to build and deal in motorcars, vehicles, cycles, velocipedes, flying machines, launches, etc., whether worked by electricity or other power.

Welsh Electric Traction Company, Limited.—Capital, £25,000. Objects: to carry on the business of railway, tramway, ferry, telegraph, telephone, and general contractors and proprietors, engineers, manufacturers of rolling-stock, vehicles and ships, carriers, electrical, mechanical, hydraulic, and general engineers, electricians, suppliers of electricity, etc.

Tomlinson and Hayward, Limited.—Capital, £36,500. Object: to acquire the business of a manufacturing chemist and chemical manufacturer carried on at Lincoln as Tomlinson and Hayward, and to carry on the business of manufacturers of photographic and electrical apparatus and materials, etc.

Electrical Transport and Power Company, Limited.—Capital, £10,000. Object: to apply for any provisional or other order or Act of Parliament to enable the syndicate to construct tramways or light railways and a bridge and works appurtenant thereto in the island of South Hayling or elsewhere, and to carry on the business of tramway, light railway, ferry and bridge promoters, constructors and proprietors, electrical engineers, electricians, suppliers of electricity, etc.

PROVISIONAL PATENTS, 1900.

DECEMBER 17.

23065. A trolley-pulley adjuster for electric tramcars. David Lewis Reaney, 30, North-street Stokes Croft, Bristol.

23014. Improved high-voltage, quick-break, single-pole, double-pole, or multi-pole switch. Albert Edward Short, Kimberley Villa, Balham-road, Lower Edmonton, London.

DECEMBER 18.

23087. Improvements in apparatus for electrically operating keyed musical instruments. Stephen Keeler Reynolds, 70, Market street, Manchester. (Complete specification.)

23103. Improvements in electric railway systems. The British Thomson-Houston Company, Limited, 83, Cannon-street London. (William B. Potter, United States.) (Complete specification.)

23104. Improvements in systems of motor control. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (Albert H. Armstrong, United States.) (Complete specification.)

23106. Improvements in galvanic batteries. Charles Arthur Allison, 52, Chancery-lane, London. (The Waterbury Battery Company, United States.) (Complete specification.)

23107. Improvements in galvanic batteries. Charles Arthur Allison, 52, Chancery-lane, London. (The Waterbury Battery Company, United States.) (Complete specification.)

23113. Improvements in current meters. Charles Jasper, 111, Hatton-garden, London. (Complete specification.)

23137. Improvements relating to plugs for electric switches. Max Vogel, 45, Southampton-buildings, Chancery-lane, London.

23146. Improvements in electricity meters. Ernest Schattner, 55, Chancery-lane, London.

23155. Improvement in the arrangement and connection for single and multiplex wireless telegraphy. Victor Isodore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

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23163. Improvements in portable apparatus for wireless telegraphy for military and other purposes. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

23168. Improvements in and connected with electric circuit-closing apparatus. Paul Carus, 37, Chancery lane, London.

DECEMBER 19.

23234. An electrical apparatus for operating signal and other levers. Rodolph Alloth, Edmond Bernheim, and Eugene Sartiaux, 4, South-street, Finsbury, London.

23240. Improvements in motor-gear cases for electric cars. William Cox, John Maitland Smith, and Alexander Maitland Smith, 4, South street, Finsbury, London.

23242. A new or improved regulating device for electric current generators. Maurice de Hoor, Frederic Reinitz, and Leopold Stark, 18, Buckingham-street, Strand, London. (Complete specification.)

23246. Improvements in and relating to electric motors and generators. Martin Kallmann, 18, Southampton-buildings, Chancery-lane, London.

23254. Improvements in telephone systems, the invention being also applicable to phonographs. George Benjamin Oscar Sleebos, 55, Chancery-lane, London.

DECEMBER 20.

23303. An improved process and apparatus for the manufacture of lead castings for electric batteries and the like. The British Power, Traction, and Lighting Company, Limited, and George James Gibbs, 28, New Bridge-street, London.

23309. Improvements in electrical accumulators. The British Power, Traction, and Lighting Company, Limited, and George James Gibbs, 28, New Bridge-street, London.

23310. Improvements in electrical accumulators. The British Power, Traction, and Lighting Company, Limited, and George James Gibbs, 28, New Bridge-street, London.

23314. Improvements in electrolytic apparatus for production of chlorine and alkali. James Mactear, Birkbeck Bank-chambers, Southampton buildings, London, W.C.

23322. Improvements relating to speed regulators for electric lifts. Jasper Wetter, 37, Essex-street, Strand, London. (The Elektrizitäts-Aktien-Gesellschaft, vormals Schuckert und Co., Germany.) (Complete specification.)

23323. An improved controller and switch for motors for electric lifts. John Bush, 90, Lausanne road, Nunhead, London.

23329. Adjustable connections for electric lamps. Thomas Hargreaves Brigg, 321, High Holborn, London.

DECEMBER 21.

23359. Improvements in insulators for electric conductors. Sidney Joseph Atkinson and Wilhelm Schmahl, 3, St. Nicholas's-buildings, Newcastle-on-Tyne. (Georg H. R. Büttner, Germany.)

23361. Improvements in and relating to electrical fuse carriers for distribution boards and the like. George Sperryn and William Henry Wood, 104, Colmore-row, Birmingham.

23366. Improvements in or connected with electric motors. William Whiteley, jun., Market-place, Huddersfield.

23385. An improved machine for winding electric cables on drums or reels. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

23386. An improved electric dry core telegraph and telephone cable. Ernest Alexander Claremont, 4 Bloomsbury-square, London.

23387. Improvements in the manufacture of braided cords or cables for electric lighting and like purposes. Carl Schürmann, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23389. Improvements in regulation of dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

23390. Improvements in controller casings. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Charles L. Perry, United States.) (Complete specification.)

23391. Improvements in electrically-operated switches for controlling circuits at remote points from central stations. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Howard R. Sargent, United States.) (Complete specification).

23392. Improvements for preventing fluctuations in rotary motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Arthur L. Hadley, United States. (Complete specification.)

23393. Improvements for preventing fluctuations in rotary motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.) (Complete specification.)

23394. Improvements in electric brake systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

23395. Improvements in means for transmitting motion to a distant point. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (David P. Thomson, United States.) (Complete specification.)

23396. Improvements in rotary transforming apparatus. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

23397. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

23398. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

23401. Improvements relating to electric accumulators. Alfred Pouteaux and Albert Wolff, 45, Southampton-buildings, Chancery-lane, London.

23413. Improvements in or connected with the electro-deposition of metals or metallic alloys. George Edward Vaughan, 57, Chancery-lane, London. (Helmuth Koegel, Germany.)

23417. Improvements in or relating to galvanometers. André Blondel, 111 Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 6, 1900, being date of application in Belgium.) (Complete specification.)

23422. Improvements in or connected with controllers for use with electrically-driven capstans and for analogous purposes. William Harding Scott, 47, Lincoln's-inn-fields, London.

23432. Improvements in electric bells. Walter Reginald Lambert and Veritys, Limited, 73, St. Stephen's-road, Upton Park, London.

23433. An improved cut-off for electric arc lamps and similar electrical installations. William Reginald Ridings and Veritys, Limited, 73, St. Stephen's-road, Upton Park, London.

23434 A new or improved watertight holder for electric lamp globes. Percy Garniss Ebbutt, Charles Percy Brown, Herbert Samuel Smith, and Veritys, Limited, 73, St. Stephen's-road, Upton Park, London.

DECEMBER 22.

23448. Improvements in telephone switchboard cords. Alfred Whalley, Ashville, Helsby, near Warrington.

23461. New method of impregnation and isolation of endless protecting pipes, tubes, or cylinders to lay underground cables, electric wire, and other conductors or liquid acid, etc. Wayss and Freytag, 2, Kronprinzenstrasse, Bonn, Germany.

23462. Moulding machine for manufacture of protecting channels for the purpose of laying and protecting underground conductors, cables, electric wires, or liquid acid made of cement concrete, beton, or any other artificial stone or material. Wayss and Freytag, 2, Kronprinzenstrass, Bonn, Germany.

23484. Improvements in the means of controlling electric motors. Edward Henry Tyler and Charles Ashley Carus-Wilson, 41, Old Queen-street, Westminster, London.

23485. Improvements in electric motor control. Edward Henry Tyler and Charles Ashley Carus-Wilson, 41, Old Queen-street, Westminster, London.

23487. Electro-mechanical emergency brake for tramcars driven by electricity. Emanuel von Planta, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 23, 1900, being date of application in Switzerland.) (Complete specification.)

23490. Improvements in or relating to electric switches. Frederick Hagger Headley, 322, High Holborn, London. (Complete specification.)

23491. Improvements in means for extinguishing arcs formed on the breakage of electric circuits. Thomas Herbert Minshall, 322, High Holborn, London.

23492. Improvements in and relating to methods for testing electric circuits. Thomas Herbert Minshall, 322, High Holborn, London.

23514. Improvements in electric house service or fuse boxes. William Thomas Burbey and Arthur Joseph Clarke, 77, Chancery-lane, London. (Complete specification.)

23523. Improvements in electric block signalling and in supplying electric current to trains in connection therewith. Baptistin Cruvellier, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Jan. 12.

1899.

22330. Primary batteries. Robinson. (Robinson.)

25186. Apparatus employed in wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company, Limited.

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25216. Electric cable conduits. Heyl-Dia.
25423. Electrical resistances. Dulait and Garbe.
25631. Electric light switches. Lundberg and Lundberg.

1900.

610. Electric order telegraphs for use on shipboard and elsewhere. Kronheimer.
1039. Electrical conductors or cables. Edmunds.
1825. Dynamo-electric machines. Lamme. (Date applied for under International Convention, June 30, 1899.)
1937. Overhead collectors for electrically-propelled railway vehicles. Urquhart and Goodwin.
2050 Controlling electrically-propelled vehicles. Tyler.
2670. Production of electric incandescent lamps. Hutchison and Packard.
3143. Electric relays. Brown.
3144. Telephones. Brown.
3192. Electric batteries. De Castro and Schlomann.
3253. Electric switches Spooner. (Neveur.)
3762. Application of steatite to electrical purposes as an insulating material. De Mare and Frémy.
4046. Fusible cut-outs for electric installations. Hemingway and Coley.
4672. Electrical terminals. Walker.
6138. Synchronous motors more especially applicable to combined cinematographic and phonographic apparatus. Spooner. (Joly.)
6662. Telephonic transmitters. Hunter.
7561. Maximum indicating devices applicable for measuring electric currents and for other purposes. British Thomson-Houston Company, Limited. (Westendrap.)
11603. Electric railways on the third-rail or surface-contact systems. Lake. (McElroy-Grunow Electric Railway System.)
11556. Terminals and supports for Nernst lamp glowers. Hanks.
11562. Electric lamps. Hewitt.
12702. Electrical accumulators. Riasse and Sengeisen.
12846. Portable electric safety lamps. Glasmachers and Müller.
13134. Electric arc lamps. Walton. (Date applied for under International Convention, Dec. 21, 1899.)
14506. Dynamo-electric machinery. Brookes. (Cotton.)
14743. Electric cut-outs and the like. Clayton.
15378. Means for generating or converting alternating electric currents. British Thomson-Houston Company, Limited. (Lunt.)
16761. Electrically-operated pumps. British Thomson-Houston Company, Limited. (Hewlett.)
17174. Carbon brush-holders for dynamos. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengeeellschaft.)
19497. Automatic circuit breakers for electric circuits. British Thomson-Houston Company, Limited. (Hewlett.)
20522. High-potential line switches for electric currents British Thomson-Houston Company, Limited. (Hewlett.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Dec. 29	666	632	+ 34	21,167	18,091
Birmingham Trams.	,, 29	4,360	3,710	+ 650	—	—
Blackburn Corp'rat'n	,, 14	432	327	+ 104	22 341	19 902
Blackpool Corporatn.	,, 27	266	156	+ 110	28,196	20.693
Blackpool-Fleetwood	,, 29	221	213	+ 8	20,285	20,297
Bolton Corporation..	,, 30	1,396	-	—	52 840	—
Bradford City Trams	,, 30	1 067	353	+ 714	22,535	15,251
Bristol Tramways Co.	,, 28	4,969	3 048	+ 1,921	—	—
Carlisle Tr'mw'ys Co	,, 15	121	—	—	4 260/	—
Central London Ry.	,, 29	6,135	—	—	116 479	e —
City & South London	,, 30	1,704	966	+ 738	43 273	25 982
Cork E. T. and L. Co.	,, 27	450	410	+ 40	21,198 c	19,621
Dover Tramways ...	,, 29	185	158	+ 27	10 618	10 044
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Dec. 28	3 738	2,988	+ 750	—	—
Dublin S.D. Electric	,, 28	816	664	+ 152	—	—
Dundee Tram Co. (b)	,, 6	480	352	+ 128	—	—
Glasgow Corporation	,, 29	9,530	8 506	+ 1,023	—	—
Halifax Corporation	,, 30	784	513	+ 271	30 246	23,947
Hull Corporat'n E.S.	,, 29	1.884	—	—	52,159a	—
Liverpool Corporat'n	,, 22	9,053	7,213	+ 1,840	406 243	351,154
Liverpool Overhead	,, 30	1.397	1,305	+ 92	42,571	41,655
St. Helens Tramways.	,, 19	—	—	+ 205	—	—
Sheffield Corporation	,, 30	3,338	—	—	—	—
Southampton Trams	,, 27	730	320	+ 410	—	—
Southport Corporat'n	,, *8	366	329	+ 37	—	—
Swansea Tramways..	Oct. 5	447	263	+ 184	7,093	4,462

a Since April 1. b Partly electrical. c Since Jan. 1. e From July 30. f From June 30. * Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	11/16-13/16 xd
British Insulated Wire, Ord., 1-40,000	5	–	10½-11½
—— 40,001-70,000	5	–	10½-10⅝ xd
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½ xd
—— 5 per cent. Mortgage Debentures	100	..	100-106
British Electric Works, Ordinary, 80,001-95,000	1	..	⅛
—— 6 per cent. Cum. Pref., 1-80,000	1	–	⅛
—— 4½ per cent. First Mortgage Debentures	108	–	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4½-5
Brush Electrical Engineering, Ordinary	2	–	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	..	1-1⅛
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	–	101-103 xd
Callender's Cable, Debentures	100	–	99 103 xd
—— Ordinary	5	–	12½-13½
—— 5 per cent. Pref.	5	–	5½-5⅝ xd
Crompton and Co.	3	–	5½ 6
—— 5 per cent. Debentures	—	–	99-103
Edison and Swan United, Ordinary	3	–	1⅝-2⅛
—— 5 per cent. Debentures	5	–	3½-4¼
—— 4 per cent. Deb. Stock, Red.	100	–	88 90
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	..	96 100
Electric Construction	2	–	2-2⅛
—— 7 per cent. Cumulative Pref.	2	–	2⅛ 2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	103-106
W. T. Henley's Telegraph Works, Ordinary	5	–	13-14
—— 4½ per cent. Preference	5	–	5½-5⅝
—— 4½ per cent. Debentures	100	–	108 112
India Rubber, Gutta Percha, and Telegraph Works	10	–	20½-21½
—— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	2	–	38 42
—— 5 per cent. Bonds	100	–	101 104
Telegraph Manufacturing, Ordinary	5	–	10-11
—— 5 per cent. Cum. Pref.	5	–	5½-5⅝
Willans and Robinson, Ordinary, 1-80,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 80,001-90,000	5	–	6⅝-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	103-105
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10 11
—— Debenture Stock, Red.	100	..	100-103 xd
Brompton and Kensington, Ordinary	5	–	7 8
—— 7 per cent. Preference	5	–	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6½-6⅝
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	–	5½-5⅝
Chelsea Electricity Supply	5	–	6½ 7
—— 4½ per cent. Debentures	100	–	109-112 xd
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	122-127 xd
County of London and Brush Provincial, Ordinary	10	–	8½-9½
—— 6 per cent. Cum. Pref.	10	–	11½ 12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106 109 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4½-5
—— 4½ per cent. First Mort. Deb.	100	–	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7½-8½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9½-10½
London Electric, Ordinary	3	–	1½ 2
—— 6 per cent. Pref.	5	–	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	12-13
—— 4½ per cent. First Mortgage Debenture Stock	10	..	110-113 xd
—— 5 per cent. Mortgage Debenture, Red	100	–	96 99 xd
Notting Hill Electric Lighting	10	–	14½-15½
Oriental, 1879	1	–	1½-1⅝
—— £5 Shares	5	–	7-7½
—— £4½ Shares, New	4½	..	5⅜-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	–	75-85
Royal Electrical Company of Montreal	$100	..	170 190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 6 per cent. Debenture Stock	100	..	95-96
South London, Ordinary	5	–	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	–	8½-9½
—— 5½ per cent. Deb.	100	..	98-101 xd
Westminster, Ordinary	5	–	17½ 18½
—— 80,001-109,437	5	–	12-13
Electric Railways.—			
Central London, Ordinary	10	–	9½ 9¾
—— Pref. Half-Shares	5	–	4¾-5¼
—— ,, ,, deferred	5	–	4¼ 4½
City and South London, Consolidated Ordinary	100	–	52 56
—— Ordinary	10	–	4½-5½
—— 4 per cent. Debenture Stock	100	–	115 120
—— 5 per cent. Pref. Stock '91	100	–	138 143
—— ,, ,, ,, '96	100	–	130-135
Liverpool Overhead, 5 per cent. Pref.	—	–	13-13½
Waterloo and City, Ordinary	100	–	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-15
Brisbane Tramway	100	..	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9½-10½
British Electric Traction, Ordinary	10	..	13½-14½
—— 6 per cent. Cm. Pf. 80,001-90,000	10	–	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4⅜-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4½-4⅝
—— 5 per cent. Deb. Stock, Red.	100	–	102-105 xd
—— Prov. Cert., all paid	—	..	94-97 xd
Kidderminster and District Lighting and Traction, Pref.	10	–	9½-10½
New General Traction, Ordinary	5	–	3½ 4
—— 6 per cent. Cum. Pref.	5	–	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	16-17
—— 5 per cent. Cum. Pref.	10	..	10½-10⅞
Potteries Electric Traction, Ordinary, 26,667-40,000	10	–	10½-11½
—— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
—— 4½ per cent. Debenture Stock	100	–	102-105
Telephones.—			
National Telephone, Ordinary	5	–	4½-4¾
—— 6 per cent. Cum. First Pref.	10	–	12-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	5-5½
—— 4 per cent. Deb. Stock, Red.	100	–	99-102 xd
—— 3½ per cent. Deb. Stock, Red.	100	–	94-97 xd
Oriental Telephone and Electric Company	1	–	⅜-½

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NOTES.

Anglo-German Cable.—It is stated, on the authority of the Berlin *Post*, that the new Anglo-German telegraph, which is being manufactured by a German firm, cannot be laid before the spring.

Increased Gas Charges.—From an official summary of gas charges in 34 of the principal towns and cities of the kingdom, we gather that there was last year an average advance in price of as near as possible 8 per cent. In no instance has there been a decrease as compared with a year ago.

Tramways and Light Railways Association.—A meeting of the council of the Tramways and Light Railways Association was held at Amberley House, Norfolk-street, W.C., on Friday last week, when the six retiring members were determined for this year, and six new names were selected to propose for election at the adjourned general meeting.

Finsbury Technical Lectures.—We are informed that at the Technical College, Finsbury, Prof. Silvanus Thompson will lecture on Wednesday evenings during the Lent term on magnetism and electromagnetism. The Monday lectures during January will be by Dr. E. W. Marchant on alternating currents, and later Prof. Thompson will resume the subject of dynamo design.

Proposed Memorial to Lord Armstrong.—It is only natural that Rothbury, the home of the late Lord Armstrong, should take the initiative in a movement to perpetuate the memory of the deceased engineer. We note with pleasure that at a special meeting of the Urban Council it was suggested, and unanimously approved, that the Council, as the representatives of the inhabitants of Rothbury, should adopt this course. It was decided to take the preliminary steps in the matter without unnecessary delay.

Madras Electric Tramways.—Good evidence of the enterprise of electric tramways undertakings comes from Madras, where the tramway company have now instituted a quarter-anna fare, which is just about a farthing in English money. Such a low fare is unique, but it speaks well for the success of such systems in India, and indicates a strong management on the part of those responsible for the working of the tramways. A more frequent service is also provided for, cars running at intervals of 7½ minutes in some places.

Opposition to the Tube Railway.—Apparently the "twopenny tube" is not such a general favourite as may be supposed. We notice that at an informal meeting of Hampstead residents it was decided to form a committee to oppose the extension of the tube railway from Holly-hill under Hampstead Heath, with stations on the Heath and at North End. The reason for this resolve, we understand, is that it is thought that to build stations on Hampstead Heath will spoil the beauties of the spot, at present so much appreciated by the majority of Londoners. We think, however, that the opposition should be based on the ground of the inconvenience of these railways having no common terminus.

Electric Legislation.—The old Electricity Act that was passed as long ago as 1877 in Bombay was first used recently. It seems that an electrician named Gapal Dayal had broken the law, in that he supplied electric light installations to certain shops during the Dewlai festival without giving due notice to the Commissioner of Police. He escaped, however, with a caution, as he pleaded that he was not well up in a law which had been on the statute books since 1877 without being enforced in any way. We are not told by our contemporary, the *Eastern Engineer*, that any complaint was made by the electric light authorities, and fail to see what the police have to do with the permission to use electric lighting.

Newspaper Cars.—The Union Traction Company, of Philadelphia, have introduced a system of distributing the newspapers in the early morning by means of trolley cars. These start from the centre of the city in the early hours before the ordinary traffic is commenced, and are said to travel at a rate of 35 miles per hour over the street railway tracks in that city. This speed includes a stop every three-quarters of a mile in order to put down a newspaper man. Up to the present, we believe, the service is an experimental one, in order that experience may be gained as to the possibilities of maintaining a regular service at high speeds over such lines. Of course, a speed of 35 miles per hour would be quite impossible through the ordinary traffic of the streets.

Tesla.—The exploitation of Mr. Nikola Tesla in the yellow papers of the States can have done his reputation no good. We regret that this class of sensational report has now been taken up by one of the London dailies, which was the first to announce the receipt by Mr. Tesla of a mysterious message from Mars. The message is, of course, meaningless and the grounds for believing that any signal from space had been received most obscure, but the above scientist continues to furnish additional statements to the reports on the matter. It is pitiable to see the engineer who invented the multiphase system of power transmission, and who has done such valuable original work for other departments of electrical engineering, so fond of the cheap notoriety to be gained by sensational paragraphs in daily papers.

Chronometers.—Mr. Cornu, a well-known French scientist, has recently been carrying out some extensive experiments on the effects of the earth's magnetic field on the rate of chronometers. His conclusions, which one could have predicted from first principles, are that the earth's field has a distinct influence on the time-keeping of chronometers. The influence, however, is not a fixed one, but depends upon the magnetic movement of the balance wheel, and of the hair-spring. The obvious conclusion is that in order that chronometers may be quite free from interference from either variations in the earth's field, or from artificial magnetic fields produced by electric light wires, etc., they should be constructed on the non-magnetic principle. This, we believe, is being done by the best makers.

Case of Lead-Poisoning.—Recently a man named J. E. Darbyshire died from lead-poisoning after having been engaged in laying electric light cables for the last three months. At the inquest the doctor who attended the man stated that the deceased must have contracted the lead-poisoning from handling the leaden covering of the cables. Some people were more susceptible than others, and he remembered a case of lead-poisoning where the subject had merely handled leaden type for a short period. This is the first case of the kind we have heard of, but if there be risk of lead-poisoning in carrying out such work as the laying of electric lighting cables, surely it could be obviated by the men while so employed wearing a gauntlet or piece of leather in the palm of the hand.

Society of Arts Lectures.—A course of four special lectures on "Polyphase Electrical Engineering" have been arranged to be given by Mr. Alfred C. Eborall at the Society of Arts on April 26, May 3, 10, and 17. As the

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subject is one of very great interest in connection with the development of electric railways and other applications of electric power, the council believe that members will be glad to have placed at their disposal the latest information on the subject by one who has made a special study of it, and is recognised as an authority. The conditions of admission to the lectures will be the same as for the Cantor series, each member, besides his personal admission, being entitled to give one ticket to a friend. A limited number of tickets will also be given to genuine students of the subject. For these application should be made to the secretary.

Parcel and Goods Delivery. — The Pittsburg Express Company has now organised a complete system of the delivery of goods in their suburban districts, employing trolley cars for this object. The cars in question, which are able to hold eight tons of goods, are mounted on a single truck, which gives a 7½ft. wheel base. The goods are brought to fixed points and thence distributed at intervals to seven termini at distances varying from 7 to 14 miles. There are no less than 16 deliveries per day, which gives a total mileage of 270 car miles per day. From the description which appears in the *Street Railway Journal* we gather that these goods cars are largely used for interurban traffic, and we can quite understand that the ordinary passenger traffic would be rather disorganised if house-to-house collection and delivery were undertaken from the electric cars.

Chinese Telegraphs. — In Mr. Archibald Little's interesting articles now appearing in the *Globe*, entitled "A Plea for the Chinese," attention is called to the unsatisfactory state of the telegraph communication in China. We gather that the organisation of the telegraph system is bad, that the charges are high, and that the length of time taken for certain messages is so long as to render them almost valueless when they arrive. The proposed solution of removing the present management of the lines from the Chinese and placing them under European control is rather a large order. It is, however, essential for the safety of the foreign inhabitants of the country that the telegraph system should be in reliable hands, so that messages can be quickly transmitted without fear of preferential treatment. The financial result of this would amply repay all concerned, and we trust that it may be arranged as one of the concessions when the present state of affairs is cleared up.

Central London Railway Vibration.—On the invitation of the Central London Railway Company and a committee representing the owners of houses in the vicinity of the line, the Board of Trade have appointed a committee consisting of Lord Rayleigh, F.R.S. (chairman), Sir John Wolfe-Barry, K.C.B., F.R.S., and Prof. Ewing, F.R.S., to consider to what extent the working of the traffic on the Central London Railway produces vibration in the adjacent buildings, and what alterations in the conditions of such working or in structure can be devised to remedy the same, and to report to the Board of Trade. The first meeting of the committee for the transaction of business will be held on the 11th inst. Voluminous evidence, we hear, has been prepared on behalf of residents *en route*, and it is understood that, in view of the other important projects for electrical underground traction coming before Parliament next session, the enquiry is likely to be of an exhaustive character. It is believed that the committee's report may influence the new schemes to come before Parliament this year.

Bradford Tramways. — All has not gone on so smoothly for the last few months between the Tramways Committee of the Bradford Corporation and the Electricity Committee as one might wish. Under the original agreement the latter contracted to supply the Tramways Committee with power at the rate of 1d. per Board of Trade unit. It now turns out that this figure is less than the actual cost price, which is as near as possible 1½d. per Board of Trade unit. The Tramways Committee, however, have undertaken to pay the cost price for power. But a conference has been arranged to take place between the heads of the departments concerned relative to the matter. Practically speaking, the question is merely one of account, but the point may incidentally arise as to whether or not it would be cheaper to establish a generating station apart from the lighting station for the supply of power for the tramways alone. We are in favour of the combined working, and think that it is absurd in a town like Bradford to have two undertakings under the Corporation each generating electricity independently.

Telephone Calls.—The length of time which is allowed to elapse between the ringing up of an exchange and the reply by the telephone attendant is responsible for a large amount of the delay in telephone working. It is, of course, dependent upon the number of lines which each operator has to control. In the middle of the morning, when everyone is using the telephone, this interval between the call and reply is at its worst, and the delay is then nearly always due to the insufficient staffing of the exchange. At other times of the day delay may occur through inattention on the part of the operator, and it is this delay which we trust will be observed when the new Post Office system in London is opened. There is only one way to prevent it, and that is to keep a good supervision over the staff, which with telephone facilities can easily be done. We notice that in one town in the States one of the supervisors is always recording this interval without the knowledge of the staff. The system is said to have had most beneficial results in decreasing the waste of time which hitherto occurred. Three seconds are allowed for the operator to reply, and if she has not answered in that time the supervisor makes a mark against her name, the value of which increases with the length of time before she replies.

Bolton Tramways Circle System.—Having had the corporate management of the electric cars at Bolton for exactly 12 months, the Tramways Committee now propose to establish a circle system in the centre of the town, their main object being to solve the congestion difficulty due to all cars starting from the same point. At the first Council meeting of the year last week a vigorous discussion took place on the subject. It was pointed out by a dissentient to the scheme that it would involve changing of cars to all passengers who desired to travel outside the circle, and that such a system would not be tolerated by the public. The majority of the councillors, however, supported the scheme, holding that it was the only way in which the congested state of the streets in the centre of the town could be removed. A quicker all-round service would be obtained, and, above all, the circle system would result in a saving of nearly £11,000 per annum. Also it was hoped the necessity for widening the streets for double rails, at a cost of about £400,000, would not arise. With the adoption of the circle tramway to connect up the terminii of their various lines to the suburbs, we understand the fares will be reduced, and this, no doubt, will find favour with the majority of the inhabitants of Bolton.

Cheap Water Power.—It is not the largest water powers which are necessarily the most cheap to develop, and while the Niagara schemes have done good service in bringing before the public the possibilities of large power

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distribution schemes, it is quite likely they will fall considerably behind new undertakings in the price at which they can afford to distribute electrical energy. The civil engineering work which has to be done in developing a large water power enters into the cost per horse-power delivered afterwards. It is well known that in the case of the Niagara schemes the outlet tunnel and the main shaft for the turbines were exceedingly costly to construct. These items serve to keep up the capital outlay per kilowatt installed. The St. Lawrence Electrical Power Distribution Company has saved these heavy items, and in consequence expects to get its plant laid down at a very much less cost per kilowatt than the original Niagara Company. We also hear that the Ontario Power Company has secured water rights on the Welland River which will be easy to develop at a comparatively small cost. In fact, the company's engineers estimate that it will be able to produce as much power with an expenditure of one million as the Niagara Company has secured for an expenditure of three millions.

Electric Flash Communication.—An interesting lawsuit between a Mr. Frost and a Mr. Pinkerton in New York, arising out of the application of electric light for signalling purposes, is reported in the *Electrical World*. So far back as 1891 Frost was arrested by Pinkerton during a famous fight made by Philip Dwyer against the poolrooms, and this was the cause of action. Dwyer barred out the wires of the Western Union Telegraph Company to prevent the poolrooms from getting the results of the races. Frost and several companions, it is alleged, went to the races armed with electrical appliances for flashing the information desired by the poolrooms. It is asserted that the coachman on the carriage in which Frost and his companions were wore a high hat. In the top of the hat was a hole about the size of an egg, and inside the hat the coachman had an electric light. By means of a code of signals the results of the races and the betting were flashed to operators stationed in the cupola of a hotel opposite the grounds. On the authority of the Jockey Club officials Pinkerton arrested Frost. Both Frost and his wife, who were in the carriage, assert that they were roughly handled by Pinkerton's men. The facts as to the electrical apparatus were duly attested in the trial of the action, which resulted in a verdict in favour of Frost for £1,000 damages.

Belfast Electrical Committee and the Labour Council.—The outcome of a deputation from the Labour Council to the Belfast Electrical Committee is that the latter have agreed that no men in future shall be appointed by them to take charge of engines, or to do engineering work, unless they are qualified as engineers. Mr. Bawman, of the Labour Council, was asked by the Electrical Committee, after the deputation had withdrawn, whether it was desired that the man at present employed in that capacity at the electric works, who had served the Corporation well for seven years, should be dismissed. We are glad to say that Mr. Bawman replied in the negative. He told the committee that if they would resolve that in future all men who were employed as engineers should be men who had served a legitimate apprenticeship as engineers, he would be satisfied. This the committee agreed to do. While we concur that in the case of a mechanic the man employed in that connection should be a qualified engineer—*i.e.*, have served a certain term of apprenticeship—we are unable to agree that this is necessary in every case. In electric light stations there are many jobs which do not require the attendance of what are termed "skilled" mechanics, and in these instances the station engineers are quite capable of training the ordinary workman up to their duties.

Berlin Tramway Casualties.—At the suggestion of their Emperor, the German authorities are at last taking active steps with the view of preventing any more additions to the many accidents that have occurred in Berlin since the introduction of electric accumulator carriages by the Great Tramways Company. The Emperor's intervention in the matter has been brought about by the death of Lieut.-General Pockhamer, who was caught by the projecting guard of an electric wagon and dragged a distance of some 50 yards before he was extricated from the position. His injuries were so severe that in a short while he succumbed to them. During December there were five similar accidents. The authorities, it is said, have for some time since been occupied with the problem, but up to the present their deliberations have not resulted in any better regulation of the traffic, nor in a decrease of the number of accidents, which are described as terrifying Berlin. The Emperor William now suggests the appointment of a special commission to investigate the merits of all foreign, and especially American, inventions for diminishing the dangers attendant on fast-running accumulator carriages. The company has naturally assented to this proposal, and has intimated that no expense will be spared in fitting the carriages with the devices that may be recommended by the commission.

The Double-Filament Lamp.—An American firm of incandescent lamp manufacturers in the States known as the Phelps Company, at Elmwood, Indiana, is turning out an incandescent lamp with two independent filaments. One of these is to be used at ordinary times, while the other, which develops much less candle-power, can be employed throughout the night. As a rule these filaments are made to give 1 c.p. and 16 c.p. respectively. The change over from one filament to the other is made by turning the lamp in a screw socket. The watts per candle-power required by the small filament are much greater than that of the 16-c.p. one. Due to this, the life of the small filament is said to be much more than the life of the 16-c.p. one. It is certainly a more economical arrangement to employ two filaments like these than to have a resistance or impedance inserted in series with a single-filament lamp, because if the temperature of the filament is reduced in order to reduce the amount of light, there is still a large waste of energy in heat rays. The doubtful point about the lamp now before us is whether the 1-c.p. filament can be made to stand at the average voltages now employed. The illustration shows the 16-c.p. filament to be a long one and the 1-c.p. a short one. If this is so, the diameter of the small filament must become exceedingly small, and we should almost doubt that the life could be depended upon, as stated, for some 1,200 to 7,000 hours.

Institution of Junior Engineers.—Having had its notice drawn to the increasing importance of the subject of works management and the absence of facilities for its study, the council of this institution have arranged for a course of six lectures to be given by Mr. A. H. Barker, Wh.Sc., etc. This gentlemen is especially well fitted to deal with the subject, being a manager of an engineering works himself. We understand that every opportunity will be given for treating special points introduced by those attending. From the syllabus of the lectures we gather that in the first, on Feb. 5, Mr. Barker will refer to the advantages of electrical driving over mechanical driving. Useful advice will also be given on motors, dynamos, foundations, belting, conveying appliances, etc. At the second lecture, on Feb. 20, the lecturer proposes, among other things, to deal with the relative economy in working, the price, and the advantages and disadvantages of hand cranes, power cranes, and electrical cranes. The

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three following lectures will be delivered on March 7 and 19 and April 3 respectively. We notice that at the last lecture, on April 25, Mr. Barker will give some valuable information as to the mode of estimating, a matter of considerable importance. In view of the great value of a knowledge of the methods of economical manufacture and the commercial conditions prevailing in modern engineering establishments, the course should prove both instructive and interesting to young engineers who in their ordinary positions with engineering firms are debarred from all access to commercial information. The lectures will be given on each night at eight o'clock at the Westminster Palace Hotel.

Lamp Carbons.—An article in the *Elektrotechnischer Anzeiger*, which deals with recent improvements in electric lamps, incidentally remarks upon the great attention which has been bestowed upon the manufacture of carbons for arc lamps. The old method, which consisted in mixing powdered carbon with certain syrups, has been discarded, because, though of excellent quality, the carbons produced by this method were very expensive. Present practice consists in mixing different proportions of carefully selected and powdered gas coal with lamp-black and tar. Sometimes chemicals are added in order to increase the light intensity or durability of the carbons. The well-incorporated mixture, after being cleaned, powdered, and thoroughly kneaded, is finally subjected to a very high temperature. All European manufacturers give the positive carbons a core composed generally of 80 to 85 per cent. carbon, 5 to 6 per cent water, and the rest of silicates and borates. This provision assists the generation of vapours which are beneficial to the conductivity and steadiness of the arc, while it at the same time lowers the limit of tension at which the hissing of the arc commences. In the U.S.A a carbon of inferior quality for home consumption is prepared from lamp-black and chemically-cleansed petroleum waste. Such carbons must necessarily be very soft, and are plated with copper in order to render them serviceable for low-tension lamps. The practice of coppering has been discarded in Europe, chiefly because the dropping of particles of the melted metal decreased the steadiness of the arc. There is no other reliable method of ascertaining the quality of the carbon than that of testing the same in the lamp itself.

Machine Friction.—In his interesting paper read before the Civil and Mechanical Engineers' Society last week, Mr. W. B. Esson assumed an average loss of 40 per cent. between the indicated horse-power of a works engine and the brake horse-power actually given to the driving pulleys of the various machines in factories. The conclusions based on this assumption clearly showed that even in the best of cases, as far as mechanical driving was concerned, there was an advantage in the conversion of the factory to electrical means of transmitting power. The various curves given by the author were all drawn for the best possible case from the mechanical transmission point of view. Any deviation from the conditions assumed, such as would be the case by the use of isolated engines, or of widely scattered workshops, would tend to throw much greater advantages on the side of electric driving. There was one point, however, which was not referred to by the author, and that was the ease of repair when electric motors are used as the driving power. In the case of a steam-engine driving a complete factory, the breakdown of any part of the engine will entail the closing down of the whole of that factory until the repairs have been made good. Of course, the same would be the case if a single engine only were used in the power station generating electricity. On the other hand, it is usual in such power stations to divide the plant up into two or three generating units, which prevents the above. The risk of breakdown in transmission of power by electricity throughout a workshop is therefore much less than when mechanical driving is employed. The motors can all be standardised, and in the event of any defect occurring to any motor it can be quickly replaced by a spare one.

Conductors for Railways.—In all the heavy electric railways used in Great Britain, such as the Liverpool Overhead, the Central London Railway, etc., the conductor conveying the electricity to the train has been laid alongside the track, and has offered a firm bearing for the collectors. In consequence of this, there has been no trouble in collecting the heavy currents required in starting, and there has been comparatively little interruption from faults in the conductor. In America, and particularly at Baltimore, overhead construction has been used with trolley collectors. The editor of the *American Electrician*, after experience of these lines, concludes that this overhead arrangement is totally inadequate for heavy traction. The progress of the trains at night when the overhead and trolley is used is marked by a display of fireworks from the trolley wheels which is not edifying. Our contemporary, therefore, commends a new railway which has just been opened, because its engineers have adopted the third-rail system. This system was originated, we believe, by Drs. Hopkinson for the electric railways laid down by them in Ireland in the early days of electrical engineering. The only trouble which seems likely to arise from the use of this third-rail system is in connection with low-lying sections of the railways, which are liable to flood. The leakage caused in such an event would be excessive, and it is a point which will require careful consideration when the underground lines in London are being converted. Owing to the low level of this railway, we have frequently seen it flooded in places by water returning up from the sewers. The question will then arise as to whether this cannot be prevented in future, or if it will entail the use of elevated conductors to guard against heavy leakage of the currents at such times.

Electrical Installation Rules.—The London and Lancashire Fire Insurance Company have forwarded to us a new edition of fire rules, which we see are drawn up by Mr. T. L. Miller. We have looked through the same, and consider that they are on the whole moderate in their demands, reasonable in their precautions, and exceedingly valuable as a warning to electric light consumers and plant owners as to what to avoid. A strong warning is given against the employment of unreliable contractors for electrical work, but it is, of course, impossible to tell the private individual how to discriminate between reliable and unreliable contractors. It is easy to see, when looking through these rules, that in the course of their preparation their author had before him instances of fires that had occurred in central stations. For instance, he specifies that the connections at the back of the main switchboard are to be of bare copper as far as possible. We suppose that more fires have been caused through the insulation of conductors at the back of the switchboard catching fire from an arc than from any other cause. We do not quite see, however, how a main switchboard can be considered to be complete if it must be arranged so that all current can be entirely disconnected in the event of a fire starting on the board. To get this, one would have to arrange a series of quick-break switches on all the conductors leading up to the board, and these would have to be isolated from it. If equal precautions were then demanded, as they should be, one would go on adding isolated switches, each to protect the one before it. We

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are pleased to note that, at the end of the rules, the Institution tables as to the currents which various conductors are allowed to carry are given, and are adopted by the company. We see no reason why, however, the company should withhold the statement that the tables published by them are taken from the installation rules of the Institution of Electrical Engineers.

Electric Railways in Great Britain — The *Canadian Engineer* is responsible for the statement that the development of electric lines in this country is due to the energy and courage of a number of Canadian and American railway men. However this may be, there is no country in the world where electric railways for light inter-town traffic have such an open field as in Great Britain. Our contemporary expresses the conviction that until now such enterprises have made little headway in England. "One reason of this," the article proceeds, "is the remarkable respect in which private rights of ownership are held. Right of way is obtainable, generally, only by purchase of land at prohibitory figures, and it is difficult even to run a wire over farm land. Another reason is the slowness and great cost of obtaining charters, as each incorporation has to be obtained by an Act of the Imperial Parliament at frightful costs for legal services." The writer, however, concedes that, in spite of the difficulties of such enterprises, a number of lines to be worked by electricity are being built in various parts of the kingdom, the big underground electric railway schemes of London having started the movement. These railways, it is admitted, will be much better suited to the requirements of the great network of towns and villages of Great Britain than the light steam railways, and will enable the country districts to make considerable progress in the abolition of the old and costly style of transportation by wagon. It appears that the development of electric railways in Canada and the United States is advancing most favourably, and the railway trunk line managers, after holding aloof for a long time, have at last come to recognise that the trolley lines can do for them what steam trains must fail to do as local feeders. While the writer of the above article is quite correct in attributing to the tramway and railway law in this country a large proportion of the delay in the improvement of inter urban communication, he has not acknowledged the great advance made under the Light Railways Act. He would also find on enquiry that while Canadian and American engineers have executed a large amount of contract work on such lines, the conception of the scheme and the design of the equipment has been mostly due to English engineers.

Manchester Telephone Question.—The Mutual Telephone Company, of Manchester, is again making an attempt to get the consent of the Manchester Corporation to its holding a license in that city. On Thursday last week a deputation representing over 500 prominent merchants, manufacturers, traders, and professional men waited on the Lord Mayor of Manchester to put the case of the company before him. The memorial in which the case was stated referred to the fact that the Mutual Telephone Company has secured a telephone license for Salford and some other districts close round Manchester, but that until they get the consent of the Corporation the Postmaster-General will not issue the company a license for that city. It will be remembered that 13 months or so ago the Corporation refused this consent, and that it was feared the Mutual Telephone Company would go out of existence in consequence. The licenses granted for the surrounding districts, however, have prevented this. In the interview with the Lord Mayor, Mr. Wm. Thomson was the principal speaker, and he had to be called to order by the Lord Mayor for the way in which he reproached the City Council for breach of faith. We hold that he was quite right in his contention that the Mutual Telephone Company of Manchester and the Glasgow Corporation were largely responsible for the change in policy of the Government by which municipal telephones became possible. The company was formed in 1896, we believe, and in April, 1897, the Corporation of Manchester passed a resolution in favour of the company laying down a competitive system of telephones. This resolution the Corporation would not confirm when asked to do so 13 months ago. Mr. Thomson contended that since that refusal the Telephone Committee had only been delaying matters, as they had come to no conclusion whatever as to whether the Corporation should carry out the work or not. Other speakers of the deputation urged on the Lord Mayor the advantages which would ensue from an active competition. In reply, the Lord Mayor stated that he would bring the matter before the Council this week, but without wishing to commit his colleagues in any way, he thought that the Corporation had quite enough in hand at present with their electric lighting and tramway schemes.

Incandescent Gaslight in Germany. — A contributor to the *Zeitschrift für Electrotechnik* compares the respective developments of the electric and gas lighting industries in a manner altogether unfavourable to the former. As an example of the successful competition offered by the incandescent gaslight, he points out that in Berlin, where the electric arc found an early footing for street-lighting purposes, there existed in 1899 over 27,000 incandescent gas lamps in the public thoroughfares, while the number of public arc lamps installed amounted to only 235. Further, in Strassburg it was proposed to increase the electric lighting of the railway station approach by two arc lamps, and to substitute 16-ampere lamps for the nine-ampere lamps previously used. The electric light company offered to undertake the lighting at an annual charge of about £145, but the gasworks company offered to light the approach by means of incandescent gas lamps at an annual charge of £135, and succeeded in obtaining the order, despite the insignificant difference of £10 in the amounts. It is also an undeniable fact, observes the writer, that valuable improvements have been made in the manufacture of the incandescent gas mantle, and will probably be followed by others. Comparing the relative progress made in the manufacture of the electric incandescent lamp, the writer finds cause for further complaint. True, he remarks, we are constantly reading that this or that factory has increased its daily output of lamps to so-and-so many thousands, but at the same time the average quality of the lamps placed upon the market is becoming worse from day to day. Manufacturers will no longer guarantee their lamps, a state of things which calls for immediate attention. He doubts the capability of the Nernst lamp in its present form to effect the necessary remedy, and dwells at some length upon the several well-known defects which at present stand in the way of its commercial success. In conclusion, the writer urges his readers to pay careful heed to the progress of the gas-lighting industry. At the same time it must be remembered that the success of the incandescent gas lamps in side streets in competition with incandescent electric lamps has not in this country been followed by a displacement of arc lamps in the main streets. On the above writer's own figures the costs of arc lighting and incandescent gas are very nearly the same. Our local conditions have tended to the success of the arc lamp.

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PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 906, Vol. XXVI.)

Jointing.—A very great deal depends on the jointing if running without faults is desired. There is no reason at all why joints should be badly made, or why they should go wrong after being well made, if proper precautions are taken. It is quite common at the time of a fault to hear the chief engineer say, "Better have the joint opened," but the mains engineer, if he has the jointing well done, can be quite certain that the fault is not in the joint.

The first thing necessary for good jointing is a good jointer well supplied with good tools. A good kit of jointer's tools cannot be purchased intact, but must be made up by the mains engineer to the requirements of the system of cable. If a complete kit is bought, nearly the whole of the tools supplied will never be used, as the people who supply the kit do not seem in the least to know what is required. A good jointer's kit will contain the following tools: A lock-up box; two round, covered flat tins, one to hold a pound roll of rubber strip, the other to hold a similar quantity of waterproof linen tape; one tin for powdered resin; one large and one small soldering bit; one screw-top can, pint size, for benzoline; one benzoline blow lamp; one small and one large ladle, wrought iron; one medium-sized metal-pot; one hack knife; one two-bladed clasp knife; two medium-sized shifting spanners, preferably Clyburn; two screwdrivers, one 14in. or so long, the other 8in. long; one large and one small gimlet; two second-cut three-faced files, 14in long; two second-cut flat files, 8½in. long; one bow hacksaw, with removable blade; several spare hacksaw blades; two cold chisels, each about 10in. long, of ¾in. steel; one heavy hammer and one light ditto; two pairs 8in. gas pliers; two pairs cutting pliers, one 6in., the other 8in.; and if wood troughing has to be cut, a small axe and two medium-sized chisels for wood will be required. Pipe cutters for cutting armour should not be allowed; three-faced files should be used.

Fine dry weather is certainly desirable for joint-making, but cannot always be had, and excellent joints can be made in wet weather if proper care be taken. Tents usually sold for jointers' use are nothing like large enough for all jointing jobs, and a tent can be easily rigged up by laying a small tarpaulin over wood trestles. A very large amount of jointing is now done in wet weather. To make a first-class joint, time is necessary. An ordinary straight-through joint on a concentric main can be made and the box filled in within three hours; a concentric three-way tee joint takes about four hours: this for actual jointing work.

We have been reading and hearing lately about some very quick work in the way of joint-making, but record breaking on electric mains should certainly not be indulged in. Besides, of what use is it to be so very quick? A certain number of jointers must be kept on in any case, and if they make all the joints in one day they will be doing nothing for the rest of the week. Jointers cannot well be put to other work than jointing Far better to take a fair amount of time and make a good job. One often sees advertisements for jointers who are capable of making lead wiped joints. Such a jointer is valuable, as few can do any lead work, except enough to burn the lead of the cable; but in any case, whether the jointer can make wiped joints or not, wiped joints should not be used under any circumstances. An iron box filled with good waterproof compound, is the only way to protect a joint properly. No jointer should be allowed to fill in a joint-box until the joint has been examined by the engineer-in-charge or the foreman Frequently joints on concentric mains have been found with two or three of the outer wires sweated to the inner coupling on the underside; this is because the jointer only thinks of the part he can see. To stop this sort of thing, the jointer should be provided with a small mirror for holding under the joint Iron joint-boxes should be well dried out before being placed in position. All joint boxes should be well supported underneath, preferably on a flat stone slab or bricks, to prevent them tipping Time should be allowed for the filling in compound to sink before the box is closed down. The time required varies according to the size of the box. The smallest joint-box should not be covered down under half an hour. Many large boxes require several hours Such boxes should be opened again the next day and refilled after the top of the set compound has been well warmed with a blow lamp flame.

The best material, and one absolutely reliable for filling boxes, is a compound black in colour supplied by most cable-making firms. If the boxes are properly filled with this compound, no water will ever get into the joint. The compound, after being boiled, should be skimmed and allowed to cool somewhat, then poured into one corner of the joint-box to be filled, thus driving out all air from the box, and also guarding against any foreign matter which may be in the compound resting or lodging across the fittings. Resin oil is often used for filling joint-boxes, but is not reliable, as it is no heavier as a rule than water, which often finds a way into the box, gradually displacing the oil. The oil also disappears along the cable, thus leaving the box only partly full. There is really no need to use oil, as unless underground switch-boxes are used, box compound can be quickly removed to gain access to fittings. If underground switch-boxes are used, of course oil must be used, but this often goes so hard in the cold weather that it is almost impossible to use the switch. Paraffin wax has been suggested as a box filler, and ought to answer well if the cost is right, as it can so easily be cut out cold. As quick disconnecting boxes are very necessary, it would probably be better to use boxes whose fittings were coupled with links rather than switch-boxes. These links could be brought fairly near the top of the box, and if the top part of the box were filled with paraffin wax it would be quite simple to disconnect. The lower part of the box could be filled with the ordinary compound, which would have to be allowed to cool and set hard before the wax was put in. Compound in the bottom of the box and resin oil on top should never be sanctioned: it always results in a beastly mess.

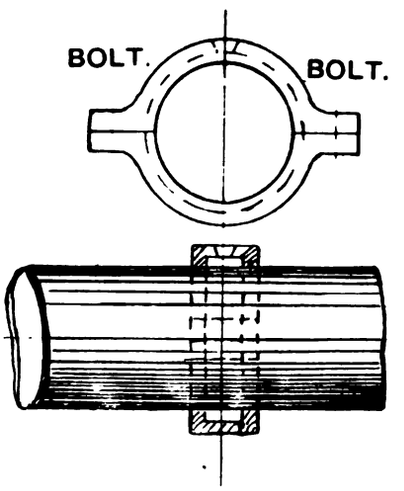

FIG 5.—Earthing Clip.

All straight-through joints on armoured feeders and solid-laid feeders should be disconnecting boxes, also, of course, on feeders in conduits. These disconnecting boxes should be surrounded by a brick built box, so as to avoid the trouble of opening ground at the time of disconnection. The surrounding brick box should be large enough to allow a man to stand down at the side of the joint-box. Switch-boxes for high-tension work should not be used, as it is always doubtful if the switch is on or off once it has been moved from its original position; it is a good rule never to have high-tension switches that cannot be seen, especially if men's lives are depending on the position of the switch. All high-tension boxes, if they are not surrounded with solid filled-in earth, must be earthed to the nearest water-main. A good connection can be made with such a clip as is shown in Fig. 5. It is made in cast iron, and is exactly like an eccentric strap; the inner groove is to be filled with molten lead. Earth-wire should be stranded iron wire, coated with Dr. Angus Smith's compound. Galvanised iron wire is no good at all; a $^{7}/_{16}$ galvanised iron cable will be eaten through in less than two years in any soil if used as an earth-wire.

All joints which are disconnecting by means of links must have the links screwed tight home, and must be guarded with lock nuts. Contact is a thing of which no jointer seems to have the slightest knowledge. A very much exaggerated

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view of what is often found in a straight-through link joint is shown in Fig. 6. In some cases no continuity has been made at all, as the cables have been bent to suit the position of the box instead of the box being placed to suit the cables. If a joint has to be completely opened, the best method of procedure is to loosen the nuts holding down the cover, and to stand a small fire devil on the box until the lid can be removed easily. The ground must then be opened underneath the box, and oily waste burned under it. If this is done, the box will soon drop off the joint, and what compound remains on the joint can be warmed off with a blow lamp The joint can be finally cleaned with paraffin. Sweating metal should be made of two parts pure tin and one part lead. All fittings must be well sweated on to the conductors; bad sweating in a stranded conductor causes resistance and heat. Resin must always be the flux used, no acid being allowed. Before sweating, the insulation of the cable must be well wrapped with tape, this tape being removed after the joint is cold.

Probably the most difficult joints to make so as to obtain good results are the service and straight joints made on vulcanised bitumen cables laid solid. These joints are often made without fittings of any kind, and have to be lapped up with bitite lapping and tape, then painted well with hot compound before being filled in solid. The tee service joints made so must be well examined underneath with a mirror, first to see that no sweating metal points are left, and to see that the joint has been evenly lapped or taped. If iron boxes are used in conjunction with solid-laid systems, the boxes should be designed with projecting ends large enough to allow the main troughing to rest in the projections; thus the bitumen in the main troughing will, when filled in, come in contact with the outside of the box. Boxes so designed need have no other pocket for bitumen, such as is found in

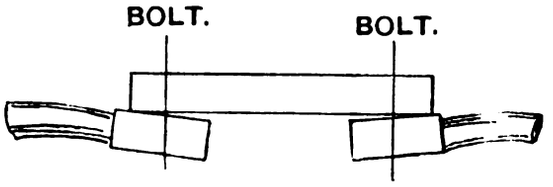

FIG 6.—Link Joint.

boxes designed for armoured cable work. Saving in the number of joints on a main can often be effected by making a tee joint serve also the purpose of a straight joint at the same time. It is only necessary to bring the main cable halfway into the box at each side, the outer conductor coupling then bridges over the two cables, thus forming a straight joint, the tee cable being put on in the ordinary way. This method of jointing is very useful when repairing a distributor of concentric type. Service joints, both high and low tension, should not be fused, but should be disconnecting joints. Consumers could easily then be disconnected at any time; this would be specially useful if a main had to be tested at night. Joints made on rubber-insulated cables underground should be vulcanised, afterwards taped up and painted with anti-sulphuric varnish. The use of rubber solution should be discouraged, and, except for vulcanised joints, should never be used. If a joint is to be taped up with rubber strip, the hand should be clasped over the taped joint for a few seconds, and if the strip was clean when put on, it will adhere quite well without the use of solution. A sticky tape, such as Blackley tape, should be used to finish off.

As cable-makers very often seem to have little idea what sort and size of fittings are required to suit their own cables, the mains engineer would do well to design his own boxes.

(To be continued.)

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Concluded from page 14.)

If the magnet is made solid, the lines of force of the cross-induction will flow along the shortest path—*i.e.*, near the polar face to a great extent. For this reason some makers, while employing cast steel magnets and yoke, will use a cast-iron polar shoe varying from ½in. to 1in. in thickness, which is worked at a very high degree of saturation. This requires an increase in the field excitation, but not to any great extent, as the length of the path of the forward induction through this cast iron is only relatively very small compared with the length of the whole magnetic circuit, while it adds to the reluctance of the path of the cross-induction, especially at the trailing horns, where the cross-induction augments the forward induction. These polar shoes are used indiscriminately with and without a slot in the magnets. If the magnets are cast with a slot, it is the usual practice to continue the slot through the polar shoe, leaving sufficient metal again only at the sides to hold the two parts of the shoe together. Another method which is almost universally adopted is to increase the forward induction in the air-gap to the very fullest extent, and this is done by reducing the length of the armature and of the polar angle. This practice is often carried to very extreme lengths, for while with smooth-core armature the usual density for the induction in the air-gap is from 4,500 to 6,000 C.G.S. lines per square centimetre, it is quite common with slotted armatures to find an induction in the air-gap of 8,500 C.G.S. lines, or in some cases even up to 12,000. This increased induction will necessitate increased field excitation, but since when the induction is carried to these higher limits the air-gap is made very short, this increased excitation is not nearly as great as would be required in the case of a smooth-core armature.

We have seen that for the purposes of sparkless commutation it is necessary that the short-circuited coil should be travelling through a magnetic field where the induction is not as great as under the pole-pieces, but is only of sufficient strength to generate a current in the short-circuited coil equal to that flowing through the series of coils it is about to join, and for this reason with a smooth-core armature full advantage is taken of the magnetic fringes of the polar horns. It is evident that with a slotted armature and a greatly diminished air-gap, these magnetic fringes will not exist to the same extent, but that the lines of force will pass along as more perpendicular lines into the armature. It may also be observed here that the magnetic leakage of the machine altogether with a slotted armature will be greatly reduced. In order to obtain this necessary reversing field, the horns of the polar field are cut away, so that at the extreme horns the distance from the core to the polar face is greater than what it is at the centre. This device causes the lines of force to crowd together towards the centre, and if properly proportioned will give the necessary field for sparkless commutation, while at the same time it to a certain extent adds to the reluctance of the path of the cross-induction. Some makers have, in place of so shaping the polar horns, put on the polar shoes in a slanting position, so that the leading and trailing edges are not parallel with the coils, with the result that the short-circuit coils first come under an angle of the leading horn of the shoe, and the area of this horn covering the inductor gradually increases until it attains its maximum.

In the *Electrical World and Engineer* of New York for April 22, 1899, is a full description by Mr. Robt. Lundell of another device to eliminate the evils due to cross-magnetisation. Mr. Lundell states that machines with the pole-pieces he describes are built by the Sprague Electric Company, and are designed to fulfil the following specification: "Each machine shall be of simplest design, small possible dimension and weight per kilowatt output. It must not heat more than 75deg F. above the surrounding air after a continuous 10 hours' run at full load. It must be non-sparking at the brushes between no load and 50 per cent. overload, and it must not show injurious sparking at short time overloads of 100 per cent. without change of position of brushes. (The brushes on a dynamo, after once being set in proper position, should never be disturbed, as any change of position will alter the potential as well as the percentage of compounding.) The machine must respond quickly to change of load, and the characteristic curve of potentials for various current outputs should approximate as nearly as possible to a straight line." If this specification can be fulfilled without

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any great sacrifice in the efficiency of the dynamo, the device is worthy of deep attention. Fig. 36 gives a view of the magnet and polar shoe, and it will be seen that the two distinctive features are the slot through the centre of the magnet similar to that described above and the elongated trailing horn. Mr. Lundell, in his article, says that this arrangement is adopted to overcome the cross-magnetising or distorting effect of the armature reactions, as the demagnetising effect may be easily compensated for by the compounding. He claims that since strong fields are expensive on account of the increased size and weight of frame they involve, and large air-gaps are

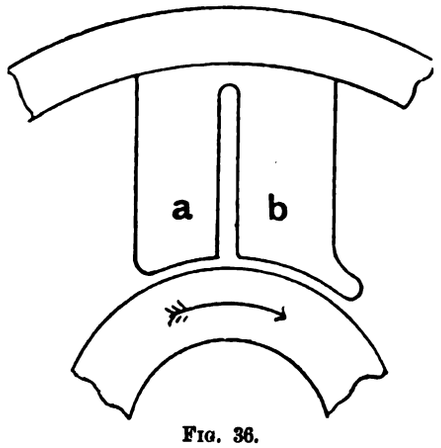

FIG. 36.

not only inefficient, but also have the same objections, his method will achieve the desired result, and will also effect a general reduction of the total weight, dimensions, and cost. Mr. Lundell continues: "To understand the fundamental feature of this construction it may be well to look at Fig. 36, with a view as to what will happen if the field magnet is slowly energised from an outside current while the armature is standing still. With a weak magnetising there will be a practically equal magnetic density under the entire pole-face. But as the magnetising force is increased, we shall find that

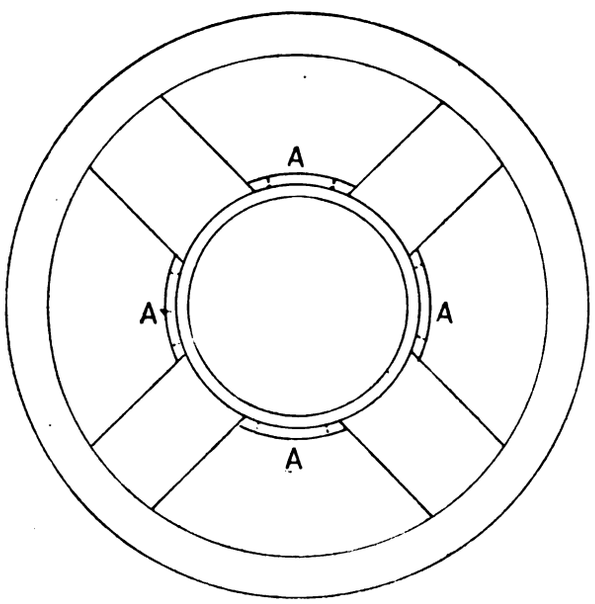

FIG. 37.

the magnetic density under the pole-face of *b* will soon cease to increase in the same ratio as the density under the pole-face of *a*. In fact, the density under *b*, when the magnetising force has reached a certain point, will remain almost constant as compared with the density under *a*, which still increases with the magnetising force. This is due to the fact that the core *b* has become saturated on account of its small cross section as compared with its large polar area, whereas the core *a* is far from saturated and is still very receptive of magnetising force."

It is further claimed that if the core *b* be saturated by means of the shunt only, owing to the proportions of *a* and *b*, the cross-magnetising force of the armature and the series ampere-turns will have little effect upon the core *b*. But the compounding turns will quickly change the density under the polar face of the core *a*, as this core *a* is not nearly saturated, and, therefore, sensitive to changes in the magnetising force. The compounding turns will, therefore, strengthen the magnetic density under the leading horn *a*, at which point a strong field is required for the purposes of sparkless commutation.

The writer has not yet had the opportunity of making any tests upon a dynamo built in accordance with the above design, but Mr. Lundell publishes the report of the late Dr. John Hopkinson upon this improvement, in which occurs the statement: "I am satisfied that this device would be practically successful in avoiding the necessity of shifting the brushes, and, in my opinion, it is by far the simplest expedient which has yet been proposed to attain this desirable end."

Another method of overcoming the cross-induction in multipolar dynamos is that shown in Fig. 37, where the polar shoe is continued as a thin shell all round the armature. Holes are cast in this shell between the magnets, so that only two flanges of small cross-sectional area are left, one on each side, as shown at A. This arrangement increases, to a certain extent, the amount of leakage from pole to pole, but it produces enormously over-saturated polar horns, which are not greatly affected by the cross-magnetisation of the armature. The generators for the

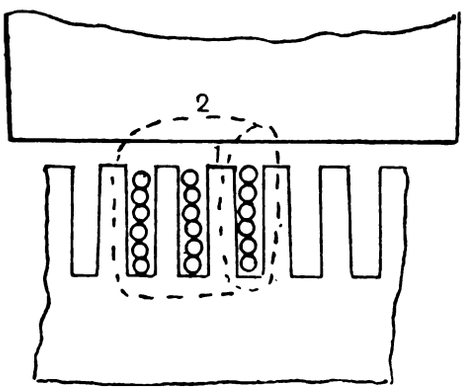

FIG. 38.

Blackpool and Fleetwood electric railway were built with the addition of this polar shell, and have given very good results.

The next device proposed to eliminate armature reaction is that patented in February, 1898, by Mr. V. A. Fynn, and has for its object the diminution in the self-induction of the short-circuited coil. Fig. 38 shows a section of an ordinary toothed armature with six wires per slot. Mr. Fynn claims that if, instead of the three belonging to one coil being placed in one slot, they are spread over three slots, as shown, the self-induction will be greatly reduced, as there will be a longer path for the lines of force to flow along (as shown by the dotted curve No. 2, where the dotted curve No. 1 represents the path along which they would flow, were all the three wires laid in one slot), and consequently the reluctance in this magnetic circuit will be increased and the self-induction equally reduced. The arrangement appears to have many of the disadvantages of a chord winding, as only one inductor can possibly be in the proper position for commutation, and it appears to be doubtful whether the gain is commensurate with the disadvantages. A very similar arrangement was tried by Mr. Sayers some years ago, but abandoned, and it is probable that as much is lost in commutation as is gained by the reduction of the self-induction.

BALANCE V. SYMMETRY.

It has been pointed out repeatedly during these notes that, in order to obtain a well-designed dynamo, due attention must be paid to the symmetrical arrangement of all the parts. An unsymmetrical arrangement of the armature coils, either as regards their length, gauge, resistance, or position on the armature core, will cause sparking at the brushes when the machine is run. The size and permeability of the magnets must also be alike. This is especially

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necessary with a parallel-wound multipolar dynamo, otherwise a larger E.M.F. would be induced in the coils under the stronger poles. With a series-wound armature this would not be of such importance, as one inductor of each coil would be under each of the poles at the same time.

Correct balance of the armature is also of the utmost importance, as owing to the high speed, if it is at all out of balance, there will be great vibration when the machine is run. If the dynamo is to be belt or rope driven, the armature should be balanced before the pulley is fixed, and again after, the compensating piece should in the latter case be attached to the pulley. It is not a sound mechanical practice to correct an unbalanced rotating piece of mechanism by fixing to it another mass of metal equally out of balance but in the opposite direction; each part should be truly balanced in itself if perfectly smooth running is required. The evils due to vibration are very great: the brushes are thrown on and off the commutator, the extent being limited by the strength of the springs; and not only do these rapidly deteriorate owing to increased wear and tear, but also flats are formed on the commutator and sparking is set up, while, in addition, all the nuts and bolts have a tendency to become loose, and, generally, a machine in which there is an undue amount of vibration will require considerably more attention on the part of the attendant than will one which runs smoothly.

Conclusion.

In conclusion, the writer would urge upon the student who wishes to become a successful designer the great necessity of paying attention to details, and of only trying such modifications of existing types as are in accordance with the fundamental principles of dynamo design, and to have a clear and well-defined reason for every departure from existing practice. Above all, careful notes ought to be taken of every test, especially of tests made upon machines in the design of which experiments have been made. It is quite possible that there are very simple remedies for many of the evils of the armature reactions which have so far escaped notice, and these remedies will only be discovered by a study of the fundamental principles, backed by the experience and knowledge gained from the tests upon every class and type of dynamo.

It is doubtful if the efficiency of the present-day dynamo can be greatly increased, seeing that dynamos can and are being made with an efficiency of 96 per cent., or even slightly more; the great advance must then be made upon securing true fixity of lead combined with high efficiency, a simplification of the parts, together with a diminution in the weight, size, and cost of the dynamos. While with the increased demand for motors for all classes of work, they must be made stronger, not necessarily more massive or mechanically stronger, but they must be made to withstand rapid and constant fluctuations in the load, and, also, they must be built capable of withstanding, without sparking or great attention, overloading to an extent of 50 per cent. or more above the rated output.

DISPOSAL OF REFUSE AND GENERATION OF ELECTRICITY IN THE CITY OF LONDON.

We have received a copy of the report of Mr. Arthur A. Voysey, electrical engineer to the Corporation of London, as to the best means of cremating the whole of the house and trade refuse of the City, and for the generation of electricity from the destruction of the matter. To begin with, Mr. Voysey calls attention to one lesson which is to be learnt from the observation of recently erected works—viz., that on sanitary, engineering, and economic grounds the refuse should not be moved out of the carts until it is put into the destructor. This meant that it would be necessary to have spare bodies for the carts, but the expense of extra bodies would be trifling when compared with the expense incurred in the construction and working of complicated apparatus for storing, raising, and distributing the refuse among the various cells, a work which, in his opinion, could be effectively executed by a simple overhead traveller driven by electric motors. On the question of electric motor dustcarts, Mr. Voysey refers to the short life of the electric cabs in London. He points out that to be discharged beyond a certain point is what destroys a battery, and in a cab service it was very likely to occur, whereas in a dustcart service it should never happen. Electric barges would be a cheaper means of taking away the sweepings, clinker, etc., from furnaces, he estimates, than the present, and in addition to the running of dustcarts and barges, electricity could be used for lighting the works and also the City streets. If required, sufficient electricity might be generated for all these purposes. With regard to public lighting, the engineer states that the relations existing between the Corporation and the City of London Electric Lighting Company are of an uncertain nature, but it should be borne in mind that the agreements under which the public lighting has been carried out, supposing they be held good at law, are determinable, at the pleasure of the Corporation, seven years after the completion of the whole of the lighting. Mr. Voysey then goes on to consider whether electricity might be suitably generated in connection with destructors. A consideration of the kind of load provided in charging batteries for the motorcars and barges by day, and supplying current for the public lamps by night, showed it at once to be ideal; and while for most purposes he was opposed to the establishment of small generating stations, he thought it exceedingly unlikely that it would be possible for many years to come to buy electricity at less than 1d. per unit, which was probably what it would cost if generated in connection with the destructors and for the purposes he had mentioned. The chief reason why electricity could be so cheaply generated was that the total output of the generating machinery would be high in proportion to the maximum rate of output as compared with the average electric supply station. A strong reason in favour of the Corporation generating its own supply, assuming that electric motor dustcarts or barges be adopted, was that the growing custom of electric supply undertakings was to use a pressure of 200 to 250 volts. In the opinion of Mr. Voysey, this pressure would not be so well suited for charging the accumulators as would a pressure of 100 volts. He then proceeds to show in what manner his scheme could be carried out. In the first place, Mr. Voysey points out that a capital expenditure of about £9,000 would be necessary, and supposing the lease of Letts's Wharf, where the existing destructors are in operation, could not be renewed in 1909, the destructor for all practical purpose would become valueless. Therefore, if it were decided at once to cremate the whole of the house and trade refuse, there would be a risk of increasing the present expenditure by the amount of the capital expenditure on new destructors, which would be equivalent to about £1,100 a year. As regards the electrical part of the scheme, the engineer advises that it should be carried out in the most gradual and tentative way. Trials of electrically-propelled dustcarts and barges should first be made. While these were being carried out, the question of public lighting should have developed to such an extent that it would be possible to determine definitely when and under what circumstances the public lighting could be taken over, and the saving to be effected thereby. The question of site would then have to be considered. His estimation was, provided his suggested scheme proved successful, that the space required would be less than half the space now used at Letts's Wharf. In conclusion, Mr. Voysey emphasises the fact that he had approached the question of the generation of electricity from the heat produced by the cremation of refuse by endeavouring to show how a profitable demand could be provided. If such demand were not obtained, the generation of electricity should be left alone, for it was only by superiority of load factor that a small generating station could expect to rival the larger stations in the cost of generation.

Opposed Bills.—Notices of opposition were deposited on the 9th inst. as follows: against the London County Council's Tramways and Street Widenings Bill (3); the West and South London Junction Railway Bill (1); and the London United Tramways Bill (3).

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THE CASE FOR ELECTRIC POWER DISTRIBUTION.*

BY W. B. ESSON, M.I.C.E., M.I.E.E.

In opening the case for the electrical distribution of power let me clearly indicate the scope of my remarks. First, I distinguish between electrical *distribution* of power and electrical *transmission*, and observe that I do not intend to say much of the latter. It is admitted that for transmitting power the electrical method has no rival when the points between which the transmission takes place are beyond quite a moderate distance. For short distances the telodynamic system of transmission by means of wire ropes is a rival worthy of consideration, but on the European continent, where this method has been developed to the fullest extent, I am not aware that the total distance has ever exceeded three-quarters of a mile. Possibly from this up to a mile or so there is a debatable land which is liable to be turned over to electrical transmission or telodynamic transmission as circumstances may direct, but beyond this electricity holds the field; and if it will not pay to transmit the power electrically, it will not pay to transmit it at all. For *transmitting* power, then, there is no question as to the superiority of electricity, though in many cases the advantages attendant on its use for *distributing* power are not so clear.

For the working of tramways and light railways, the all-round advantage possessed by electricity over other agencies as a means of traction has been proved. There are also good reasons for believing that there is an important future for the transmission of electricity from large generating stations situated advantageously with regard to fuel to, places scattered over a considerable area less favourably situated, and the Electric Power Bills, the granting of which by Parliament constituted the electrical feature of last year, will enable us to see shortly whether our hopes with respect to these schemes are well founded. But with none of these things am I to occupy your attention. I am simply to discuss the *pros* and *cons.* of electric power distribution in factories and workshops, and to see where an unbiassed consideration of this subject will lead us. This is merely a problem in mechanical engineering, and mechanical engineers as a class generally bear in mind that their business is to secure the best results at least expense.

Whether power distribution can best be carried out electrically by continuous currents or by alternating currents of two or three phases is another question I am not dealing with now; that's the sort of thing we read papers about at the Institution of Electrical Engineers over the way; its discussion here, however, would take us beyond the range of general principles, and would require a greater amount of time than we have at our disposal. Our business to-night will be to consider the circumstances upon which must depend the decision as to whether electricity can with advantage displace the older methods of power distribution.

To begin, then, the older forms of power distribution we think about displacing may be generally summarised under two headings: first, cases in which the power is supplied by a number of engines driving individual machines or departments of the works; and, secondly, cases in which one engine furnishes the whole power which is distributed to the various machines by shafting and belts or ropes.

Considering the first group, a large number of tests have been made to determine the steam consumption of small engines, with the result that these have been proved to be terribly wasteful. They consume in steam anything from 50lb. to 250lb. per indicated horse-power per hour, and upon the tests made upon 100 engines taken at random, Mr. Bryan Donkin found that the average consumption was no less than 150lb. These engines, though presumably not very carefully looked after, are not treated with exceptional neglect, and may be considered as representative of the ordinary performance of the auxiliary engine usually seen in paper mills, bleach works, foundries, and the like. Seeing that first-class engines of moderate size running at full load consume only 20lb. of steam per indicated horse-power non-condensing or 17lb. condensing, you will see that there is here a considerable margin of loss for possible reduction by a more economical system of distributing the power.

But if these results are so poor with auxiliary engines running indoors, what shall be said of the clattering, noisy, dripping abomination running in the open, with its loose joints, its escaping steam, and streaming glands familiar to everyone who has been through a shipbuilding or bridge-building yard? What such an engine costs in steam it is difficult to say, and when the additional loss due to condensation in the distributing steam-pipes is taken into account, it will be realised that there are here enormous fuel losses to be diminished by the introduction of more economical methods.

It must not be supposed that I am purposely selecting bad examples in order to make out a strong case for electrical distribution. I am merely taking things as you and I know them to exist, and considering the conditions under which these isolated engines of which I am speaking have to run, you will see that much better could not very well be expected from them. Travelling in Yorkshire the other day I observed in the collieries and ironworks I passed, long ranges of steam-pipes, from which the non-conducting composition once covering them had long since fallen off, leaving them altogether unprotected from the weather, while in scarcely a single instance was the covering intact and in good order. The same is to be found in any old-fashioned shipyard or bridge works, and it must be allowed that to keep steam-pipes in good condition in the open requires a considerable amount of pains to be taken. Again, to keep those badly used engines as they ought to be kept would require a great deal of attention; this attention they do not get, and uneconomical even when cared for, they get worse and worse with time. It is different, of course, with auxiliary engines on board ship. These are of high-class workmanship, generally of the compound type, and having the advantage of exhausting into the condenser when the main engines are running, besides being, comparatively speaking, all close together, they give very good results. It may be said that in the mining districts coal is so cheap that it scarcely matters what the engines consume. Well, that is a point to be considered later; at the moment I am merely pointing out that the fuel consumption is extravagant beyond all reason, and please remember that one of the principal sources of loss—the condensation in the pipes—goes on whether the engines are running or not.

The second method of power distribution I have referred to is by shafting and belting, and a large number of experiments has been made from time to time to determine what fraction of the indicated horse-power of the engine is actually returned as useful power to drive the various tools and machines in our workshops and factories. It is unlikely that any of these particular determinations would exactly fit the circumstances of a new case to which we might wish to apply is, nevertheless the results are of great value as indicating what we might expect in works of a like kind. The figures are got by first indicating the engine with all the machines or tools at work, and then indicating it with these thrown off. The latter indication gives the indicated horse-power lost in engine friction and in shaft and belt friction throughout the works, and the ratio of the difference between these two indications to the higher of the two gives the fraction of the indicated horse-power utilised to drive the machines. For engineering shops in which heavy machine work is being done, the power utilised to work the tools is found from several tests to give an average of 45 per cent. of the indicated horse-power. For shops in which light machine work is carried on, such as the making of sewing machines, bicycles, small tools, etc., the useful return of indicated horse-power available for driving the machinery is again found on the average to be 45 per cent. From the results obtained by making tests in eight factories in America engaged in the engineering trades, we learn that the power utilised to drive the machine tools averaged 56 per cent. of the indicated horse-power, while in one extreme case, that of the Baldwin Locomotive Works, the return was only 20 per cent. From tests made in over 300 factories and workshops in France we get an average return of less than 60 per cent., while returning home again, in the three principal shops of the Gloucester Wagon Company, the return was found to be 60·25 per cent., 44·9 per cent., and 38·3 per cent. respectively.

In these tests it is assumed that the ratio of the difference in the indicated horse-power loaded and unloaded to the indicated horse-power running loaded expresses the power utilised, and this carries with it the further assumption that the friction losses are constant, and independent of the work being done. This is found to be practically the case. Once upon a time it was thought that the friction of an engine increased largely with the load, but this is not so. In many instances there is no appreciable increase at all, and in any case the addition is quite small. The same holds good for shafting and belting. Practically there is no increase of friction with the load, and any slight difference would only make the results worse than appears from the test, for in that case obviously we have not at full load debited the transmission with the full friction loss.

The figures show great variation among the results, but that is only what we might expect. There is no fixed or even approximate relation between the indicated horse-power and the length of shafting, number of pulleys, or number of belts. Every factory is laid out on different lines—some may be on one floor, some occupy several floors, and so on. Again, even if care is taken to arrange the shafting in a scientific manner—a condition seldom fulfilled, let me say—it is unlikely that it will remain long in first-class order. It is not easy to maintain shafts in perfect alignment. The bearings are seldom very carefully attended to as regards lubrication, and in adjusting the cap bolts a careless labourer may very easily increase the friction of a journal by 100 per cent. But when all care is taken, it is unlikely that we could with any degree of certainty count upon a greater return than 60 per cent of the indicated horse-power as an average. In some cases, of course, it would be more, in some cases less; but in fixing on the above figure

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as a basis for comparison, I think I am, if anything, giving shafting and belting the advantage.

Taking 60 per cent., then, as the useful return, this means that 40 per cent. is absorbed in friction. The engine accounts for 10 per cent. of the indicated horse-power, an amount which cannot very well be reduced; and of the 90 per cent. which is given to the crankshaft, two-thirds reaches the machines as useful work, one-third being wasted in heating bearings, bending straps, and wearing things out generally. It is this last item, representing 30 per cent. of the whole indicated horse-power, that we want to have a cut at.

We have seen that the friction of the shafting and belting remains constant, and from the nature of things the shafting and belting must keep on running whatever the number of machines at work. There is no way, when we stop a machine, of reducing the loss in transmission by the proportion which might be *pro rata* allocated to that particular machine, consequently, though the machines at work in the shop may only be a fraction of the whole, all the shafting must run for them. The effect of this on the useful return is very well shown by the diagram Fig. 1. Here distances measured along O X as abscissæ represent fractions of the load, and ordinates the horse-power. The line O A represents the useful work done, and the line B C the indicated horse-power of the engine, distances between these two lines measured as ordinates representing the waste. At full load we have a useful return of 60 per cent. of the indicated horse-power, at three-quarters of full load 53 per cent., at half load 43 per cent., and at quarter load 27·3 per cent. This, then, is the average result we may expect to obtain with power distribution by shafts and belts. The percentage of

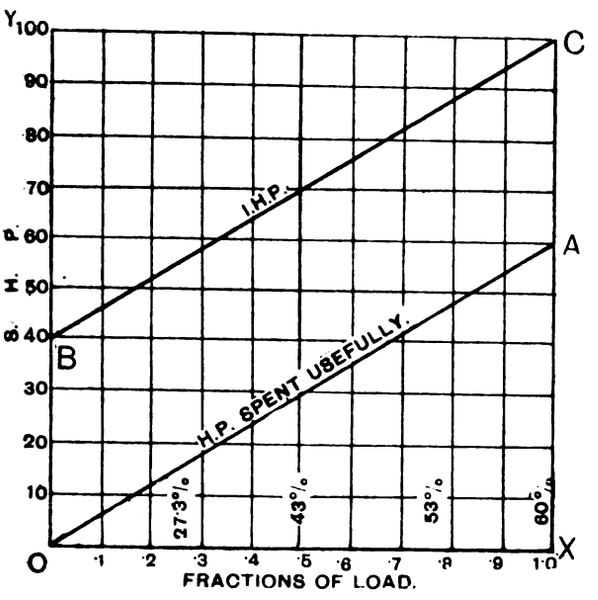

FIG. 1.

useful return always decreases rapidly as the machines are thrown out of work, or as the load on them is diminished.

So much for the data at our disposal regarding the older methods of transmitting power. We will now see what can be done by electricity. Beyond emphasising the previously expressed law of friction, we need not at the present stage trouble ourselves about the engine, as, whether it drives shafting or an electric generator, it may be assumed to be of the same class, and to behave in a similar manner under steam. We shall still take the friction of the engine to be constant for all loads, and assume that it absorbs 10 per cent. of the full load indicated horse-power.

To begin, then, with the generator. This may be directly coupled to the crankshaft of the engine, and we may assume that when fully loaded it gives at its terminals a useful return in horse-power of 90 per cent. of the power given to the shaft. With large generators a somewhat larger return is frequently obtained, but 90 per cent. is a good all round figure. We may as well be on the safe side, and it does not do to be too sanguine. On the other hand, it is unlikely that a generator would be installed of such small size that the return would not reach 90 per cent. According to this, the useful electrical return at the generator terminals is 81 per cent. of the indicated horse-power of the engine.

Now for the law of the generator. The internal losses in the machine itself are partly independent of and partly dependent on the electrical power it is giving out. They consist of the energy expended in forcing the current through the copper windings of the fixed and rotating parts, and of the energy expended in iron parts which are subject to the continuous reversal of their magnetism while the machine is working. For the sake of analogy, we may very well call the former electrical friction and the latter magnetic friction. The magnetic friction is practically constant for all loads, the electrical friction is in part constant and in part variable. The variable part increases as the square of the load, so all the losses may be expressed in the form $= a + b\,C^2$, where a and b are coefficients depending on the construction of the machine, and C the current, which for a machine giving uniform electric pressure is, of course, proportional to the output. For the generator giving, as we have assumed, a useful return of 90 per cent., the coefficient a will have a value of, say, 6 per cent. of the power put into the shaft of the machine at full load, while the value of $b\,C^2$ at full load would be about 4 per cent. Fig. 2 shows the useful return obtained from the generator at various loads computed on this basis. Abscissæ measured along O X represent fractions of the output, and ordinates represent the horse-power. Heights measured to the line O A give the useful return, and measured to the line B C give the indicated horse-power. Distances measured vertically between O A and B C give that part of the horse-power wasted in engine friction and in the magnetic and electrical friction I have alluded to. You will see that the waste rises in a curve, owing to part of the loss increasing as the square. There results a useful return at the terminals of the machine of 81 per cent. at full load, 77·7 per cent. at three-quarter load, 71·3 per cent. at half-load, and 56·4 per cent. at quarter load.

The electric power has to be distributed and converted where required into mechanical power through the agency of a system of electrical conductors and the electric motors. In the former the loss due to electrical friction is proportional to the square of the current, and it is very usual to fix the section of copper so

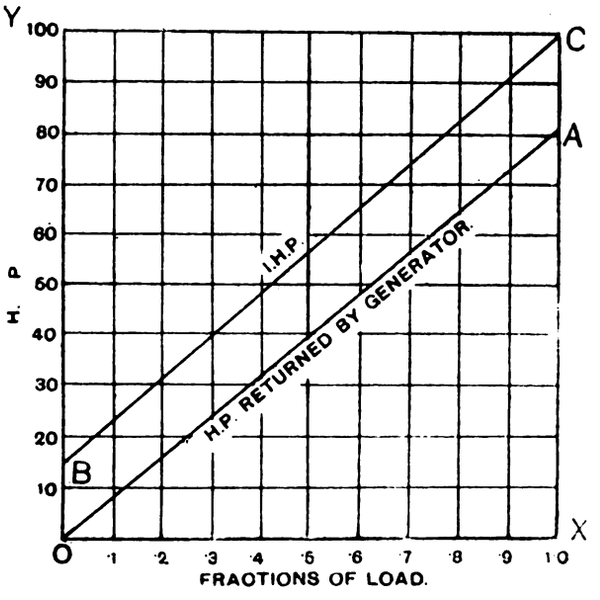

FIG. 2.

that the power wasted in the conductors at full load shal be about 2½ per cent.—that is to say, the pressure at the motor end of the conductor shall be 2½ per cent. less than the pressure at the generator end. In terms of the full load indicated horse-power of the engine this would mean that the loss is about 2 per cent.; diminishing as the square, at half load it would be one quarter of this, and so on.

We have now to consider the motors, and the law which governs the losses in these is just the same as that which governs the loss in the generators—that is to say, there is a certain loss which is constant and independent of the work the motor is doing, and a certain loss which is proportional to the square of the load. The useful return obtained from individual motors varies with their size, this reaching 90 per cent. of the electrical horse-power put into them in motors of 50 h.p., and falling to 75 per cent. or so in motors of 1 h.p. If we assume that the motors installed are mixed large and small, and that the return all round is 85 per cent., we shall, I think, get pretty close to the conditions of practice; and on this basis, then, let us see what net return we get from the whole distributing system. Before calling your attention to any further diagrams, however, let me point out one respect in which electrical power distribution differs radically from distribution by shafting and belts. It has already been pointed out that with the latter distribution the loss remains the same, whether many or few machines are at work; accordingly the percentage of power lost in distribution, referred to the work expended usefully, increases enormously with very light loads. With electric distribution, however, this is not the case, as the motors are stopped running when their power is not required. Accordingly, for the time being, and until the motor is started again, the proportion of distribution loss which may be allocated to

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the machine or group of machines which the motors drive absolutely ceases, so far as one important factor is concerned.

The useful return obtained from a system of power distribution by electricity is shown in Fig. 3. As before, abscissæ represent fractions of the load, and ordinates horse-power. The line O A shows the horse-power usefully returned, and the line B C the indicated horse-power. As will be seen, at full load we get from the motors 66 per cent. of the indicated horse-power, at three-quarter load 64·3 per cent., at half load 59 per cent., and at one-quarter load 47 per cent. This is under the best conditions, the motors being stopped as the machines they drive are thrown out of action. If the motors were allowed to run—that is, if the plant were run under the worst conditions—the indicated horse-power would be as shown by the dotted line, D C, in which case the return would be at full load 66 per cent. as before, at three-quarter, half, and one-quarter loads 62, 57, and 41 per cent. respectively. We shall assume for the purposes of this argument that the real return lies between the two. Note, however, that at full load we get 66 per cent. for electricity as against 60 per cent. for shafting, and at one-quarter load about 44 per cent. as against 27 per cent.

By superposing diagrams Figs. 1 and 3, and reducing the useful return to a common basis for both, we get Fig. 4, which shows the indicated horse-power required for electrical and mechanical distribution respectively, the line B C representing the former and the line D E the latter. Distances between B C and D E measured on the ordinates show the difference in the indicated horse-power required by the two systems. Observe that at full load we save about 10 per cent. in the indicated horse-power by electrically distributing the power, and at

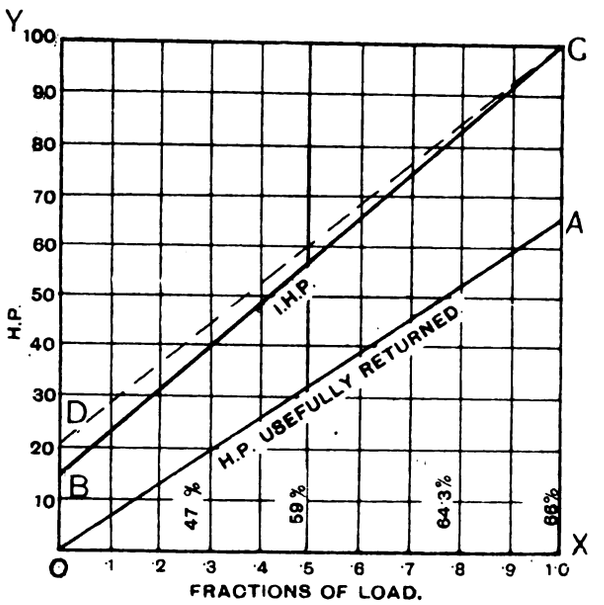

FIG. 3.

three-quarter, half, and one-quarter loads 16, 24, and 38 per cent. respectively.

The law governing the steam consumption of the engine now demands attention. How is the steam consumption influenced by the load on the engine, and what is the cost of steam per indicated horse-power at various loads? The law connecting the steam consumption with the load has been investigated by several engineers, notably by the late Mr. Willans, who made many interesting and valuable experiments on the subject. Mr. Willans found that in an engine running at a uniform speed and with constant ratio of expansion, the total steam consumption might be expressed with remarkable accuracy in the form $= a + b$ I.H.P., where a and b are constants depending on the construction of the engine. This means that the steam used in the engine is made up of two quantities, one of which is constant and independent of the work being done, the other of which is proportional to the indicated horse-power. For engines which have a variable ratio of expansion the law is somewhat different, but it will be sufficient for our purpose to assume that in the engine we have chosen the steam consumption follows the above stated simple law, and the argument is not altered thereby. Taking 20lb. per indicated horse-power per hour as the consumption of steam for a non-condensing compound engine and 17lb. for the same engine working condensing, the diagram Fig. 5 shows the results obtained from an engine of 150 i.h.p. Abscissæ give the indicated horse-power, while ordinates represent the total steam consumption per hour. The line A B gives the results for condensing, and the line C D those for non-condensing. It will be observed that the water taken by the engine when doing no work, but simply running round at full speed and over coming its own friction, is, in the case of the non-condensing engine, no less than one-third of the steam it requires for running when giving its full power; while in the case of the condensing engine it is rather over 20 per cent. The figures are from actual practice, so you need not worry about their accuracy. In consequence of there being a certain quantity of steam which is independent of the load, the quantity per indicated horse-power increases greatly at light loads in non-condensing engines, and less so in condensing engines; consequently the saving in fuel is not, as has been so often assumed, proportional to the saving in indicated horse-power.

At this stage we may fitly make enquiry as to the capital outlay required for a scheme of electric power distribution. It need scarcely be said that this depends entirely upon the amount of the power and the character of the area over which it is to be distributed. The extent of the works and the number and size of units into which the power is to be divided have all to be considered, so that dealing with general principles my only course is to adopt, for the sake of argument, a fair average and leave it to you engineers to make the necessary correction for each individual case which comes before you. The cost of generators per horse-power varies with their size, and the same holds for motors, the price of the latter running from £5 per horse-power for 50-h.p. sizes to as much as £15 per horse-power for sizes of 3 h.p. For every horse-power delivered at the motor shafts we have to furnish by the generator 1·2 h.p., and as regards the conducting system, the cost of this depends upon the extent of the premises and whether the power is delivered in large or small lots. I am going to assume that, taken all round, the capital expenditure, including generator, switchboard, conductors, motors, and fixing, will amount to £20 per horse-power of motors installed, this being, in my opinion, a fair average. For the moment I am not counting as part of the expenditure, on account of electrical distribution, the cost of the engine, as we require an engine

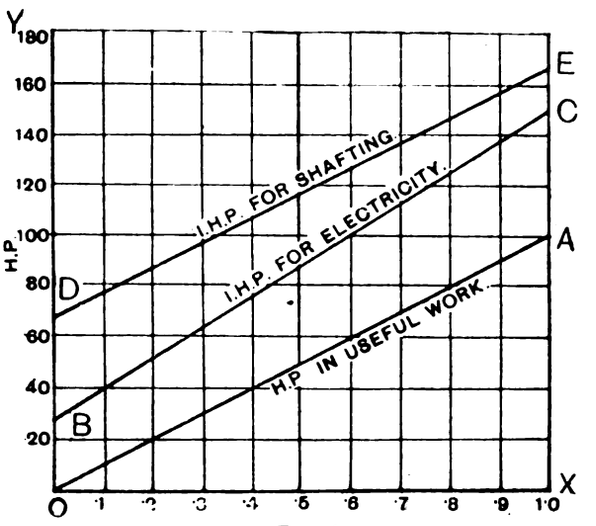

FIG. 4.

in any case, whether we distribute its power mechanically or electrically. If it becomes necessary to consider the cost of the engine, it may be taken at £3. 10s. per indicated horse-power.

Now, if it is difficult to strike an average for the cost of an electric distribution plant, it is still more difficult to get a reliable average of cost for shafting and belting. The figure I give for this must be considered as subject to great variation. It is taken at £5 per horse-power installed. The depreciation in belting we know to be extremely high, and for the purpose of this argument I shall assume that the all-round depreciation on the plant required for mechanical distribution, including belts or ropes, may be taken at 15 per cent. That on the plant for electrical transmission may be very fairly taken at 5 per cent. Allowing interest at 5 per cent., there requires to be set aside annually to meet interest and depreciation, for electrical distribution £2 per horse-power installed, and for mechanical distribution £1 per horse-power installed. To make the adoption of electric distribution worth while, then, there must be shown a direct or indirect annual gain in its favour of £1 per horse-power, being the difference between these two amounts.

We have now got together such data as are available for our purpose of comparing from the economic point of view the different systems of distributing power. Combining Figs. 4 and 5, there is shown in Fig. 6 the total steam consumption in the engine both for mechanical and electrical distribution, and it is upon the results here represented that we shall base our estimates of the fuel cost. I shall take it that the motors installed aggregate 100 h.p., and that we use for driving the generator the 150-i.h.p. engine, for which has been given in Fig. 5 the steam consumption. Abscissæ represent the

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horse-power obtained from the motors, and ordinates the steam. The full lines, A B and C D, represent the consumption per hour for mechanical distribution, non-condensing and condensing respectively, while the dotted lines, E F and G H, represent the consumption for electrical distribution. Now, it will be seen that electrical driving has everywhere the advantage over driving by shafting and belting. This saving increases as the power is reduced, so the question arises in getting out our comparison of costs, What proportion of load should we assume to represent the conditions of actual working? Suppose we say that 80 per cent. of the machines run simultaneously, then we save about 10 per cent. of the steam by adopting electric driving, but when running at very light loads—working overtime, for instance—we may, as shown by the diagram, save over 25 per cent. Possibly, if we assume that the load throughout the year averages three-quarters of the full load we shall not be very far out. On this basis, by employing electrical instead of belt driving it will be seen that we save 13 per cent. in steam. Note that though the saving in power at quarter load is 38 per cent., the saving in fuel is, due to the law of the steam-engine, only about 24 per cent.

The cash value of this saving depends upon the price of fuel, having regard to its thermal value. This varies in every district. At the pit's mouth it is low; in the London district it is high. You would, of course, be able from the circumstances to assign the proper value in each case, but for the purpose of the present argument we shall assume that every 100lb. of steam raised costs 1d., this corresponding to value for coal of about 18s. per ton. Now, on reference to the diagram Fig. 6, it will be seen that driving electrically at three-quarters load we save 375lb. of water every hour we run. According to the price assumed, this is equal in money to 3¾d. per hour, and for 3,000 hours per annum, which allows for some overtime, we get a saving of £46. 17s. 6d. due to electric driving.

Note that, provided a similar engine is used for electric and belt driving, the saving is no greater in a condensing than in a non-condensing engine. From the diagram Fig. 5 it will be seen that the addition to the steam consumption is per indicated horse-power the same for condensing as for non-condensing, though on account of the quantity of steam, which is independent

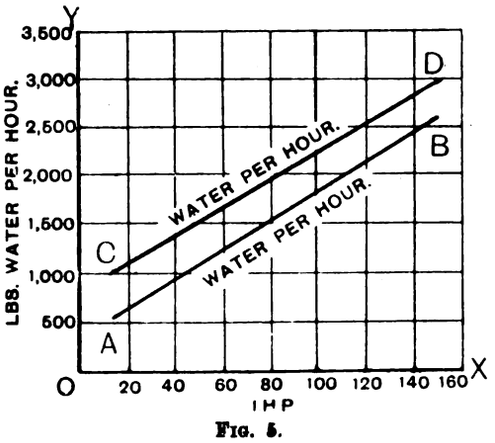

Fig. 5.

of the indicated horse-power, being in the former case less, the total consumption for a condensing engine of given size is correspondingly diminished. By electric driving, however, we simply reduce the indicated horse-power, and as the steam to be subtracted for a given reduction of power is the same both for condensing and non-condensing, the fuel saving is not in the least influenced.

It appears, then, that taking this case of mere substitution of electric for belt driving there is not a large saving in the direction of fuel consumption to be expected. With regard to the belt driving, the assumption was made that friction, including that of the engine, accounted for 40 per cent. of the indicated horse-power, but it must be remembered that though this is a fair average, on occasions friction runs away with as much as 80 per cent., while in some cases only 20 per cent. is lost, and the only way therefore to get at the real waste is to treat specially each particular problem that turns up. It will be readily understood that the balance may, according to circumstances, lie with either method of distribution. It depends largely on the area over which the power is spread.

Again, the saving depends, as we have seen, on the average load. If it is necessary to work a good deal of overtime, when only a few of the machines scattered about the various parts of the works have to run, the saving is increased; on the other hand, if full load is the rule and partial load or overtime the exception, the saving is not so great. Further, in the case considered, the assumption is made that in adopting electric distribution *all* the shafting and belting is dispensed with. This, however, is not at all likely, and the question is, even with the best arrangements made for electric distribution, what proportion of shafting and belting is it necessary to retain? Proposals have come before me which admitted of the shafting being reduced to a negligible quantity, but there are cases, on the other hand, where the shafting and belting could not be appreciably reduced by the introduction of motors. One example comes forcibly to my recollection—that of a cotton mill in India. It was proposed to drive this electrically, but the mill was all on one floor and the machinery was so compactly and symmetrically arranged that no point could be found in the distributive system where the introduction of motors would save in friction anything worth speaking of. So far as fuel consumption goes, this is the crux of the matter. Wherever we put in a motor, in the nature of things we lose at once, and between the motor terminals and its shaft, 10 to 15 per cent. of the power we have delivered to that point. If we continue with shafting and belting we save this loss, and the question, therefore, is: Do we gain, by employing electrical distribution up to that point, such an advantage over distribution by shafting as will justify us in dropping that 10 or 15 per cent.? Undoubtedly we do often, but it was not so in the cotton mill referred to. And from another point of view this kind of case is the worst for electric driving, as a mill generally runs at full load or is stopped altogether. When slack, half or three-quarter time is worked, as the case may be, but they work full load whilst they are at it. Here it may be

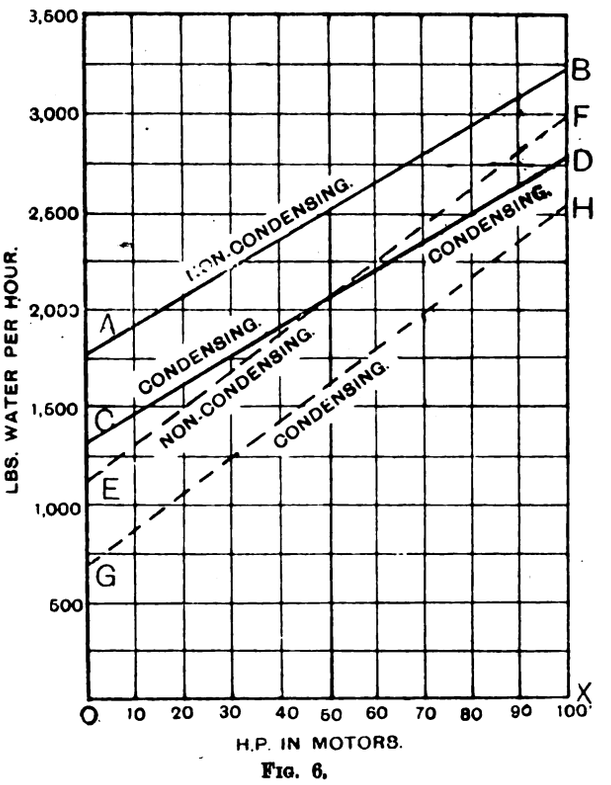

Fig. 6.

mentioned that on the Continent, where cheap electrical power is purchased for manufacturing purposes, it is customary for such power to be distributed by shafting and belting. A few motors are installed to drive different sections of the works, just as steam-engines might be installed, but it is unusual to employ separate motors for individual machines. In America the same holds good. In textile factories either one large motor or a number of smaller ones are installed, say from 50 h.p. to 130 h.p., as in a cotton mill lately set to work in Carolina. Again, in engineering works it is usual when the machine tools require less than 4 h.p. each to group them on short lines of shafting, each section taking about 24 h.p.

Lastly, there is, of course, the cost of fuel influencing the saving. If the fuel costs per ton less than I have assumed, always having regard to its thermal value, the saving will be less; if it costs more, the saving will be greater. Once I was asked to advise a company as to the advantage which might be expected from doing away with the large engines driving different sections of their works, centralising the boiler and engine plant, and distributing the power everywhere electrically. As it turned out that the fuel used consisted chiefly of shavings and sawdust, which cost nothing, the conversion would have been, considered from the fuel point of view, the maddest folly, but, as we shall see later, there are other matters to be taken into account besides fuel, and it is just possible that in cases apparently unpromising a consideration of these may sometimes turn the scale. In the meanwhile, remember that upon these three factors the saving in fuel depends. They are: the average load, the amount of shafting and belting which can be displaced, and the cost of fuel, and it is necessary to give these their proper value for each case that arises.

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Turning to the replacing of small engines by electric driving, there is here no question as to fuel economy. In works divided into sections of considerable size, each driven by a high-class compound engine, it is no doubt more economical, if the distances are not excessive, to distribute steam through carefully lagged pipes than to adopt electricity and substitute for these engines electric motors; but in the case of small steam-engines the results all point the other way. From the diagram Fig. 6 it will be seen that for 75 h.p. delivered we use about 2,500lb. of steam per hour for electric driving working non-condensing, and it is safe to predict that if this power were given by five single-cylinder engines of 15 b.h.p. each, the consumption would not be less than 4,500lb. of steam per hour. This means 2,000lb. excess of steam for every hour worked, or, on the basis we have taken, an expenditure of 1s. 8d., amounting for a year of 3,000 hours to £250. If it were possible to work the generator engine condensing, the saving would be £300 per annum. The electrical equipment certainly costs more than the steam equipment, but taking fuel at the price we have assumed, it would pay in an existing works to put in an electric plant complete and sell the engines as old iron.

But if this saving can be shown by displacing engines which cannot be considered very bad as things ago, what shall be said of the saving effected by displacing the rattletrap engines spoken of in the beginning of this paper. The waste of steam is here enormous, and if the power were furnished, not by engines of 15 h.p., but by engines of from 2½ h.p. to 5 h.p., running under usual conditions, the water used would be not less than 8,500lb. per hour. This means that electrical distribution would result in a saving of 5s. for every hour run, and for 3,000 hours this amounts to no less than £750 per annum. This is for fuel alone, and does not take into account the reduced wear and tear of boilers due to only one-third of the number being required for steam raising. In such cases, if the cost of coal were only one-third of what we have assumed, it would pay to electrically distribute the power and throw the engines on the scrap heap.

Hitherto we have dealt only with the question of fuel, but there is also the matter of attendance to be considered, and in my opinion electric motors require less attendance than do shafting and belting, even if the latter are looked after properly. But the fact is that while motors are generally under the supervision of an intelligent person, shafting and belting are too often left to the mercies of people who have been in no way trained to think; and consequent on the services of an electrician being sometimes enlisted, it has been thought that the cost of attendance on electric plant must be considerably more than on shafting and belting plant. This is by no means the case, for as there is no machine to compare in mechanical simplicity with an electric motor, it requires very little attention, and the greater part of the belt mending being dispensed with, there is, I think, in the matter of attendance, a clear gain for electric distribution.

Where electric motors are substituted for small engines, however, there is no question as to the saving in the matter of attendance. The wearing parts of an engine are many, whereas in motors these are reduced to two bearings, and by making them substantial, and providing them with automatic lubrication, their wear may be rendered excessively small. Electric conductors properly insulated will last for many years without the least attention, but this can scarcely be said of a range of steam-pipes erected in the open, and subject to contraction and expansion. There are joints to make and keep right, there are also glands to pack in the engines, and working joints to be constantly taken up if such poor efficiency as is possible to the system is to be maintained. But—and this is the melancholy truth—the attention is not given, and for the simple reason that the engines will work without it. Let steam blow from the pipe joints; let the engine piston leak; let water stream through all the glands, and still the engine will work. That is the mischief of it. If an engine refused to work with either of these defects it would have to be kept in order, and minimum waste would be thus ensured. But it continues to run with all its faults, and an enormous coal bill bears witness to its inefficiency, and to the fact that because it will run anyhow it does not get the attention that it ought to.

Now, it is different with electric motors. These require considerably less attention than engines *should* get, and very much less attention than they *do* get, but they insist that the little attention which is required shall be given to them. They must be kept clean and dry; and when we have said this we have said all, as good motors will, working under these conditions, run for an indefinite period without giving trouble. If these conditions are not fulfilled, a breakdown is likely to result, with consequent stoppage, for a motor will not run having a defect which renders it inefficient. They run therefore at their proper efficiency or not at all; they do not with the lapse of time eat electricity as engines eat steam; they need but little looking after, and the nature of the attention required is such that everything under this heading can be carried out systematically and at small cost. By keeping an eye on the current indicators we can always tell what is going on in an electric system, but working with small steam-engines there is nothing to indicate when the steam consumption becomes abnormal. Again, the boilers are generally dotted about the works—a couple here, a couple elsewhere, and so on. By centralising the boiler plant, we can with electric distribution effect further economies in the attendance and further reduce losses, whilst, needless to add, there is in electric conductors no waste analogous to that due to condensation in steam-pipes which goes on whether the engines are running or not.

Hitherto we have dealt with direct savings in fuel and attendance, and these appeal principally when proposals are before us for electric installations in existing works. When laying-out new works the object, of course, is to adjust exactly the means to the end—that is, to arrange everything so that the particular articles manufactured shall be produced in the best quality at the lowest cost and with the greatest expedition. Now, when shafting was the only means at our disposal for distributing the power, the machines had to be located with regard to the most convenient arrangement of driving, and in many instances the position which best suited the shafting did not agree with the position of greatest suitability for the work to be done. With electrical driving it is altogether different. Shafting cannot be made to turn corners without cumbrous and noisy gear, but electric conductors can be led anywhere without trouble. While with belt driving, machines must be installed with special regard to the run of the shafting, electric driving places no restriction as to the position of the machines, and they can be placed with regard only to economy in production. It is conceivable that the advantages secured by electricity under this heading may in many instances be so great as to dwarf the direct savings of which I have already spoken, and this is what was in my mind when I remarked a few minutes ago that fuel was not the only thing to be considered. Quite apart from any saving of labour in the attendance on the distribution plant, we have the economy of labour in production which results from our being able to place our machines in the positions best suited to secure continuity in the treatment of the raw material, and this is a very great advantage. Again, as regards cost of plant, having no time-worn machinery to displace, we have not to make for new works any sacrifices of capital. The result of all this is an increased output proportionally to the capital outlay in machinery, while better lighting of the shops due to the absence of overhead shafting and the greater cleanliness resulting undoubtedly make for the same end. He would, indeed, be behind the times who would think of laying-out new works without taking seriously into consideration the advisability of distributing the power by electricity instead of by the ancient method of shafting and belting. It is not contended that increased output will necessarily follow a displacement of small steam-engines by electric motors, as here the economies are chiefly in the direction of diminished coal bills and less labour in attendance. In displacing shafting and belting, however, where the saving in the coal bill and attendance is not so marked, we have to look to the increased output as constituting the chief advantage.

Wherever electric motors have displaced small steam-engines large savings have resulted, and cases have been known where the whole cost of the electrical plant has been returned in one year as saving in fuel and wages. In dyeing, bleaching, calico printing and paper works, in sugar refineries, in sawmills, in iron and steel works, in shipbuilding and bridge-building yards and boiler shops, the electric motor has pushed the steam-engine out, to the great advantage of the producer. As applied to haulage and pumping in mines and collieries, electricity has proved invaluable. For driving live rolls, bending rolls, punching machines, shears, portable drills, and the other tools about an ironworks, the electric motor is by far the most efficient appliance; while for working cranes, hoists, elevators, turntables, fans, pumps, and performing the like functions, it has no equal. When once an installation is put in, it takes very little time to appreciate the possibilities of electricity. Beginning possibly with a small electric light installation, in the course of time two or three motors are requisitioned to drive out-of-the-way machines; by-and-by more motors are added, and so the development goes on until it is determined to adopt electricity wholesale for driving the machinery. This is history which has repeated itself over and over again.

Electricity, moreover, stimulates expansion on account of the extreme flexibility of the electrical system. When a new machine can be planted down anywhere without reference to existing drives it is a very different matter to having to consider how the shafting can be extended, how it can be carried from building to building, whether walls are strong enough to support it, or how steam is to be led to the spot. In this matter of convenience there is really no comparison possible between the electrical and other methods of power distribution, the facility with which electric conductors can be extended and led in any desired direction, and the extreme simplicity of the electric motor, placing it far and away beyond rivalry.

Again, not only does electricity save money because it pro-

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vides us with a better method of distributing power, but consequent upon its having been recognised by the mechanical engineer as a trustworthy agent always available for his use, he has been led to devise entirely new ways of doing things, by which the cost of production has been greatly lessened. I need only cite the economies which, due to the use of electricity, can be derived from the utilisation of blast-furnace gases. The gas is burnt in gas-engines or under boilers for steam-engines, the engines driving electric generators, from which power is distributed electrically to motors placed all over the works. Such a plant has been running at the rail mills of the North-Eastern Steel Company, of Middlesbrough, for some time now. Steam is generated in gas-fired boilers to supply horizontal compound-condensing engines having two-phase generators directly mounted on their crankshafts. Part of the current is used at the ironworks to drive the motors for working the ram and charger for the coke ovens, with the disintegrator, elevators, and other accessories of the coking plant, and part is transmitted through overhead conductors to the steelworks, there to be distributed among motors driving the mechanics' shops, the travelling cranes, saws, rail straighteners, and pumps, and put to all the various uses which can be found for motors in an up-to-date rail mill.

The mechanical engineer should be as keenly alive to the advantages gained by electric distribution as he is to the advantages gained under different circumstances by hydraulic distribution or compressed air. This does not mean that he should be able to design either electric, hydraulic, or pneumatic machinery, which is properly left in the hands of competent experts, but he should be thoroughly conversant with the possibilities of all the appliances from which he has to choose. We should say that the engineer who did not know how a steam or gas engine or water-motor acted was ignorant of his business—in fact, we should not call him an engineer at all—and no engineer can claim to be of the twentieth century who does not possess some notion of magnetic fields and the generation of electric currents. I want to emphasise this because I think that the application of electricity would have gone ahead more if engineers had taken more trouble to understand it, and it is certainly their business, as I have said, to be familiar with the nature of the tools they have to work with. There is nothing particularly subtle about the construction of an electric generator, and engineers should be as familiar with electric conductors as they are with steam or water pipes; though they are wrapped in rubber there is no reason why they should be wrapped in mystery.

In concluding this paper, mostly written in the train, I would remind you that I have by no means exhausted the subject. On the contrary, I have been obliged to confine myself to a general treatment, leaving members themselves to fill in the details applicable to each particular case. For the purposes of the argument it has been necessary to make an assumption here and a supposition there and to adopt hypothetical values elsewhere; but an honest endeavour has been made throughout to present the case fairly. It is nothing to us what vehicle be employed for the achievement of our ends. We have to select the best, but beyond doubt there is an extremely strong case for adopting electricity for the distribution of power in the great majority of industrial operations, and often when, as in many instances, it involves the scrapping of existing plant. I have in this paper assumed that the aggregate horse-power of the motors installed is equal to the power which the generator can supply. As we have taken the average running load of the motors to be three-quarters of the power installed, obviously the generator would do smaller; but having regard to the temporary loads due to electric cranes, turntables, hoists, etc., we may as well let the relative proportions stand, as the aggregate capacity of the motors to the capacity of the generator depends entirely upon the nature of the business carried on. In no case need the generator be larger than we have assumed, and if it is too large, the difference is against electric distribution, both as regards capital outlay and running charges. We are, therefore, on the safe side.

And so I bring this somewhat sketchy contribution to a close. If, in calling your attention to the great field which is opening up to the engineer in the electrical distribution of power, I have been fortunate enough to interest you, I am very well satisfied.

Discussion.

The President (Prof. R. H. Smith), in opening the discussion, said that they, being described by Mr. Esson as twentieth-century engineers, should be anxious to be at the head of all possible progress in engineering work.

Mr. Holroyd Smith expressed his thanks to Mr. Esson for the very interesting paper he had given them. He himself belonged to the old and, perhaps, misguided school who would not admit that there was no difference in the frictional loss in an engine between light and heavy load. He believed that the higher the load, the greater was the frictional loss. In his paper the author had made comparisons which did not give electric transmission all the benefit of the doubt. However, Mr. Esson had shown them the great advantage to be obtained from electric transmission in cases in which it replaced isolated steam-engines, and in this he quite agreed. In dealing with the question he should like to know what was the economical unit of horse-power to start at? It could be implied from the paper that the best unit to take was 100 h.p., but perhaps Mr. Esson would make it clear later on. The author had told them that they ought now to be turning their attention more to electric distribution, but he gave them to understand at the same time that they must not attempt to design these generators and motors themselves. They were to leave that to experts, and, speaking for himself, he would only be too willing to leave such difficult matters to experienced men like Mr. Esson. He most heartily congratulated and complimented Mr. Esson on the light he had thrown on the subject by the reading of his paper.

Mr. R. W. Weekes thought that the paper showed that the question really depended upon the area over which you had to distribute the motors. In the case of a cotton mill, where practically all the machinery was on the one floor there was not much to be gained by electric transmission; but if you took a shipbuilding yard, a mine, or a railway siding with hauling gear, the introduction of electric distribution of power would certainly show a good gain over the costs you had to put up with with small steam-engines. That was the real outcome of the paper.

Mr. R. Foot considered that the paper they had heard read opened out immense fields to the minds of most engineers. The twentieth century would probably be the century of electricity, in the same way that the nineteenth century had been the century of steam. There was no doubt that the application of electricity for driving machinery of all descriptions was very complex. They were still left very much in the dark as to how electricity could be applied so as to give economical results. He believed that in many cases this question had been overlooked by engineers. Within recent years works of great magnitude had been constructed, but electricity had not been introduced where it could have been employed with the very best results. The paper was an important one for reference, and he thought the twentieth-century engineer would be glad of all such assistance in the development of the more universal application of electricity. The paper was clearly the result of exceptional experience in these matters.

Mr. E. K. Scott said that in the first part of his paper Mr. Esson had considered the simple case of a shop which had only shafting, but in practically all of these places a little engine or two was to be found, which made the case for electric driving a very good one. It was most important that in all places where textile materials were manufactured shafting should be abolished, because the drippings of oil and the dust carried by belts were very detrimental to such products. On the Continent they had the advantage of water power, and in many textile mills electric motors were now employed. Where this was so a much superior material was produced, there being no overhead shafting to throw the grease about on the fabric. They were at a disadvantage in this country, because those who had employed electric power were not given to letting their competitors and others know what the saving was. A case in point was a factory where in 1892 two electric motors were introduced as an experiment, and now the whole place was completely run by electric motors, showing that as they went along there was a great saving, but the firm kept the figures private.

Mr. A. Hanssen had listened, he said, to Mr. Esson's paper with great interest. He had certainly made out a very strong case for electric driving. With reference to the question of economy, he knew a case where a small feed pump used something like 250lb. of steam per indicated horse-power, and there was no leakage anywhere. The difficulty was that there was no way of reducing this loss, which occurred where small engines were employed. The quantity of steam they used was out of all proportion to the work they did. It would really seem as if people had no confidence in any other power than steam as applied to this matter. From his point of view, compressed air offered advantages over electricity that had not been properly appreciated yet. For the last 10 years or so electricians had had it all their own way, but he was convinced that in the future electricity would have a very formidable rival in compressed air. He had had experience in compressed air, and it was a power which was not only extremely handy and always applicable, but entirely without danger, whereas it was impossible to say that electricity was not associated with a certain amount of peril. These advantages, combined with the great advantage that with compressed air you could get a direct reciprocating power, proved that in some cases compressed air was better than electricity. Of course, in many instances electric transmission stood without a rival. Compressed air could not economically transmit pneumatic pressure over 20 or 30 miles like electricity, but for short distances, in towns where the factories were situate in the same neighbourhood, compressed air would prove itself to be equal to, if not better, than electric transmission. Electric power had had a long innings in this country, and was being largely used at the present time for tramways; but in New York there was a powerful syndicate for introducing compressed air transmission for tramways. With this system the need for overhead wires, which were used to a great extent for electric transmission, was obviated. Pneumatic transmission could be employed with more economy than electricity, and as good a result was obtained. Even where electricity had established itself all over the world it was now rivalled by compressed air, which would before long be extensively used.

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Mr. A. S. E. Ackermann (hon. secretary) expressed the opinion that there would probably be more trouble than some of the speakers had led them to believe with regard to electric transmission. With reference to the "abominable drippings" from the shafting mentioned by Mr. Esson in his paper, he did not believe this was such a great evil as had been made out. If engineers were careful, it could be avoided. A point which had not been considered that evening was with regard to gas-engines. During the discussion on a paper read at the Institution of Mechanical Engineers a short time ago on gas-engines, it was pointed out that another rival to electricity would be the gas-engine—that instead of having one large electrical station for the supply of energy, there should be several gas-engines placed in certain parts of the district for which the energy was provided. This was a matter, he thought, worthy of consideration. As to Mr. Hanssen's remarks about compressed air, it certainly was common in Paris, and some of the trams in that city were run by compressed air. The question of loss from steam-pipes had been referred to. He had recently conducted some trials on the distribution of heat which had to be carried a distance of some 300ft. This was an extreme case, but he was very much surprised with the results, for the loss from the net heat sent out from the boiler-room before it reached its destination was 40 per cent. With regard to friction in shafting, etc., he was very astonished to hear that 80 per cent. was lost in the Baldwin Engineering Works. The average loss was 50 per cent.

Mr. A. D. Constable thought that in a case where an engine, such as a winch, was only used for a limited period electricity could not be economically applied, on account of the high cost of the electric motor and gear.

The President, in proposing a vote of thanks to Mr. Esson for his valuable paper, said he was rather sorry that the discussion had taken such a one-sided direction He should have liked to have seen a little more opposition on the question of the applicability of electricity as a driving power. Some 15 years ago he insisted very strongly indeed that the transmission of power for electric current for driving all sorts of machines would eventually become a very much larger industry than electric lighting. He still held that opinion, and agreed with Mr. Esson's paper as a whole, but the author was not quite explicit enough with regard to his data. For instance, with the present system of transmission, out of a loss of 40 per cent. Mr. Esson had credited the engine with 10 per cent. In his opinion, the proportion should have been larger, and if that were so, the case for electric transmission would not have been so strong as it stood at present. Then, again, the author had taken no account of the loss at the other end of the transmission. That would make the case for transmission by electricity a still less favourable one. At the same time, however, he could not agree with Mr. Hanssen with regard to air transmission, having had experience of it himself, and found that you could not get more than 35 per cent. of the indicated horse-power, and sometimes only 26 per cent. Until they got some better means of reducing the speed from the motor to the machine than by the inter connection of countershafting, they would not have the full advantage of electric transmission. Mr. Esson had assumed for the purposes of his case that shafting was badly lined up. Although that might have been the case in days gone by, shafting could be very accurately lined up now with very small cost, and that assumption was ill-founded. Again, the author stated that shafting was looked after by incompetent men. That was not so, for he knew from experience the men employed in this work were as intelligent as those engaged in other departments. With regard to the manner Mr. Esson had worked out the subject he quite agreed, and also that electric transmission would be more used in the future.

Mr. Esson, in a brief reply, said that, with regard to the efficiency of the engines, it was said by the president that a brake horse-power equal to 90 per cent. of the indicated horse-power was far too high. He could not agree with him on that point. He knew that with the engines used for electrical driving they did get an actual efficiency of 90 per cent., and also with the large horizontal engines. He, therefore, thought he was justified in taking that figure as the average efficiency. In reference to the loss of transmission with the old system, he had stated that 30 per cent. was due to shafting and 10 per cent. to the engine. If the president, however, thought that a larger proportion of that loss ought to be credited to the engine, he was willing that it should be so, for the sake of argument. As the president had said, his case would not be quite so strong, but, at any rate, there was a loss of 40 per cent. somewhere. With regard to the question asked by Mr. Holroyd Smith, the unit of horse-power depended upon the size of the works and what had to be done. He had taken it at 100 h.p. because it was an easy figure to calculate upon. Mr. Weekes had put the question in a nutshell by saying that the whole thing depended upon the area over which the energy had to be transmitted. In conclusion, Mr. Esson expressed his obligation for the way in which his paper had been received.

Corundum.—According to our contemporary *Electricity*, the largest corundum mill in the world commenced working on Nov. 21 last at Raglan, Ontario. These works when in full swing will be able to turn out 15 tons of corundum per day, reclaimed from 100 tons of rock. It is said that the company owning those works are receiving large orders from engineering works in Europe for their product.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

341. Give the formulæ for the construction of a choking coil required to give a definite voltage with a given current and periodicity.—E.

342. What is the most effective method of taking weekly rough test for insulation resistance on three-wire continuous concentric cables with the neutral wire earthed at station end, and with current always on the mains? And, again, what is the effect, and the best method of procedure, in the event of a permanent short-circuit developing on the above mains—firstly, with motor balancer running for balancing purposes; and, secondly, with cells in use for balancing, the machines running on the outers being provided with minimum cut-outs only? Also state what difference of pressure this short-circuit would make on the lamp circuits on each side of the system.—E. C. B.

ANSWERS.

[*Erratum*.—In the answer signed "E. M." to No. 333, inserted in our last issue, the resistance of a 100-voltmeter is given as 30,000 watts. This should be 3,000 watts.—ED *E E*]

Question No. 336.—On switching on a motor to a single-phase alternating circuit, the volts appear to drop quite out of proportion to the increase in load. Why?

Best Answer to No. 336 (*awarded* 10*s.*).—The apparently disproportionate drop in the terminal voltage of an alternating generator when a motor is switched on is due to the latter having not only resistance, but also self-inductance On this account, the induced E.M.F. in the generator has not only to drive the motor current through the combined resistances of the two armatures and leads against the back E.M.F. of the motor, but has also to overcome an E.M.F. of inductance lagging by 90deg. behind the current in the motor. This self-induced E.M.F. is produced by the variation of current in the armature coils of the motor, and is at its maximum when the current is changing most rapidly, which, on the assumption that the current varies as the sine of the phase angle, is when it is just reversing its direction of flow—*i.e.*, one quarter of a cycle, or 90deg., after its maximum. This condition as to the form of current wave is approximated to in most machines.

Let it be assumed that generator and motor are running in the same phase with respect to terminal E.M.F. Let N denote the frequency; C, the current in amperes; L and L′, the inductance of motor and generator armatures respectively; R and R′, the resistances of the same. Then the E.M.F. overcoming resistance is $(R+R')\,C$ (neglecting the small resistance of the connections), and that overcoming the inductance is $2\pi N (L+L') C$. These are two vector quantities—*i e*, they have direction as well as magnitude—and consequently the resultant E.M.F. is found by drawing two straight lines to represent them in magnitude and direction, and then joining their ends by another line—a proceeding identical with the construction of the well-known triangle of forces. Thus, if (Fig. 1) A B represent $2\pi N (L+L') C$ and O A represent $(R+R') C$, the armature E.M.F. in the generator must be O B in excess of the motor's back E.M.F. The construction also shows that the current lags behind the armature E.M.F. by the angle A O B. This angle of lag, usually denoted by ϕ, is evidently such that its tangent is $\frac{R+R'}{2\pi N (L+L')}$. The

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result of the current lagging is that the maximum current flows when the armature coils of the generator are in a favourable position for exercising a considerable demagnetising effect, and consequently, unless the excitation is increased, fewer magnetic lines are cut, and the voltage falls by an amount much greater than the C R′ drop.

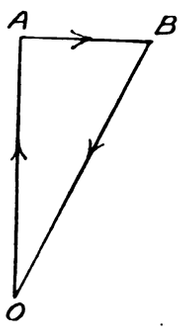

FIG. 1.

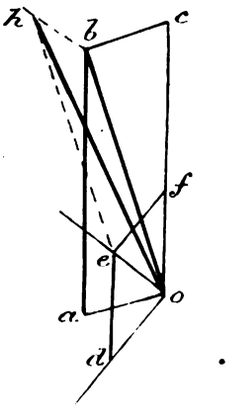

FIG. 2.

In connection with this question it is interesting to consider the state of things when a number of circuits having resistance and inductance are switched on to a generator in which the excitation is adjusted to maintain the induced armature E.M.F. constant. This is equivalent to finding the conditions when the motor is switched on to a generator already supplying a lagging current to a circuit. Slightly modifying the previous construction, let $o\,b$ represent the value of C R for the circuit, and $o\,a$ represent $2\,\pi$ N L C for the same. Then $o\,c$, equal and parallel to $a\,b$, denotes the E.M.F. which is to remain constant. Let $o\,e$, $o\,d$ be drawn to represent the resistance and inductance components of the motor, the angle $c\,o\,e$ being such that $\tan c\,o\,e = \frac{R}{2\,\pi\,N\,L}$ (of motor). From c is set off $c\,f$ = the back E.M.F. of the motor; $f\,e$ is drawn parallel to $o\,d$, and $d\,e$ parallel to $o\,c$. The motor current is now given by $\frac{o\,e}{R}$. If the circuit and motor currents be set off to scale along $o\,b$ and $o\,e$, as $o\,g$, $o\,h$, the diagonal $o\,h$ of the parallelogram on them gives the resultant generator current, and its lag may be increased, unaltered, or reduced, according to the lag of the motor—*i.e.*, accordingly as $c\,o\,e$ is greater, equal to, or less than $c\,o\,b$.—ZIPHERN.

Answer to No. 336 (*awarded* 5*s.*).—The large drop is accounted for by the highly inductive nature of the load. All alternate-current motors, but especially single-phase ones, have a very low power factor at starting—*i.e.*, the current taken lags almost a quarter phase behind the applied voltage. A single-phase motor requires a starting current at least equal to the normal full-load current, even when running on a loose pulley and doing no work whatever, and this current is made up of a large magnetising current in quadrature with the voltage, combined with a small power current (representing the losses in the core, in the bearings, and in the windings) in phase with the voltage. These lagging currents have a marked effect on the voltage drop of the apparatus supplying the motor, whether it be a transformer, an alternator, or a rotary converter, and may cause a drop three or four times as large as that caused by an equal non-inductive load, such as would be taken by incandescent lamps.

The actual drop produced by switching in a given motor depends largely on the design of the supply apparatus. Thus a transformer with a very small amount of magnetic leakage will be far less affected than a badly designed one with considerable leakage. Every transformer or alternator has a certain drop in voltage with increasing load, and this drop is due to two distinct causes, one being the ohmic resistance of the windings, and the other the increase of magnetic leakage from the primary and secondary windings in a transformer, or from the armature winding in an alternator, produced by the increase in current. The resistance drop is in phase with the current, whilst the leakage drop is in quadrature with it. On this account the two drops cannot be directly added together, but must be combined by some such method as that shown in Fig. 1. The horizontal line, A B (Fig. 1), represents the load current in direction. The line A E represents the voltage at the motor terminals when the starting current is passing, and is drawn at an angle ϕ to the current line, A B, such that cos ϕ is equal to the power factor of the motor at starting. From the point E a line E R is set off parallel to A B, and representing the

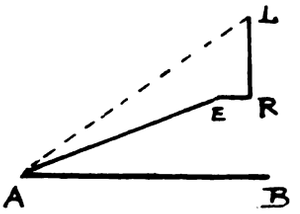

FIG. 1.

ohmic drop in the transformer or alternator to the same scale as A E, represents the terminal voltage to. From R the line R L is drawn at right angles to A B to represent the leakage drop in the transformer or alternator. Then the difference between the length of the dotted line, A L, and the line A E is the actual drop in voltage produced by switching in the motor.

FIG. 2.

Since in all actual cases the leakage drop, R L, is considerably greater than the resistance drop, E R, it will be seen that the total drop (A L – A E) is a minimum when the load is non-inductive—*i.e.*, when A E lies along A B, as in Fig. 2—and is a maximum when the lines A L and A E are in line, as in Fig. 3—*i.e.*, when the load is

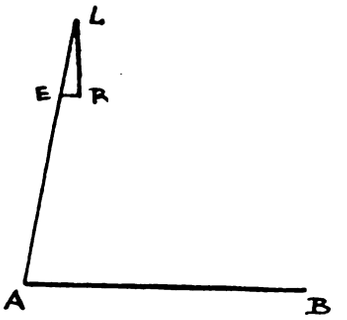

FIG. 3.

highly inductive and the angle of lag ϕ nearly 90deg. The former represents the case of an incandescent lamp load, and the latter the case of a motor at starting.—Q.

REVIEWS.

The Practical Electrician's Pocket-Book and Diary for 1901. Published by Messrs. S. Rentell and Co., Limited, Exeter-street, W.C. Price, 1s.

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THE BRUSH AND THE BRITISH ELECTRIC TRACTION.

An extraordinary general meeting of the Brush Company is called for Jan. 14 next to consider and, if thought fit, to adopt an agreement with the British Electric Traction Company. It will be best to quote the exact words of the circular sent to the Brush shareholders on this subject:

"With the object of obtaining an interest in the Brush Electrical Engineering Company, the British Electric Traction Company, as will be seen by the agreement, offers to issue fully-paid ordinary shares ranking for dividend as from April 1, 1900, to shareholders in the Brush Electrical Engineering Company, in exchange for fully-paid ordinary shares of the Brush Electrical Engineering Company ranking for dividend as from Jan. 1, 1900, in the proportion of one £10 ordinary share of the British Electric Traction Company for seven and a half £2 ordinary shares of the Brush Electrical Engineering Company; all transfer fees and other expenses incidental to this exchange of shares being borne by the British Electric Traction Company. When an exchange involves fractions of a share of the British Electric Traction Company, scrip will be issued for such fractions, and scrip for fractions amounting to a whole share will, within a limited time to be notified later, be exchangeable for a certificate for a whole share, after which date they will not be recognised. In the event of the shareholders adopting this agreement, the offer for exchange of shares will be formally confirmed by notice to you from the British Electric Traction Company, and the option thereunder must be exercised within twenty-one days from the date of issue of such notice. The market value of the existing £10 ordinary shares of the British Electric Traction Company is about £13. 5s., and that of the £2 ordinary shares of the Brush Electrical Engineering Company about £1. 15s."

It will be seen from this extract that the British Electric Traction Company, in the event of the Brush shareholders agreeing, practically obtains control of the manufacturing concern, or rather absorbs it without monetary complication. The market values of the shares are taken as units, and one set of shares is exchanged at this value for the others. On the other hand, the British Electric Traction Company is a dividend-paying concern, whilst the other for a short period has not been over fortunate. All this, however, is merely a question of finance. In addition to the foregoing there is provided an exchange of directors, all pointing to the supposition that this move is merely a temporary one, and that the complete amalgamation of the two concerns will not be very long delayed, the two directorates then being combined. From a business point of view the action is somewhat difficult to understand. The Brush concern is an old-established one, and has had a rather chequered career, but the market price of its shares seems to indicate a somewhat tarnished reputation. The British Electric Traction is comparatively a new company, and has energetically entered into the development of electric tramways.

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That there is a large and lucrative field of work in this direction nobody denies, but necessarily it is of a slightly speculative character—the quality of the speculation depending very largely upon the acumen of the directorate. It may at once be said that the directorate of the British Electric Traction are experienced, and, therefore, select the best and not the doubtful schemes brought to their notice. The Brush Company has given attention to the building of apparatus for tramway work, and this seems to be the guiding principle which has brought about the suggested amalgamation. It may be doubted, however, whether the proposed agreement between the two portions of the linked concern will be altogether beneficial to the shareholders of the British Electric Traction Company. A concern requiring, as the above parent company does, large quantities of apparatus should be able to place its contracts at competitive prices, and with penalties for default in delivery. In the present case it is suggested that the materials shall be manufactured by a subsidiary and controlled company at fair prices, less 5 per cent. discount. In view of the great competition for the supply of tramway orders, which will grow keener as the three new works now being constructed in this country get fairly started, one is inclined to doubt if 5 per cent. off a fair price will be less than the open market rates. However, the combination is of the same kind which has proved successful on the Continent and in America after years of trial. The success in the present case depends on the policy of the reconstructed board of directors with regard to the equipment of the Brush Works and to the various patented articles now manufactured by the company. More capital may be required for machine tools and new workshop facilities, but, above all, a wholesale scrapping of all types of machinery on which money has been lost in past years must take place. Then, when making few articles, but in great quantities, the proposed combination of a manufacturing and a financing firm may at last achieve success in Great Britain.

CREATURES OF ADVERSE CIRCUMSTANCES

The above is the description of the shareholders in the Metropolitan District Railway as given by their chairman last Monday. The adverse circumstances are not such as call forth much pity, even though the income of the company has decreased by about £1,000 per week as compared with last year's returns. The reasons for this decrease are not so much the competition of other lines and means of communication as the disgraceful state of the District Railway. Still, at the meeting in question, the shareholders decided to give their directors powers to issue £500,000 of ordinary stock and £166,000 of debenture stock on such conditions and terms as they may think most advantageous to the company. The chairman hoped that in return for the above stock they will succeed in getting a full electrical equipment, and added that they "must either electrify the railway, or the property must go to the dogs." We agree with the verdict, but see no reason why the chairman should not have put the matter before the shareholders in equally strong language five years ago. The vexed question of the method of financing the conversion is still, in our opinion, a most open one, and it remains to be seen how far the profits from the conversion of the line for electrical working will reach the present shareholders. The chairman's remarks as to a lump-sum contract being possible with the above stock as payment for the complete equipment were most vague, and unless the ordinary stock is made into a preferred issue, we doubt the possibility of such a deal. Perhaps, after all, the method of getting an outside authority to put down the plant and supply power at schedule rates per train mile, as suggested by a certain Bill to come before Parliament, may have to be adopted.

FORTHCOMING EVENTS.

FRIDAY, JAN. 11.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Address by Mr. Wilfrid Airy, B.A., on "Geodesy."

SATURDAY, JAN. 12.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., "The Education of a Shipbuilder," by Prof. J. Harrard Biles.

MONDAY, JAN. 14.

Institution of Mechanical Engineers.—At 8 p.m., graduates' meeting. Prof. J. A. Ewing on "The Structure of Metals," illustrated by lantern slides.

TUESDAY, JAN. 15.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers to be further discussed are: "Glasgow Bridge," by Mr. Benjamin H. Blyth, M.A.; "Railway Bridge over the Fitzroy River, at Rockhampton, Queensland" by Mr. Walter J. Doak, B.E.; and "The Niagara Falls and Clifton Steel Arch Bridge," by Mr. Leffert L. Buck, M.I.C.E.

Royal Institution of Great Britain.—At 3 p.m., Prof. J. A. Ewing on "Practical Mechanics" (experimentally treated); "First Principles and Modern Illustrations" (lecture I.).

WEDNESDAY, JAN. 16.

Institution of Civil Engineers.—Students' visit to the Houses of Parliament to inspect the ventilating, warming, drainage, and lighting arrangements.

THURSDAY, JAN. 17.

Chemical Society.—Ordinary meeting at Burlington House, W.

FRIDAY, JAN. 18.

University College, London.—Lecture on "Liquid Air," by Dr. W. Hampson; the first of a course of six.

Royal Institution of Great Britain.—At 9 p.m., discourse on "Gases at the Beginning and End of the Century," by Prof. Dewar.

Institution of Mechanical Engineers.—At 8 p.m., annual general meeting. Adjourned discussion on "Power Gas and Large Gas-Engines for Central Stations," by Mr. Herbert A. Humphrey.

LONDON CHAMBER OF COMMERCE.

A meeting of the Electrical Trade Section of the London Chamber of Commerce was held at the offices on the 8th inst., Mr. Sydney Morse presiding.

The CHAIRMAN made a statement of the principal matters which had occupied the attention of the section during his period of office. He referred more particularly to the evidence which the section had brought before the Royal Commission on Local Taxation with respect to the action of rating authorities throughout the country to the detriment of large industrial undertakings. They had urged the importance of uniformity of rating throughout the country, and also the creation of an independent valuation authority, and if effect were given to these principles their position would be more satisfactory. The section had also been actively concerned in connection with the question of

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municipal trading, and was represented with other trades on a special committee of the Chamber which had organised a large amount of evidence given last session before the Joint Committee of both Houses. Having expressed the opinion that the section had done good work for the electrical industry in this and other matters, he proposed that Mr. R. Percy Sellon be elected as his successor in the chairmanship of the section, which was seconded by Mr. MUSGRAVE HEAPHY, and carried unanimously.

Mr. SELLON, after returning thanks, expressed the desire that the section should become still more useful in the future, and reminded the members that meetings could always be called whenever occasion arose. He moved a hearty vote of thanks to Mr. Morse for his services as chairman of the section during the past four years.

This having been carried by acclamation, Messrs. Alexander Siemens and W. L. Madgen were elected deputy-chairmen of the section.

Attention was called to the action of gas and water companies in endeavouring to upset the settlement of the Joint Committee in regard to the question of earth returns as embodied in a clause which had been inserted in various Provisional Order Bills, and which the Board of Trade had always insisted upon. It was decided to appoint a special sub committee to consider and report on the whole matter with a view to future action in the interests of the electrical industry.

ELECTRICAL ENGINEERS (R.E.) IN SOUTH AFRICA.

On the 20th ult., at the ordinary meeting of the Institution of Electrical Engineers, Lieut.-Colonel CROMPTON delivered the following lecture, illustrating some of its features by lantern slides:

At the request of your president I have prepared a narrative of the war services of the small body of Electrical Engineers who left England early in the spring of this year for South Africa, and who have now returned. I must commence by reminding you that the corps of Electrical Engineers (R.E) Volunteers was raised by the help of this Institution in order to enable electrical engineers to place their services at the disposal of the country in case of need. It is acknowledged that every year electrical appliances will be more and more used in military operations. Up to last year the special work on which the corps had been instructed and drilled for home service had been the management of the searchlight apparatus used at various points for coast defence, to which has been added some instruction in submarine mining and cognate matters. As both officers and men of the corps felt that the training which everyone in the electrical profession must go through has made us all handy men, not only for electrical, but for general mechanical engineering work, we offered our services for the war in South Africa. Our offer was accepted in December, 1899. and, after some consultation with the War Office, an equipment was designed by our own officers, and was manufactured with such rapidity that our first detachment was ready for embarkation early in March. Five officers and 47 men were mobilised in February, and on March 16 five officers and 47 men embarked from Southampton on ss. "Tagus." On the 17th two officers and one non-commissioned officer embarked on the "Custodian" in charge of the equipment. The equipment has already been described in the technical journals; I will remind you that its main features are portable searchlights mounted on carriages somewhat similar to those used for field artillery guns, the electrical energy being generated by dynamos carried on small compound steam traction engines. Special cable carts were also provided.

I do not propose to take your time in giving the details of construction of the projectors, engines, dynamos, or other apparatus; those interested in these matters will have full opportunity of examining it in March next, when the headquarters of the corps are completed. Although steam traction engines were chosen, it was foreseen that the oil-engines to which the corps is so well accustomed at its annual trainings would have had great advantages if a portable type of oil-engine had been procurable. A supply of arc lamps, with special lanterns which could be readily packed, and incandescent lamps with fittings, were also sent out for the electric lighting of working parties, depôts, and railway sidings. A novel feature of the equipment was that 20 bicycles were provided, with reels on which fine, uninsulated copper wire was coiled, to serve as telephone conductors, and a special light and very portable type of telephone was obtained, which, as will be seen hereafter, gave excellent results. The whole of the remainder of the equipment, which contained, among other things, complete sets of repairing tools, tube wells, pumps, and portable forges, was carefully considered, and subsequent experience showed that it was well chosen.

The "Tagus" arrived at Cape Town on the 4th, and the unit disembarked on the 6th and were encamped at Fort Knokke for a few days. The "Custodian" arrived on April 12, and the equipment, including two of the eight-ton traction engines and four five-ton wagons, were unloaded that night. Colonel Girouard, the director of railways, at once applied to have the Electrical Engineers attached to the railway reconstruction trains, and they were ordered to get ready to move up country as quickly as possible. On Saturday night, April 14, the whole of the equipment was packed on five large bogie trucks, but even their start seemed likely to be delayed, as the line was blocked with press of traffic. Under these circumstances the unit received an invitation from the electrical engineers of Cape Town to attend a smoking concert to be given in their honour on the following Tuesday, but unfortunately this could not be accepted, as on Monday morning the unit suddenly got orders to start After a journey of three days and four nights it arrived at Bethulie at 5 a.m., April 20, and at once off-loaded the equipment, and within a few hours the first installation of temporary electric light for war purposes was erected on the Bethulie road bridge, which was then temporarily in use for railway purposes, during the time that the low-level deviation railway bridge was then constructed by the Railway Pioneer Regiment to replace the original railway bridge which had been destroyed by the Boers. At first six arc lamps were found sufficient, and these were erected and worked nightly from one of the dynamos mounted on its traction engine at the river bank. As soon as the low-level railway bridge was completed the installation on the road bridge was dismantled and transferred to the new bridge, the approaches to which being tortuous, and having steep gradients, had to be worked by the engine-drivers with the greatest caution, so that for some days the arc lights were used to light these approaches. The first time the field telephones were put to work was at this place. A line was laid across the bridge for the use of the railway, and a good telephone service established.

During the time that the corps was at Bethulie Sergeant-Major Brown, R.E., and Sapper Phillips, E.E., were sent out with part of the telephone equipment to accompany a flying column which left Bethulie on May 2 to join General Hart, who was then moving south from Smithfield. As the telegraph line between Bethulie and Smithfield had been destroyed, the new field telephones were brought into use to maintain communication with the flying column, and this was kept up without any failure during the time the column advanced until it met General Hart. General Hart was thus enabled to be put into communication with Lord Roberts *vid* Bethulie, temporary communication being made between General Hart's camp, 1½ miles from the telegraph line, by bare copper wire (No. 22 gauge) laid on the ground from the bicycle reels, supported by a special belt to the body.

On May 6 the unit arrived at Bloemfontein, and was split up into two sections—one going on direct to railhead, which was then at Vet River, the other section remaining at Bloemfontein to carry out the electric lighting of the goods yard and locomotive shops. At this point an installation of arc and incandescent lamps was erected and worked by No. 1 engine and dynamo, and has been running ever since, the installation being gradually increased in size until there are now 16 arc

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lamps and a large number of incandescent lamps installed. It must be noted that it is somewhat of a feat to carry out a temporary job of railway lighting of this kind, and to work it continuously without any failure or interruption from May to December—*i.e.*, up to the date of writing—using only one engine with no spare plant, and the credit of this excellent service must be mainly given to the small detachment that was left at Bloemfontein under command of Corporal Bicker Caarten, to whom has since been entrusted the design for a permanent installation to replace this temporary plant. The advance section at Vet River joined the reconstruction trains and remained with them during the months of May and June—*i.e.*, until the work of reconstructing the railway was completed through the Orange Free State up to the Vaal River. The equipment of this No. 1 section consisted of No. 2 traction engine with its dynamo, two wagons, subsequently increased to four wagons, two projectors, with their limbers, two cable carts, extra cable coiled on drums, 16 arc lamps with suitable poles, hoisting gear, and the necessary accessories, a supply of incandescent lamps with suitable fittings, 14 sets of field telephones, a supply of insulated and bare copper wire telephone conductors coiled on reels which could be either carried on the bicycle or on special slings strapped to a man's chest in such a position that he could either pay out or wind up a conductor. The work at Vet River may be taken as typical of many other works at which it was necessary to work all night by artificial light. The Railway Construction Corps (R.E.) was engaged in constructing a main bridge across the river approached by long deviations from the main line; in these were three smaller bridges. The lighting plant had, therefore, to be erected at each of these bridges in turn.

When the Vet River work was completed the section moved on to Smaldeel, and there was joined by Colonel Crompton with a draft which had left Cape Town on May 4. Colonel Crompton brought with him a third traction engine with its dynamo, an additional supply of concentric cable, two additional five-ton wagons, stores, bicycles, etc. Colonel Crompton then took over command of the unit, and, as the occasion arose, the whole of the Bloemfontein section with their stores was gradually moved up to join the unit, leaving only a small detachment of six men under the command of Corporal Bicker Caarten to work the temporary lighting plant at Bloemfontein. Early in May Colonel Girouard required the services of additional railway telegraph men, and Captain Bain was detailed for this work, and with a detachment of seven men was sent on to repair the telegraph in advance of railhead. This was a service of great importance, entailing considerable personal risk and exposure. Captain Bain, who was eventually assisted by Lieutenant O'Shaughnessy, remained at this work for several months, and eventually was put in charge of the whole of the railway telegraphs in the Transvaal under Captain Manifold, R.E., administrator of railway telegraphs, his detachment being strengthened from time to time by additions from this unit, as well as from the Royal Engineers and other corps.

The No. 1 section commenced lighting work at Zand River on May 18, this work being of a very similar nature to that of the Vet River. It afterwards advanced with the railhead construction trains to the Rhenoster Spruit to assist the working party building a crib bridge at that point. Here a particularly smart piece of lighting work was carried out. The orders were received at 2 p.m. The traction engine was off-loaded from its truck and hauled its wagons and stores down to Rhenoster Spruit three miles away, the light stores going down the damaged railway line on a trolley. Eight arc lamps were fixed on poles, and light was furnished to the working party by nightfall—5.30 p.m. The new and first reconstructed bridge at Rhenoster was completed on the 29th, and there being then no large work ahead requiring arc lights, the detachment went forward with the construction train, and were employed principally on the actual work of building the crib piers, fixing the beams and laying the rails until the line was completed and railhead advanced to Taibosch. During this time the equipment was left behind at Roodeval in charge of Sergeant Phillips.

During the next eight days the detachment had an exciting time, as the enemy under De Wet and Theron were threatening the line and reconstruction works. The Electrical Engineers formed part of the reconstruction day shift the working hours being generally from 6 a.m. to 6 p.m., but sometimes up to 12 midnight, so that on these days the men were 18 hours consecutively at work. From Rhenoster up to Taibosch the enemy, at the advice of Theron, had destroyed the line very completely, not only the larger bridges, but all the smaller culverts were blown up. In some places the rails for considerable distances were twisted and contorted by dynamite cartridges fired at every fish-joint. On Wednesday, June 6, Taibosch Spruit was reached, and seeing that arc lights would again be required at this point and at the Vaal River, Captain Lloyd was sent back with two engines and a few trucks to bring forward the electric light equipment which had been left at Roodeval. His journey down the threatened line to Roodeval was a most exciting one. At Vredefort Weg he was called upon to arrest the Field-Cornet Le Roux, who, although he had taken the oath of allegiance, had been observed signalling to the enemy. This train was expected to be attacked at any point south of this, and the utmost precautions had to be taken. As the water supply at Roodeval was known to be scanty, he left one locomotive to fill up its tanks at Rhenoster and took one on to Roodeval. He found there that the small garrison had been threatened for days, and had been on harassing night duty during that time. On his approach to Rhenoster Spruit he found that the line was blocked by some trucks which were being used somewhat irregularly, for shifting tents and camp equipment required for a new camp. As Captain Lloyd knew that De Wet was preparing to cut the line to the north of Rhenoster this delay seemed likely to result in the unit losing their electrical equipment. As it was the line was only cleared in time to get the train away a few hours before De Wet commenced his attack on the Rhenoster camp, which resulted in heavy losses and in the destruction of the new bridge, the water supply, and of the valuable ammunition and stores then at Roodeval.

The return journey northwards was of the most exciting nature. The train was made up with some of the trucks in front of the locomotive, so that in case of the leading truck being derailed it could be thrown off more easily and thus less delay caused than if the locomotive itself were derailed. It was necessary to examine the track with lamps placed on the leading truck and thus by lamp signalling back to the engine-driver to control the running of the train. In this manner the train was worked back to Taibosch. At Vredefort Weg Captain Lloyd arrested and brought along with him the Field-Cornet Le Roux. By the time Captain Lloyd passed Vredeford Weg De Wet had been successful in his attack at Rhenoster and cut both railway and telegraph wires, so that the construction trains were entirely cut off from the south. During the time that the arc lights were being used on the bridge at Taibosch on the nights of the 7th and 8th, Lieutenant Pott succumbed to enteric fever. This was a great loss to the unit, as this officer had himself designed a great portion of the arc lighting and projector plant, and the loss of his services greatly crippled the unit. He had to be left at Viljeonsdrift, where he was nursed with extreme care by Dr. and Mrs. Dixon, Dr. Dixon being the medical officer to this section of the railway. Here Sapper Weakly also fell ill of enteric fever, probably brought on by the exposure at Roodeval. He lingered for some time, and eventually died at Viljeonsdrift on the 27th.

During the time that the unit was at Taibosch Colonel Crompton, taking with him Sergeant-Major Brown, R.E., and Company Sergeant-Major Rorke, went south with the field telephones to attempt to make temporary communication at the point where the telegraph lines had been cut by the Boers. Colonel Crompton returned to his command at Taibosch, leaving the two non-coms. with Lord Kitchener, who arrived at Kopjes on the 9th. They were able to establish communication with the south, and thus kept him in touch to north and south until the telegraph lines were again in working order. Railhead reached the Vaal River on June 10, and at this point an installation of 12 lamps was

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erected, and on the 11th the first train crossed into the Transvaal and some supplies were sent to Lord Roberts at Pretoria. It may be here remarked that as during the advance of railhead from Bethulie to the Vaal the arc lamps were worked on 19 nights, it is probable that the period of reconstructing the line was shortened by nearly the same number of days, but even if one night's work is only considered to be equal to two-thirds of a day's work the night work rendered possible by the section must have hastened the advance of railhead by not less than 12 days, and the money value alone of this to the nation must have many times repaid the entire cost of equipping and sending out the Electrical Engineers. After one night's lighting at the Vaal the very thorough destruction of the line to the south by De Wet necessitated the sending south for a second time both construction trains; the unit accompanied them, leaving the lighting equipment at Viljoensdrift under Sergeant Brown. The construction trains working south were constantly threatened by De Wet, and on the night of June 14 both trains were attacked by him, and were summoned to surrender.

As this was the first occasion in which the Electrical Engineers were under fire, perhaps I may be permitted to describe the attack at some length: Very early in the morning of June 14 the night working party, which consisted chiefly of Royal Engineers and Volunteer Royal Engineers, none of them being Electrical Engineers, were at work rebuilding the crib piers of the recently-constructed bridge at Leuwspruit. At this time one of the construction trains was drawn up close to the working party, who were at the break in the line, the other train being about half a mile to the north on its way to shunt empty trucks on a siding a mile further north. The first trouble noticed was the derailing of the leading truck of the northern train. This was caused by a stone having been wedged by the Boers between the main and the guard rails. As soon as the train was pulled up it was fired on by an attacking party, which apparently surrounded it. The troops on the train promptly replied, and with good effect, as the Boers drew off after half an hour's firing and concentrated their attack on the other party at the spruit, but during this sharp attack the vans and coaches of the northern train were riddled by bullets, and those sleeping in them had narrow escapes. The attack coming at first from the south side, the engine-driver started to move the engine northwards. The Boers then made a rush on the unarmed working party, who, with one officer and 60 men, were taken prisoners. The remainder, however, escaped, but could not rejoin the party defending the train.

The Electrical Engineers had formed the day working party, and having been many hours at work, and consequently very tired, were sound asleep. Those of them who were sleeping outside the trucks, close to the working party, were captured by the Boers before they were able to regain the train. At this time the Boers' firing was very heavy, and three officers—*i.e.*, Lieutenant Miclem, R.E., Lieutenant Bigg, E.E., and Lieutenant Holmes, of the Royal Irish—were seriously wounded. Three sappers were killed, the engine-driver and a number of others seriously wounded, and of the native workmen about 30 were killed or wounded. At this time De Wet sent in a messenger, summoning the train to surrender, as the Boers were greatly superior in force and had guns. No attention was paid to the message, and the remaining troops, who were then under the command of the officers of the Electrical Engineers, took up a position on a ridge of rocks which ran transversely to the train, from which the train could be protected without the men being exposed. This position was held for several hours—in fact, up to daybreak—the firing of the Boers being continuous and severe. On the other hand, the position we occupied was so strong that the Boers were unable to approach the train, and soon after daybreak they withdrew from the attack. Towards the latter part of the time the Boers were much disconcerted by the shrapnel which was fired over them by two guns placed by Lord Kitchener in a position to the south. The night was intensely cold and trying to everyone; the whole of the defending party were asleep in the trucks when the attack commenced. Although taken at such a serious disadvantage, every man on the train, without distinction, behaved as coolly and quietly as if there were no enemy present. It was a difficult matter even for old and trained soldiers to free themselves from the crowd of Basutos who formed the native working party, and who cleared out from the train at the commencement of the firing, but in spite of this there was no confusion. Ammunition was quietly served out, and our men got into such strong positions that it was impossible for the Boers to make their attack successful. Everyone behaved so well that it is difficult to single out anyone present for special praise. Although the Electrical Engineers engaged on this occasion were comparatively a small party, yet, owing to so many of the night working party having been surprised and dispersed in the first instance, they formed nearly one-third of the troops left to defend the trains. If De Wet had been successful in catching and destroying these two trains, which contained so much construction material and all the tools, as well as the most skilled body of reconstruction officers, the break in the line of communications would have remained open for a long period, and certainly would have seriously affected the future movements of the more advanced portion of the army then in the Transvaal. This attack caused the Electrical Engineers to temporarily lose the services of one officer wounded, and Corporal Sellon and six sappers taken prisoners. The remainder went south with the construction trains to Rhenoster, and assisted in the building of this important bridge. Whilst there orders were received from army headquarters that the whole of the Electrical Engineers should come up to Pretoria at once. They started on the 20th, leaving Lieutenant O'Shaughnessy to complete a system of telephones connecting Rhenoster Camp, Leuwspruit, Roodeval, and other points which had been recently threatened or attacked by De Wet. After carrying out this work he joined the headquarters at Pretoria on June 26.

(To be continued.)

ELECTRIC LIGHT IN NORTH LONDON.

PUBLIC MEETING AT ENFIELD.

The most important question which is uppermost in the minds of the people in the northern suburbs round Enfield at the present time, is electric light. A Bill is now being promoted in Parliament by the District Councils of Enfield, Tottenham, Southgate, Edmonton, and Wood Green for the purpose of obtaining powers to establish generating stations and distribute electricity. A letter of some length was circulated last week denouncing the action of the district councils, and urging the ratepayers to protest against it. The letter, which was from a private company, stated that the ratepayers of Edmonton had taken alarm at the prospect of an unlimited increase in their rates, and a vigorous protest against the scheme had been presented to the Edmonton Council signed by 700 or 800 owners and ratepayers. Wood Green was also moving in the matter, and the District Council's chairman (Mr. Littler) had resigned his position on that body rather than be a party to what he termed "such a wild-cat" scheme.

A representative of a local journal interviewed several gentlemen on the Enfield District Council, and asked them why it was that when an agreement had been come to with the North Metropolitan Electric Supply Company that the Enfield Council turned round and joined with the other local authorities in promoting a scheme of their own. The general reply was that if the company had embodied in writing what they agreed to verbally, the Enfield Council would have been perfectly satisfied. But the company jibbed, and would not entertain several important measures, and the restrictions they wanted to insert made it utterly impossible for the local body to fall in with it. There was a very strong feeling that as the promised municipal undertaking was a joint one, the expenses would be a great deal less.

The point at issue appears to be: a private company *versus* municipal enterprise. In other words, if the supply and distribution of electricity is a profitable undertaking for shareholders, who expect so much per cent. on their capital, why cannot that profit be kept for the ratepayers? It is true the North Metropolitan Electric Power Supply Company succeeded in obtaining a Bill which enables them to generate and supply electric power over an area comprising 225 square miles, but much of

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this area is rural and not of much value either to a company or to a corporation. On the other hand, the combining councils have a compact area thickly populated, and they intend doing for that district as much as any private company could do.

Estimates of the proposed expenditure have been prepared by eminent experts and carefully considered by the committee of delegates of the five co-operating councils. The total amount estimated is £400,000.

A public meeting of owners and ratepayers to discuss the question was held on Monday night at the Court House, Enfield. Every member of the Enfield District Council was present, and also representatives from other councils. Mr. J. J. Wilson, J.P., chairman of the Enfield Council, presided.

In opening the meeting the CHAIRMAN remarked that in the year 1899 the Council received three notices from different companies of their intention to apply to the Board of Trade for provisional orders to enable them to undertake the supply of electricity in the district, but only one (the Edmundsons' Electricity Corporation) proceeded with the application. This the Council objected to, in order to get time to consider the matter, and on the ground that they were themselves contemplating making a similar application the following year, and for this reason the Board of Trade refused the company's application. In June, 1900, while the matter was under the consideration of the Council, four companies, including the Edmundsons' Electricity Corporation, again gave notice of their intention to apply for provisional orders. It would thus be seen that the Council had to do one of two things; they either had to make application themselves, or allow one of the companies who had given notice to obtain the order. The Council thereupon put themselves in communication with these companies with a view to ascertaining the terms on which they would supply the district in the event of the Council consenting to their application. The replies received were very fully considered by the Council, but were not thought such that the Council could in the best interests of the ratepayers accept. The North Metropolitan Electrical Power Distribution Company also put themselves in communication with the Council, with a view to entering into an arrangement by which the Council should apply for the necessary order, and hand over the working of the same to the company; but the difficulties of entering into such an agreement appeared to the local body to be too great to warrant their doing so. The present action was then suggested, and after carefully considering the proposals, the Council came to the conclusion that a combination of the five districts, forming a considerable and comparatively compact area, could and would supply the districts affected cheaper than each district could supply itself, for, among others, the following reasons: (1) electricity could be generated on a large scale much cheaper than on a small one; (2) only one staff would be required; (3) while each district separately could not afford to pay the high salaries that a competent staff would require, the Joint Board would be in a position to command men of thorough experience; and (4) that by the employment of a competent staff the initial mistakes of such an undertaking would be minimised. The Council further felt that if anything was to be derived out of such an undertaking—and presumably there was, or the companies he had referred to would not be so anxious to get their foot in—the ratepayers were the proper persons to reap such benefits, either in the shape of cheaper electricity or reduced rates. Much stress had been laid on the statement that the Joint Board must make a large deficit for the first few years, as, in addition to working expenses, they would have to pay a proportion of the principal as well as the interest at the end of the first year; and while he for a moment would not suggest that a deficit would be made—seeing that that was inevitable during the construction of the works, be they for a company or a local authority—yet he would point out that a provision was made in the Bill to the effect that the first instalment of the loan need not be repaid until March 31 in the third year after the date of borrowing, so it would at once be seen that the loss would not be so large as stated. In conclusion, he moved the following resolution: "That this meeting consents to the Council of the urban district of Enfield promoting, in the ensuing session of Parliament, a Bill to constitute and incorporate a Joint Board representing the District Councils of Edmonton, Enfield, Southgate, Tottenham, and Wood Green, in the county of Middlesex, with powers to establish generating stations, and to produce, supply, and distribute electrical energy and for other purposes.'

Mr. HUGH TRENCHARD, one of the Enfield delegates on the Joint Board, seconded, and in the course of his somewhat lengthy remarks said it was not a question between electricity and gas. Gas had done a great work and would continue, but the main point was whether electric light should be introduced into Enfield. Private companies had tried hard to get a footing, but so far they had been staved off. Intimation had been received from the Board of Trade that unless the Enfield Council did something themselves, they would consider the Council were acting a "dog-in-the-manger" way, and let a company take a provisional order. Electric light would certainly come, and were they to allow a private company to step in, or run the scheme under the control of the local authorities? As far as the consumers were concerned, the scheme at present contemplated worked out at a moderate cost. Electric light at 6d. per unit was the same as gas at 3s. The contemplated charge would be 4½d. or 5d. Major Crozier, who held an enquiry at Warrington a short time since, had said that he had never come across a place where electric light had proved any burden on the ratepayers. If the North Metropolitan Company supplied it in bulk it could not be distributed at less than 5½d. per unit, whereas the Joint Board could supply it at 4½d. or 5d. per unit, At Eastbourne a company spent £57,000 on an installation, and the Corporation bought it for £82,000; at Hastings £54,000 was paid by a company and purchased by the Corporation at £61,000; and at Leeds a company paid £217,000, for which the Corporation paid £370,000; yet all the corporations did well, and supplied light at a fair profit and at a fair price. The population of the district in the five towns was a quarter of a million, and it was growing fast. He asked the ratepayers to be careful, and give the matter due consideration before throwing away what would prove a very valuable profit to the parish.

Mr. F. G. FITCH said the undertaking was nothing more nor less than a pure speculation. It was not prudent to speculate in a country district, and it was not prudent to go into partnership with other districts. A great part of the district was agricultural land, through which the mains would have to be laid, and consequently they would very soon be launched into difficulties and heavy expenditure. If electric light was to come it should come through a private company, and then they would have to stand the loss or receive the profit. The Enfield Council had quite enough to do to look after their own business. As regards Eastbourne, which Mr. Trenchard had brought forward, he would ask how many consumers were there in that town—409 consumers of electric light as against 5,416 consumers of gas. Mr. Fitch quoted many more statistics in opposition, and spoke of how at a church in London last Sunday the electric light went out and candles had to be burned in its stead.

Mr. ALLEN asked whether the price given for public lamps would be considerably lower than lamps for gas.

The CHAIRMAN: Less than gas.

Mr. ALLEN: Will the North Metropolitan Company supply light at 2d. per unit for public purposes?

The CHAIRMAN: Twopence for public purposes and 7d. for private purposes.

The CLERK remarked that it worked out according to the number of houses supplied. It was not a lower rate than many of the London municipalities.

A rather warm time ensued between several of the ratepayers, and the CHAIRMAN had to call for order, and remarked that the Council had no interest in the matter and were merely carrying out their duty.

In answer to Mr. H. C. B. Bowles (chairman of the New River Company), the CLERK stated that the Bill had already been deposited.

Many speeches followed advocating both parties, but it could be clearly seen from the outset that the Enfield District Council were getting the worst of it.

Ultimately the resolution was put to the assembly, and was lost, amidst applause, by 20 votes.

A poll was demanded.

Another meeting in Edmonton to consider the same subject is to be held on Tuesday next.

LIGHT RAILWAYS.

It is now almost certain that the proposed light railway between Dundee and Broughty Ferry and Montefieth will be gone on with, at least so far as is possible till parliamentary sanction is obtained.

Owing to the refusal of the Light Railway Commissioners to vary their order for the construction of electric tramways in the city to include agreements made with the tramways company and the British Electric Traction Company for the protection of public rights, considerable delay has been caused, and to get rid of the difficulty a supplementary agreement is to be entered into between the parties.

Messrs. Little and Gatey, chairman and secretary of the committee appointed to oppose the tramway scheme for the Lake District, have issued a report of the proceedings they took before the Light Railway Commissioners. After they had engaged counsel and promoted ratepayers' petitions, notice was received on Sept. 15 that the application of the British Electric Traction Company had been withdrawn. The opponents of the scheme had obtained subscriptions to the amount of £1,300, of which a very small portion was spent. If the project is abandoned, the subscribers will not be further called upon, but the committee recommend that no part of the money guaranteed should be called up until the whole matter is definitely settled, when a final apportionment can be made. In addition to the opposition organised by the committee,

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nearly all the principal owners of property along the route of the proposed tramway have signified their intention of being separately represented before the Commissioners. The committee are prepared to call a general meeting of the subscribers should circumstances render necessary the adoption of that course.

At a recent meeting of the Middlesex County Council the Parliamentary Committee submitted a report on yet another light railway scheme, which includes a line commencing at the parish boundary in Willesden, and running along the Edgware-road as far as Church-lane, Edgware. The Parliamentary Committee reported they had decided to adopt the suggestion of the Light Railway Commissioners that the order for the construction of light railways from Highgate to Whetstone, and from Wood Green to New Southgate, should be granted to the Council alone, instead of to the Council and the North Metropolitan Tramway and Omnibus Company. An agreement had been arranged between the parties, and the committee recommended that this course be adopted. They further reported: "The lines proposed to be authorised by the order are as follows: Railway No. 1.—A line of railway along Bruce-grove and Lordship-lane, in the parish of Tottenham. Railway No. 2.—A line along Bruce-grove, Bounds Green-road, Wood Green, and a portion of High-street, New Southgate. Railway No. 3.—A line commencing at the Archway, Highgate, and running along the Great North-road to Whetstone. Railway No. 6.—A line commencing at the parish boundary in Willesden, and running along the Edgware-road as far as Church-lane, Edgware. Railway No. 9.—A line commencing by a junction with railway No. 3, at a point in the Great North-road, at its junction with East End-road, and running in a westerly direction along that road for a distance of 7½ chains or thereabouts, and terminating in lands to be acquired for a generating station and car depôt. The estimate of Mr. Cooper, the engineer to the Metropolitan Tramways and Omnibus Company, of the cost of (*a*) construction of the lines, (*b*) purchase of land for generating stations, and (*c*) widenings, etc., is £347,420. In order to comply with Section 80 of the Local Government Act, 1888, your committee have asked the Finance Committee to submit an estimate to the County Council of £350,000. The Council will, if it decides to take the order in its own name, be liable to pay the costs of the company in connection with the obtaining of the order. Your committee are not, at present, able to say what these costs will amount to, but they have thought it desirable to ask the Finance Committee to submit an estimate to the County Council of a sum of £5,000." The Parliamentary Committee reported on the Finchley and Hendon Tramways Bill in favour of opposing this tramway scheme, on the ground that the Light Railway Commissioners were not prepared, on the recent application for the joint order promoted by the County Council and the Metropolitan Tramways and Omnibus Company, Limited, to include in it certain lines in the parish of Hendon, now proposed to be covered by the tramway scheme, and the County Council will no doubt again apply for authority to lay down lines in Hendon, which will be connected with the light railway lines proposed to be authorised by the County Council's joint order and No. 2 order. This was agreed to.

The promoters of a light railway scheme for the north end of the Wirral peninsula have submitted their plans to the Tramways Committee of the Wallasey Council. The intention is to connect Wallasey with Leasowe and on to Hoylake and West Kirby. It is maintained that this system will give residents of Hoylake and West Kirby easy access to any of the Wallasey ferries. It would be necessary, if the Council agreed to the scheme, that running powers be allowed over the Liscard-road system to Seacombe ferry. The Tramways Committee consider the scheme decidedly hostile to the interests of the Council's electrical tramway system, and they advise the Council to oppose it if promoted.

At the Board of Trade last week Sir Courtenay Boyle, K.C.B., who was accompanied by Mr. Hopwood, C.B., C.M.G., Mr. Thring, and Mr. Steward, held a sitting for the purpose of considering the Morley and district light railways order, which had been submitted to the Board for confirmation. Mr. S. Morse, solicitor, and Mr. William Hederstedt, engineer, appeared for the promoters, the British Electric Traction Company, Limited; and Mr. Hill Dawe, solicitor, appeared for the Great Northern Railway Company. The order authorises the construction of light railways in the borough of Morley and the urban districts of Drighlington, Gildersome, and East and West Ardsley. There was no opposition to the preamble. Sir Courtenay Boyle said there were steep inclines proposed in two of the railways, and the pattern of brake to be adopted and the mode of working would have to be carefully looked into when the time of opening for traffic arrived. The definition of a "house" in the labouring-class clause must follow the model Bill, and instead of being, as in the order, "any tenement separately occupied by any person," must be "any house or part of a house occupied as a separate dwelling." The clauses for the protection of the Great Northern Railway Company were then considered, and it was agreed that a clause should be inserted to the effect that the company shall not convey, or permit to be conveyed, goods or minerals over the light railways in competition with the traffic on the existing lines of the Great Northern Railway Company without the consent in writing of the Great Northern, which consent is not to be unreasonably withheld. This concluded the proceedings.

At the last meeting of the Welshpool Town Council, the town clerk having reported the receipt of the amended order for the Welshpool and Llanfair light railway, it was stated that the directors of that company had succeeded in getting another £7,500 free of interest added to the award of £7,000 already made by the Treasury, thus making a total free grant of £14,500.

Enquiries are being made in the Fleetwood district with the view to the proposed laying down of a light railway at Knott End.

The Treasury have issued warrants for the payment of grant and loan, amounting to £37,500, for the completion of the Dingwall and Cromarty light railway.

At the last meeting of the Crewe Town Council a letter was read from the clerk of the Cheshire Council stating that the Crewe light railways should not be constructed along the main roads outside the borough unless an obligation was placed upon the Corporation to widen the macadamised carriageway to a minimum width of 27ft., exclusive of footpaths. The Town Clerk read a letter from Mr. C. Hopkinson stating that the condition suggested by the County Council would affect about one mile of road. No decision was come to.

The provisional order for the Colne light railway has not yet been granted, but it is expected that something will be definitely known early this year. The company whom the Corporation have allowed to secure the order will lay the line and provide all equipment and work the same for a stipulated period, but the Corporation have by agreement with them reserved the right to supply the electrical energy for the same at a fixed price. The total cost of the Colne portion will probably be about £81,000. An enquiry has recently been held on behalf of the Local Government Board respecting the proposed borrowing of £40,000 for the purpose of providing plant and buildings for generating current, to work the lines referred to (so far as the same lies within the borough), and also for lighting purposes. The estimated cost of buildings and chimney is £10,000, and the remaining £30,000 for plant. This work is proposed to be proceeded with early this year. The waste heat from the neighbouring refuse destructor is to be utilised for the purpose of generating electricity.

CATALOGUES.

The British Westinghouse Company have prepared a new circular dealing with what they term engine-type alternators, by which the company mean alternators which are made for the direct coupling to steam-engines. In this case the company do not supply the main shafting and outer bearing, the alternator being held up on a spider which fits on to the shaft supplied by the engine-maker. The three 1,500-kw. alternators erected by this company at Willesden for the Metropolitan Electric Supply Company form a good illustration for the first page of the circular. In the descriptive matter which follows the alternators are divided up into two classes—viz., the revolving-armature and the rotating-field type. Of these two the company state they get rather higher efficiencies when the armature is revolving, but the fixed armature has its advantages when high voltages or exceedingly heavy currents have to be generated. The illustrations of the construction of the various details of these alternators will be of great interest to all electrical engineers who are up in machine designing, as they show evidence of great consideration both for the electrical and mechanical problems involved in the building of such large machines. Both with the fixed and revolving field magnets the cores of the magnets are made up of steel laminations. In the fixed-field type these laminations are cast into the field frame. In the revolving-field machine, while each lamination is keyed on to the spider, they are also interconnected by means of bolts which run through the whole thickness of laminated steel. Each punching is of the breadth of two poles, and these are built up so as to break joint. The bolts going through are then said to give sufficient strength to keep the ring together without any strain being put on the cast spider. In this revolving field type the coils are held on by wedges, which bridge from one pole to the next. In this way the long sides of the field windings are supported by the wedges. The machines are designed to have a temperature rise of 72deg. F. in a 24-hour run at full load with a power factor of from 90 to 100 per cent. With a 25 per cent. overload the rise goes up to 90deg., while a 50 per cent. overload can be taken over an hour without any damage being caused. The regulation on non-inductive load is said to be from 6 to 8 per cent., but we should like to have seen some information as to the drop on an inductive load, which is the real test of what a machine will do under practical conditions. The circular is concluded by a list of the various standard sizes, which gives the speed of the machines and the space required on the engine shaft, etc.

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Incandescent lamps form one of the many electrical requirements which the British Thomson-Houston Company now supply, and they have just issued a new list of these lamps. The illustrations in the list are most artistic, and show how well electric lighting can be made to harmonise with the internal decorations of houses. The lamps supplied by this company are of the Edison type, and it is pointed out that when the company is making 15 million lamps per annum they are able to get most valuable experience as to the best means of manufacturing lamps to afford general satisfaction On the question of the renewal of lamps when they became dim, a good simile is made between an incandescent electric lamp and a transformer. The lamp receives current and transforms it into light. Its efficiency as a transformer falls off with time, and may be reduced to one-half its original value without the lamp going. Any engineer having a boiler or an engine which dropped its efficiency to such an extent would have it immediately replaced or repaired, and it is pointed out that the renewal of incandescent lamps is often more important. In spite of this, and the attempts made by other lampmakers to instal the fact into users of electric light, there are those who believe in the lamp which lasts longest, and in consequence costs most in the way of electrical energy. As regards the watts per candle, we notice that all sizes from 8 c.p. to 150 c.p. can be obtained with a consumption of 3·1 watts per candle, or if a longer light is desired up to four watts per candle. With regard to the high voltage lamps for 200 to 250 volt circuits, the statement is made that these are still uncommercial except in the "lower economies." It is said, however, that the consumption of these lamps will be about four watts per candle. The company's high-voltage lamp is made with a three-turn spiral, and the two inside loops are anchored on to the base of the lamp. The same type of anchoring of the filament is used in the lamps for tramcars and railway carriages, and it is claimed that it gives the best results in that it allows a certain amount of vibration to take place in the filament. The lamps for traction work, which are run five in series off the supply, are specially graded to have equal resistance when incandescent, so that they may give equal light. The question of cost is not taken up in the list before us, which is an exceedingly serviceable one to show to customers.

Messrs. Geipel and Lange inform us that 1900 was an exceptionally busy year with them, and that they carried out a number of installations of three phase currents for the distribution of power. Amongst the new agencies which this firm has secured are Ward Leonard rheostats, motor starters, and circuit breakers; the Vulcan electricity meter; the Centrator motor speed reducing gear; and the Chapman voltage regulator, which is an automatic rheostat and maintains a constant potential both with varying speed and varying load, enabling more efficient lamps to be burned and maintaining full voltage on motors with variations in speed of the prime mover, and in many cases saving a switch board attendant.

The British Electric Works Company, Limited, having their London office at 11, Charing Cross-road, W.C., are now issuing a new catalogue of electric light accessories. This firm, which has its works at Birmingham, has introduced a number of new types in electric lighting accessories, to which we have referred during the past two years. These various leaflets are now connected together into one catalogue, which is much more convenient for reference. We do not propose again to allude to the excellent design of the lamp-holders, wall-plugs, ceiling roses, etc., which this firm has specialised. There is in the new list, however, a complete distributing system which is worthy of special notice. The idea is not absolutely new, but the firms have carried it further than any of their competitors. The system consists of making standard porcelain bases for distributing fuses and switches, and also for main fuses and switches. These are made interchangeable, and are mounted on ¼in. rods, which pass through projections at the back of the porcelain. The fuses are of the clip type, and the fuse wire is contained in a porcelain bridge piece. The advantage of the system is that a wiring contractor can quickly put together a number of these standardised units in order to obtain a switch or fuse board which he requires for his installation work. In this way the great delay which often happens in getting the fuseboards for electric light installations will be obviated.

The Newton Electrical Works, Limited, of Taunton, have forwarded to us their new century list of "Taunton" dynamos, motors, transformers, switchboards, etc. The list in question consists of some 28 pages, and contains a number of illustrations of the various types of machinery manufactured by the firm. We are pleased to note on comparing this new catalogue with previous issues that the size of the standard types made by the firm is again on the increase The new list also makes a speciality of the "Enclosed" motors and dynamos, which are specially suitable for use in coal mines and other places where inflammable gases or materials are likely to collect round the machine. In these machines the observation windows through which the commutator and brush gear can be inspected, are glazed with indiarubber packings. The machines are practically watertight, so that they can be used in damp positions, and at a small additional cost they can be made absolutely watertight. With regard to the large multipolar machines, we notice that the firm have adopted a very convenient sort of ring for supporting the brush spindles which is formed with a channel to contain the cross connecting leaves The electrical hauling gear for mines is also listed in the catalogue before us, as are also the firm's special types of motor-starting switches. These latter are specially designed to prevent large currents being taken from the motor when it is being started. This is done by a combination of a worm-gear with the contact lever.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

On Monday an extraordinary general meeting of this Company was held at the Westminster Palace Hotel, S.W., Mr. J. S. Forbes, chairman, presiding, for the purpose of obtaining the sanction of the shareholders to the raising of additional capital to provide for electric traction on the District Railway.

The **Secretary** (Mr. Wm. Jones) read the notice convening the meeting.

The **Chairman**, after impressing upon the meeting that the only business they had to consider was the advisability of sanctioning the raising of additional capital, said: You are asked to sanction our doing what Parliament has already authorised us to do, subject to that sanction. The position having become desperate, from causes over which we, at all events, have no control, nor you, something must be done. I could say a good deal upon the subject, but I presume you gentlemen here, and others interested, have been kind enough to read the circular which was issued with my signature appended to it; and if so, you will have found therein the substance of all that can be said on the matter. Will you or will you not take steps which are calculated to pull you out of a great dilemma? Well, I suppose you will. I might venture to suggest that if you do not, your position will become worse day by day. We people who have the burden of carrying a load of this sort—seeing a thing which was prosperous at one time, or bidding fair to be prosperous, brought down by circumstances which were entirely unforeseen when the railway was constructed, suffering as it does from the very legislation which bound it to its course, and which was based upon the inconvenience and evils which would arise if any railway were allowed to be constructed within the charmed circle of the Metropolitan, on the one hand, and the District on the other—feel the responsibility. It was the subject of a tremendous parliamentary enquiry, and the idea of railways traversing the centre of London was so terrible that only two out of the great many were selected—viz., ourselves and the Metropolitan. Our dangers and difficulties now have arisen from two causes having come into operation which were not foreseen at that time. The omnibus competition—you have heard of that *ad nauseam*, and we know what it is. For a number of years it has aggregated into an enormous loss to us in the way of traffic. We have had another taste, too, of some other cause—viz., the Central London Railway. These effects are visible immediately in the abstraction from us, and from the Metropolitan Company in a still greater degree, of traffic which used our lines for want of a better means of communication. Are we to sit down and cry, or are we to make some effort to retrieve the position? Of course if the advantages of electric traction are as great as they are said to be, nobody has a greater interest than ourselves in applying that remedy. In our particular system we shall have no vitiated atmosphere, we shall have plenty of room to move and we can dispense with deep descents into the earth, and systems of lifts and so forth, because we are on the surface. What we want is to apply electricity so that we may utilise our line near the surface as it is at a very small expense. We are told this thing can be done, and we ought to do it. It is now proved to demonstration that our railway can be electrified or adapted to electric traction, and, as the circular tells you, it can be done in a very short time and at a very moderate cost. If you say yes to raising this capital, that power will enable us, in some shape or other, either by our own Act or probably by some other method—some combination—to get this thing done within the amount which this vote of yours will concede to us. We shall have to decide whether we shall do it ourselves, or whether it will be wiser to put it up to contract—a lump sum contract—with responsible people, because we do not profess to be skilled in this matter ourselves. I will propose a resolution that you accord your assent to the general idea, trusting us, as you think fit, to carry it out to the best of our ability. We are very well advised by eminent scientists—Sir Wm. Preece, on the electrical question; and Sir John Wolfe Barry in other matters of adapting electricity to this particular Company. We have also tenders, in conjunction with the Metropolitan Company, from the greatest electrical firms, not only in this country, but elsewhere. You will remember we have got a Bill prepared in which certain powers are sought affecting capital—another method, in fact, of dealing with this question supposing this one breaks down. In our position we cannot afford to rely upon one chance. If we do not convert our railway we must go on depreciating, and there will be no answer that I can find against other railways being promoted parallel with our own with the express object of denuding it of the traffic which it now possesses. I make an appeal to the confidence of the shareholders on behalf of the Board and for myself on this occasion. You know we have had some ups and downs in this concern. We have been the creatures of adverse circumstances. I move the following resolutions, which have been prepared by eminent counsel: "(1) That, under the powers of the Metropolitan District Act, 1897, and the Metropolitan District Railway Act, 1900, there be created and issued £500,000 ordinary stock of the Company, and that the directors be, and they are hereby, authorised to issue such stock at such times to such persons, and on such terms and conditions, and in such manner, as they think advantageous to the Company; (2) that this meeting sanctions the exercise by the Company of their borrowing powers to the extent of £166,000 authorised by the Metropolitan District Railway Act, 1897, and the Metropolitan District Railway Act, 1900, by the creation and issue of debenture stock at such times and in such amounts and manner, on such terms, and subject to

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such conditions as the directors shall think fit, and that there be attached to such debenture stock a fixed and perpetual preferential interest at such rate not exceeding 5 per cent. per annum as the directors may determine, such interest to be payable half yearly at the same periods as the interest on the debenture stock of the Company is payable."

Mr. Isaacs having seconded the resolutions,

Mr. S. C. Noble asked whether the chairman desired them to understand that, if the resolutions were agreed to, it was not their intention to proceed with the clauses in the Company's Act by which they sought to confiscate the rights of the existing holders of perpetual preference stock by a reduction from 5 per cent. to 3½ per cent., and, if so, how they expected to raise further capital if they were guilty of so grave a breach of the Company's obligations towards existing holders of stock.

The **Chairman** said that if the shareholders sanctioned the proposal, they believed they would be armed with sufficient money to apply electrical methods to their railway as it existed. Therefore, the alternative methods would not be required.

In reply to another shareholder, the **Chairman** said the alternative was that if they could not raise the money under these powers they would then go to the shareholders for a more stringent power to raise money—in fact, over the heads of the preference holders. How was the thing to be saved otherwise? Who was going to find salvage except upon terms?

A Shareholder: That is to say, by this Bill you will rob the proprietors of some of their existing rights, and also the debenture or preference holders.

The **Chairman** said it was impossible to rob the shareholders without their consent. They were in this position—either they must electrify the railway, or the property must go to the dogs. It was bad enough now. It could not be saved without more money, and unless they found the money they would be worse off than they were at present.

A Shareholder asked how the money for electrifying the line would be found.

The **Chairman** said this was something like the idea: It would be possible to enter into a contract with some of the electrical companies. One of these companies might, in virtue of the £500,000 of ordinary stock and £166,000 debentures, enter into a lump sum contract to execute all the work necessary. They had now nine or ten tenders from people of great competence and with great capital behind them, all of whom were anxious to get hold of this work. It was very probable the Board would decide to do something of that sort.

Mr. Rawlings wanted to know whether the word "combination" had anything to do with an American syndicate.

The **Chairman** replied that he did not know much about American syndicates. It was true that there were some American people in the matter—the Westinghouse Company, for instance—but they were only one of a great many. They had tenders from all sorts of places—some from Austria, from Germany, and from firms in this country. The work must be done by a combination in the sense of going to some of those people in the manner he had described.

Mr. Walford expressed the opinion that if the line was not electrified, they would be in the hands of a receiver in a couple of years or so.

Mr. Robertson remarked that anyone could see that the District Railway as it at present existed could not be a success. If they went by the "twopenny tube" they found the difference in locomotion, comfort, light, and so forth. They must have more capital. If the scheme to electrify the line were carried out, he thought the District Railway would have a good future.

The **Chairman** observed that a large number of proxies had been received in favour of the resolutions, but he preferred that the matter should be settled by the common sense of the meeting, which he trusted would be unanimous.

In reply to Mr. Shields, the **Chairman** said that what the meeting did that day could not prejudice existing shareholders at all.

The resolutions were then put and carried unanimously.

The **Chairman** expressed the gratification the Board felt at the shareholders' unanimous decision to retrieve their position.

A vote of thanks to the chairman and directors closed the proceedings.

PERTH ELECTRIC TRAMWAYS.

The second ordinary general meeting of this Company was held at the offices, 3, Laurence Pountney-hill, Cannon-street, London, E.C., on Wednesday, Mr. Edward Heasman (chairman) presiding.

In moving the adoption of the reports and accounts, the **Chairman** said the item of permanent way represented a large proportion of the outlay. He thought that to have earned any profit at all upon the working of the first sections was a very satisfactory feature, and, indeed, they should not have been disheartened if no profit had been earned at all during that time. During the month of November the gross receipts amounted to £2,412 which was at the rate of nearly £29,000 per annum, and the working expenses for that month were about 48¼ per cent. In December, however, the gross receipts amounted to £3,410, which was at the rate of nearly £41,000 per annum, the working expenses being about 51½ per cent. This result was exceedingly gratifying. The cost of constructing the remaining routes included in the concession would be comparatively small, as it must be borne in mind that the heavy expenditure which had been incurred in connection with the erection of the power-house plant and machinery gave [practically all that was necessary for running the whole system of tramways. It would, however, be necessary to add another power-generating engine when the further sections were opened beyond the 13 miles he had already referred to, and they would see in the report that steps had already been taken for installing that. In conclusion, the Chairman read the following extract from a telegram then just received: "Newcastle-street route begins running Jan. 20; general prospects are most encouraging."

Mr. Oliver Wethered, in seconding the motion, testified from his personal observations as to the excellence of the work done in Perth from the engineering point of view, the excellence of the plant, and also regarding the excellent work done for them by Mr. Rogers and Mr. Somerset.

Mr. Alfred E. Morgan, a member of the West Australian Parliament, bore testimony to the fact that this tramway was the finest piece of work of the kind he had ever seen.

The report and accounts were then adopted, and a resolution was passed that £500 be voted to Mr. Rogers (the managing director in Australia) as a mark of their gratification for his successful management of the Company's business, and that £250 be voted to Mr. Somerset (the engineer) as a mark of gratification for his successful operation of the power plant and construction work.

Mr. Oliver Wetherhed having been re-elected as a director, the proceedings terminated.

ELECTRIC LIGHTING AND TRACTION COMPANY OF AUSTRALIA.

Directors: Joseph Bevan Braithwaite jun., M I E.E. (chairman); J. F. Albright, M.I.E.E.; Alfred U. Alcock, M I.E.E.; M. F. Armstrong; R. Percy Sellon, M I.E.E Engineer and manager: F. W. Clements M I.E.E Secretary: W. E Lane, A.M.I.E.E.

Report of the directors (with abstract of accounts) for the period from Aug. 17, 1899, the date of the registration of the Company, to Aug. 31, 1900:

The profit and loss account shows an available net profit of £6,013. 19s. 6d., and the directors recommend that this sum be applied as follows: to dividend on preference shares at the rate of 6 per cent. per annum from Sept. 5, 1899, to Aug. 31, 1900, £4,063. 10s. 10d.; balance carried forward, £1,950. 8s. 8d. Unexpected delay in securing the transfer of the properties and the Orders in Council belonging to the New Australian Electric Company, Limited, and the A. U. Alcock Electric Light and Motive Power Company, Limited, has been occasioned by the action of the Melbourne City Council and the Postmaster-General of Victoria. The directors have, however, recently received advice of the satisfactory settlement of all formal difficulties, and expect to obtain complete possession of the undertakings at an early date. In consequence of the above delay, the net revenue of the two Melbourne companies to which this Company is entitled from Jan. 1, 1899, is not available as profit, pending final completion of purchase; and it will be seen that no credit is taken for such revenue in the profit and loss account. This revenue, will, however, be available as profit so soon as the purchase is completed, and will be included in the accounts for the year ending Aug. 31, 1901. Meantime the business of the two Melbourne companies has continued to make satisfactory progress; and concentration of the generating machinery at the Richmond station, and consequent administrative economies, will follow promptly upon this Company securing possession of the undertakings. Extended Orders in Council for the supply of electricity in the important residential suburbs of Kew, Collingwood, South Melbourne, Malvern, Prahran, Fitzroy, Caulfield, Richmond, St. Kilda and Melbourne Harbour Trust, have been granted to the Melbourne companies, and in order to meet the large demand existing in these districts, orders for additional plant and mains have been placed, and some portion thereof has already been dispatched. These extended orders run for a period of 25 years from Sept. 6 1897 The Order in Council for Geelong now stands transferred into the name of this Company, and good progress has been made with the erection of a generating station upon a suitable freehold site and the laying of distributing mains. It is expected that a regular supply of electricity will be available in the beginning of next year. This order runs for a period of 30 years from Feb. 20, 1899. Reports received from the Company's engineers confirm the Board in their belief that the undertaking at Geelong will prove remunerative. Since the formation of the Company, the Board have acquired the whole of the assets of the South Australian Electric Light and Motive Power Company, Limited, including a private Act of Parliament covering the colony of South Australia, a small central station in operation at Port Adelaide, and the rights for electric lighting in the capital city of Adelaide. The station at Port Adelaide has, since it passed into the possession of this Company, been extended, and is now earning an improving revenue, which, however, does not as yet balance expenses. At Adelaide a suitable freehold plot of land has been purchased, and substantial progress has been made towards completion of the works required for lighting the city, for which purpose the necessary plant has been ordered and partly shipped. It is hoped that this station will be completed during the spring or summer of 1901. The directors believe that the Adelaide undertaking will rapidly develop and prove a valuable investment. Owing to the rapid expansion of the Company's undertakings at Melbourne, Geelong, and Adelaide, further capital will shortly be required for the purchase of additional plant and mains, and the matter is receiving the careful consideration of the Board. The Stock Exchange appointed March 21, 1900, for the special settling day in the Company's preference shares, and an official quotation for the same will no doubt be granted so soon as the purchase of the Melbourne properties has

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been finally completed. The auditors, Messrs. Cooper Bros. and Co., retire, and offer themselves for re-election.

Dr. BALANCE SHEET.

	£	s.	d.
Authorised capital:			
30,000 6 per cent. cumulative preference shares of £5 each	150,000	0	0
30,000 ordinary shares of £5 each	150,000	0	0
	£300,000	0	0
Capital issued:			
20,000 6 per cent. cumulative preference shares of £5 each	100 000	0	0
2,003 ordinary shares of £5 each	10,015	0	0
	£110,015	0	0
Creditors—Sundry creditors: head office, £1 217. 5s. 10d.; ditto, Australia, £832. 18s 5d.; bills payable, £12 000	14 050	4	3
Balance of profit and loss account	6 013	19	6
	£130,079	3	9

Cr.

	£	s.	d
Payments on account of purchase price of the Melbourne and Geelong undertakings, part of a total of £179,105	38 517	0	0
Purchase price of the Adelaide undertaking	29.493	18	2
Further expenditure on land, buildings, plant, tools, stores, etc., at Melbourne, Geelong, and Adelaide	31 805	15	1
Cash at bankers and in hand	9 416	4	8
Cash at Melbourne bankers	16 186	14	9
Cash deposited with bankers at the credit of the New Australian Electric Company, or jointly with them pending completion of purchase of the Melbourne undertaking	4 042	10	0
Sundry debtors: head office, £105. 4s. 10d.; in Australia, £485. 5s. 3d.	590	10	1
Head office furniture	26	11	0
	£130,079	3	9

Dr. PROFIT AND LOSS ACCOUNT.

	£	s.	d.
Directors' fees	1,000	0	0
Auditors' fee	21	0	0
Consulting engineers' fees	101	18	2
Head office expenses, rent, salaries, etc.	1,309	15	1
	2 432	13	3
Loss incurred in working the Adelaide undertaking	2,087	14	8
Balance carried to general balance sheet	6 013	19	6
	£10 534	7	5

Cr.

	£	s	d
Premium received on issue of 20,000 preference shares	10 000	0	0
Interest on deposits, etc.	531	14	11
Transfer fees	2	12	6
	£10,534	7	5

At the first annual general meeting of the Company at Winchester House, E.C., on Monday,

Mr. J. B. Braithwaite, jun. (the chairman), in moving the adoption of the report, said that the transfer of the two properties had not been completed, but the matter would no doubt be in order shortly, and the revenue from both companies would be available as from Jan. 1, 1899. The delay, however, had resulted in the companies having obtained powers under a new Act of Parliament for the supply of electricity to the important suburbs of Melbourne for 25 years. At Geelong the Order in Council, which was in the name of the Company, extended for a period of 30 years. The buildings at that town were completed, and the plant had been sent out. At Port Adelaide the Company had taken over a small station which had been run at a loss, but the revenue from which would no doubt be increased when the electric current could be supplied from the central station in Adelaide itself. The accounts were rather meagre, as the profits from the Melbourne stations could not be included owing to the delay in the transfer of the properties. The only items on the credit side of the profit and loss account were the premium received on the 20,000 preference shares issued, amounting to £10,000, and interest on deposits, £531. Against that, the loss incurred in working the Adelaide undertaking amounted to £2,087, and expenses to £2,432, leaving a profit of £6,013. Out of this it was proposed to pay a dividend on the preference shares at the rate of 6 per cent. per annum. Further capital would shortly have to be raised for the purchase of additional plant, mains, etc., and the matter was now engaging the attention of the Board.

The report and accounts were adopted, and a dividend at the rate of 6 per cent. per annum on the preference shares was declared.

MARCONI'S WIRELESS TELEGRAPH.

An extraordinary meeting of this Company was held on Wednesday at the offices, 18, Finch-lane, E.C., Major Samuel Page presiding, for the purpose of confirming the resolution passed at the meeting on Dec. 18, referring to various alterations in the articles of association, the principal one of which is that the directorate be increased from seven to ten. This was unanimously agreed to.

LONDON ELECTRIC OMNIBUS.

The adjourned meeting of this Company was held on Monday at the offices, 11, Queen Victoria street, E.C., Lieut.-Colonel T. T. Turnbull presiding.

The **Chairman** said the main point that had occupied the attention of the Board was how to secure an omnibus which could be run, not experimentally, but on a commercial basis. They believed that a suitable vehicle, guaranteed by the manufacturers in every way, could now be obtained at a reasonable cost. They had laid before the shareholders a scheme for reconstructing the Company, with a view to raising further money for the purpose of purchasing omnibuses of the type referred to. Turning to the accounts, the chairman pointed out that the unpaid calls amounted to £5,068. The omnibuses at present owned by the Company might be expected to realise a certain sum, although he was not able to say how much. In reply to shareholders, the Chairman stated that the new omnibuses would carry 14 passengers. The motive power to be used was now being considered by the manufacturers. Before anything definite was done, however, in the way of buying new vehicles the directors would have to be perfectly satisfied with them by a trial run of 30 consecutive days. It was proposed to run the new omnibuses all over London.

The report was adopted, and a resolution was passed to the effect that it was desirable to reconstruct the Company on the lines of the suggested scheme.

The **Chairman** said that the Board would do the best they could to carry out the scheme, but if sufficient support were not forthcoming the Company must be wound up.

LONDON AND GLOBE FINANCE.

On Wednesday an extraordinary meeting of this Corporation was held at Cannon-street Hotel. The meeting was called by a notice which stated that it having been proved that the Company could not, by reason of its liabilities, continue its business, it was advisable to wind up the same voluntarily.

Lord Dufferin, who presided, said it was with the deepest mortification that his colleagues and himself appeared before the shareholders upon this trying occasion, but he relied upon the courtesy and generosity of the meeting to listen to him. He was haunted by the fear of the effects which his resignation might produce, and when the other day he received news of the serious condition of his youngest son, and yielding to his mother's request to take her out at once to South Africa, he sent in his resignation, he did so with a clear conscience, because he knew that the circumstances under which he then surrendered his post would appear so natural and obvious that nobody would dream for a moment of placing a sinister interpretation upon it. At that time he had no anticipation whatsoever that the present trouble would overtake the Company. There might have been errors of judgment, but the policy of the Board had been honest and within the powers given by their constitution. Therefore, the directors stood together.

Mr. Whitaker Wright said that, in order to show his position, he might state that he had advanced to the Corporation a quarter of a million sterling to tide over the troubles. In order to have the control of the undertaking they had to have further capital, and he negotiated with certain parties for £500,000 to be paid down as a loan until March 31, the collateral security being over 40,000 Lake Views and a large number of other securities. Those collaterals for the loan were sold the next day, and the market was broken down. However, the Board expected to inform the shareholders next Monday that the debts had been settled.

Eventually the meeting was adjourned till Monday next, cheers being given for Lord Dufferin.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Bournemouth.—The Town Council invite tenders for 42 electric cars. Tenders by March 2. Details in our advertisement columns.

Asuncion (Paraguay)—The Municipality invite tenders for the installation of the electric light in the town. Tenders by Jan. 15, 1901.

Colne.—The Electrical Committee invite tenders for various plant. Tenders by Jan. 19. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for engine and dynamo. Tenders by Feb. 9. Details in our advertisement columns.

Copenhagen.—Tenders are invited for accumulator batteries and other electric works by the Copenhagen Electricity Company, 30, Gothersgade. Tenders by Jan. 21.

Aberdeen.—The Electric Lighting Committee invite tenders for surface condensers, air and circulating pumps. Tenders by Feb. 8. Details in our advertisement columns.

Oldham.—The Electricity Committee invite tenders for supply, delivery, and erection of engines and dynamos. Tenders by Jan. 29. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of telephone apparatus in connection with the Glasgow Corporation tramways. Tenders by Jan. 18, 1901. Details in our advertisement columns.

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Bradford.—The Tramways Committee of the Corporation invite tenders for the complete electrical overhead equipment of over five miles of tramway. Tenders by Feb. 2. Details in our advertisement columns.

Ayamonte.—Tenders for an electric installation for public lighting will be received by the Municipality of Ayamonte (Province Huelva, Spain), by Jan. 12. Specifications may be seen at this office.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Canterbury.—The Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 30. Details in our advertisement columns.

Brighton.—The Corporation invite tenders for the supply and erection at the Corporation electricity works, North road, Brighton, for various tramway plant. Tenders by Jan. 28. Details in our advertisement columns.

Tynemouth.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Tynemouth, of one 450-kw. steam dynamo. Tenders by Jan. 31. Details in our advertisement columns.

Hull.—The Works Committee of the Corporation invite tenders for the supply of one multipolar generator to be coupled direct to a Belliss high-speed engine. Tenders by Feb. 8. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for the supply and installation of the complete motor and electrical plant of the central station of the town electrical works. Tenders by April 1. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Sheffield.—The Tramways Committee invite tenders for a slow-speed vertical engine for driving a 1,000-kw. tramway generator. Specification, etc., may be obtained from Mr. A. L. C. Fell, M.I.E.E., general manager, Town Hall. Tenders by Jan. 21.

Leeds.—The Lighting Committee invite tenders for the construction of two underground transformer chambers. Specifications, etc., may be obtained from Mr. H Dickinson, manager of the department, 1, Whitehall-road, Leeds. Tenders by Jan. 14.

Batley.—The Corporation invite tenders for the supply, delivery, and erection at the proposed electricity works of three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Feb. 9. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for work to be done in connection with the electric lighting of the town hall and public offices, High street, Ilford. Specifications, etc., may be obtained on application to Mr. John W. Benton, clerk, Council Offices, Ilford. Tenders by Jan. 21.

Derby.—The Corporation invite tenders for the works in connection with a new chimney shaft, 155ft. high, to be erected at the central electric lighting station, Derby. Specification, etc., may be obtained from Mr. Arthur Eaton, architect, 6, St. James's-street, Derby. Tenders by Jan. 14.

Rotherham.—Tenders are invited for the supply of electricity meters of sizes for maximum currents of 5, 10, 20, 25, and 35 amperes. The supply pressure is 230 volts, continuous current. Tenders should be sent to Mr. H. Hampton Copnall, town clerk, Council Hall, Rotherham, by Jan. 19, 1901.

Poplar.—The Borough Council invite tenders for the supply of an electric crane to lift a maximum load of five tons, with a return block, the electricity supply being continuous current at 460 volts. Specification, etc., may be obtained from the Borough Electrical Engineer, at the Electricity Works, Glaucus-street, Bromley-by Bow, E. Tenders by Jan. 16, 1901.

Salford.—The River Irwell Conservancy Committee invite tenders for about 500 yards of tramway, 2ft. gauge, including curves, points, crossings, etc.; a hoist for tram wagons, to drawings; rolled-steel joists for tram bridges; two tram portable turntables, all to be delivered at the sewage works, Weaste. Particulars may be obtained at the Borough Engineer's Office, Town Hall, Salford. Tenders by Jan. 16.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 15, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, New Hampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston-street, Cleveland-road, and Bilston-road to the borough boundary, amounting to a route length of about 4¼ miles, mainly double track. General conditions, etc., may be seen at the office of Mr. J. W. Bradley, M.I.M.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Jan. 15.

RESULTS OF TENDERS.

Cardiff.—Mr. D. W. Davis, Trade-street, has secured the contract for the erection of an electric tram depôt, Pendyris-street, at £6,774.

Wakefield.—The City Council have accepted the tender of Ferranti, Limited, Hollinwood, for a 400-kw. engine and alternator, at £3,800.

Wrexham.—The Town Council have accepted the tender of Messrs. Brooks, Hirst, and Co., Chester and Wrexham, at £259, for wiring and lighting the markets with arc lamps.

Kendal.—The following tenders are recommended for acceptance: (1) for complete station equipment, Messrs. Johnson and Phillips, Old Charlton; (2) for mains, meters, etc., British Insulated Wire Company, Preston.

Newcastle.—The New Tramways Committee have accepted the tender of the Brockie-Pell Company for the supply of arc lamps, at £4,095. 1s., and that of Callender's Cable and Construction Company for the supply of arc lamps and telephone and pilot wires, at £2,037

Leeds.—The City Council have accepted the following tenders in connection with the extension of the mains for the two-phase distribution in Holbeck and Hunslet: British Insulated Wire Company, at £18,781 12s. 8d., for mains; Electric Construction Company, Limited, for 14 60 kw. transformers, at £119 each; Brush Electrical Supply Company, at £467.2s., for switch gear; and S. Z de Ferranti, Limited, at £344, for switch gear.

Southwark.—The following tenders were received on Wednesday: Pritchetts and Gold, 13 plates, 9in. by 9¼in. positive unformed grids ⅛in. thick, negative plain lead, ⅛in. thick, £349 (recommended for acceptance); British Power, Traction, and Lighting Company, pasted plates, lead-lined boxes, £390; Electrical Power Storage Company, 13 plates, 14in. by 14in., positive 7/16in. thick, negatives 5/16in. thick, £509; Hart Accumulator Company, plates, unformed grids, £565; Tudor Accumulator Company, 11 plates cast-lead unformed, £588.

Swansea.—The Public Library Committee have received the following tenders for the electric wiring and fitting of public library, schools of science and art, and art gallery:

West Bromwich Electric Light Company	£210	6	0
Edwards and Armstrong	340	5	0
National Electric Wiring Company	354	15	8
R. Alger and Sons, Newport	355	15	0
Spurgen and Co., Bridge-street, Peterborough	398	0	0
J. S. Brown	398	4	0
Barlow Bros. and Co., London	446	0	0
G. F. Lloyd and Co., Bristol	538	5	6
P. Symons	609	19	0
Hayes, Wood, and Co., Manchester	650	8	0

London, E.C.—The following tenders have been received by H.M. Office of Works for Block E of the Mount-pleasant telegraph factory:

		Oil materials.
E. Lawrance and Sons	£15,290 0 0	£200
J. Appleby	14,880 0 0	60
B. E. Nightingale	14,629 0 0	200
H. E. Tomes	14,399 9 0	100
T. L. Green	14,393 0 0	175
Holloway Bros.	14,250 0 0	—
W. H. Lorden and Son	14,155 0 0	378
W. Johnson and Co., Limited	14,039 0 0	239
Wilson Bros.	13,939 0 0	200
J. Chessum and Sons	13,725 0 0	120
Borrodale and Co.	13,141 0 0	—
J. Thompson and Co. (accepted)	12,680 0 0	250

Ayr.—The Corporation have received the following tenders for tramways equipment:

Cables.			
St. Helens Cable Company, Warrington	£5,138	1	0
W. T. Glover, Trafford Park, Manchester	5 444	12	1
Henley's Telegraph Works Company, Cannon-street, London	5,301	15	3
Callender's Company, Cannon-street, London (accepted)	5,158	13	0
R. W. Blackwell, City-road, London	4,872	5	5
Siemens Bros., Woolwich, Kent	6,054	4	8
British Insulated Wire Company, Prescot, Lancashire	4,941	13	3
Western Electric Company, North Woolwich, London	4,690	5	8
Overhead Cables.			
British Insulated Wire Company, Prescot, Lancashire	4,651	3	10
R. W. Blackwell, City-road, London	4,397	6	1
Macartney, McElroy, and Co., Victoria-street, London,	4,216	16	3
Lowdon Bros., Temple Electric Works, Dundee (accepted)	4,096	0	0

BUSINESS NOTES.

TRACTION.

Sheffield.—The Corporation's Bill, which includes the new tramways, has been approved by a town's meeting.

Birkenhead.—The question of the electric tram fares came before the Town Council last week, but the consideration of the matter was adjourned.

Gateshead.—The Corporation on Wednesday agreed to the extension of the period for the completion of the reconstruction of the tramways by three months.

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Cardiff.—The first rail of the electric tramways was laid last week.

Beckenham and Penge.—An extension of the line to Elmers End to the junction of the Croydon service has been agreed to, and special cables are to be laid for this purpose.

Liverpool.—The outer circular route of tramways, which will provide electric cars in the populous district between Tunnel-road, Kensington, and Anfield, will be opened next week.

Birmingham and Aston Tramways.—The directors have declared an interim dividend at the rate of 10 per cent. per annum for the six months ended 31st ult., payable 1st prox.

Chester.—The Rural District Council have given their formal consent to the Corporation Tramways Bill. The ratepayers, by a majority of 1,857, are in favour of the scheme for electric traction.

Lake Tramways.—It is again reported that the British Electric Traction Company have definitely abandoned their scheme for laying down an electric tramway service in the Lake District between Windermere and Ambleside.

Hoole.—At the Urban District Council meeting last Monday no formal resolution was passed, but it was understood that the Council agreed not to oppose the Chester Corporation bringing the tramways into Hoole as a means of revenue.

Kew Observatory.—According to the latest reports about the negotiations between the Kew Observatory authorities and the Board of Trade and the London United Tramways Company, we might expect to see the new lines open in a day or two.

Darlington.—The report of Prof. Kennedy, who has been asked to say if a system of municipal trams was likely to pay, has been referred to the General Purposes Committee. In the meanwhile further information on several points is to be sought.

Bishopsgate.—At the Vestry of St. Botolph's meeting last week it was resolved to authorise the subscription of £100 towards the fund being raised to protect the interests of the parishioners in connection with the construction of "tube" railways in the parish.

Warwick.—At Tuesday's meeting of the Town Council it was reported the Tramways Committee had had a satisfactory interview with the British Electric Traction Company, and that there was every probability that the generating station would be in Warwick.

Somerset.—The County Council at the last quarterly meeting considered drafts of the new by-laws intended to regulate the speed of locomotives and motorcars on highways and the traffic also. The general opinion was that the speed of motorcars should not be unduly restricted.

Richmond.—The Town Council have decided to oppose the new London Electric Tramways Bill, as it refers to their district. The Council considered that it would be inadvisable to proceed with any further tramway extension in the town until the horse tramway was in their possession.

Eccles.—At the meeting of the Town Council on Monday it was formally resolved to proceed in the next session of Parliament with a Bill empowering the Tramways Committee to double and alter the existing tramways in the borough for the purpose of electrical energy, to widen the roads and alter the bridges, etc.

Halifax.—The Tramways Committee have adopted a circular route of tramways between Cow Green, King Cross, along Warley-road, and back again *vid* Pellon to Cow Green. To Hopwood-lane top on the Warley-road, and from that point to Cow Green, the fare charged will be 1d. It is intended to introduce a quarter of an hour's service.

Gomersal.—The District Council have decided to give notice of intention to exercise their right to purchase so much of the undertaking of the Dewsbury, Batley, and Birstall Tramways Company as lies within their district, with the view to granting the lease of it to the Electric Traction Company, in connection with their scheme of tramways for the Spen Valley and neighbouring districts.

West and South London Junction Railway.—A meeting was held at 48, Gloucester-square, Hyde Park, on Wednesday, to consider what steps shall be taken in respect to the proposed West and South London Junction Railway. The occupiers and owners of West-end property appear to be afraid that they will be subject to the same vibratory annoyance complained of by people on the route of the Central London Railway.

Newcastle.—At the meeting of the City Council on Wednesday the widening of parts of Jesmond-road between Sandyford-road and the western approach of Benton Bridge and the construction of tramways in Market-street was recommended. It is also proposed to purchase additional boilers for the power station. The City Council have received £100,000 of the £400,000 borrowed from the Public Works Loan Commissioners in respect of the new tramways.

Bray.—At the last meeting of the Urban District Council the Town Clerk mentioned that he had received an estimate of the amount to be expended on the Bray and Enniskerry electric tramway—viz, £22,000—and suggested that the engineers should be asked to report as to how the line would affect the roads at present under control of the Council. The suggestion was adopted, and it was decided to call a special meeting to consider the engineers' report when submitted.

Kingston.—The recent poll resulted in a vote of about 3,700 to 1,100 against the promotion of the Corporation's Tramway Bill. The Corporation will, therefore, as a next step, present a memorial to Parliament complaining that the rival Bill of the London United Tramways Company did not comply with the Standing Orders of the House, inasmuch as it had not obtained the consent of two-thirds of the local and road authorities through whose districts the proposed lines would pass.

Sunderland.—At last week's meeting of the Corporation Tramways Committee a statement was submitted showing that, although there had been a heavy loss on the horse traction, the gain on the electric was so great that there had been a profit of £3,827. It was estimated that when the whole of the new system was completed there would be a profit, after allowing for every expense, of some £10,000 The committee decided to recommend the Town Council to extend the Roker section, and also the Hendon route, the latter so as to serve a very large new area by a circular line

Bradford.—At the last meeting of the Council the Tramways Committee presented a resolution agreeing to pay the actual cost price of the electricity which they take from the Electricity Committee for motive power, such cost to be arrived at by conference between the chairmen and deputy-chairmen of both committees, together with their chief officials. The present rate paid is 1d. per Board of Trade unit, and on account of the attitude of the Tramways Committee the Electricity Committee withdrew a resolution fixing the cost of power for the trams at 1½d. per Board of Trade unit. This was agreed to.

St. Helens.—The permanent-way inspection of the recently opened line of tramways running through Rainhill, Whiston, and Prescot from St. Helens was made on the 6th inst. by Lieutenant-Colonel E. von Donop on behalf of the Board of Trade. The annual supper for the employés of the St. Helens and District Tramways Company was held at the Co-operative Hall, St. Helens, on Friday last, a start being made at a quarter to 12 o'clock, after the men had finished work. Sir John Willox, M.P. (chairman of directors) presided. The Mayor and a number of the councillors were present. After the supper several songs, recitations, etc., were given. At intervals speeches were also made.

Coombe and Malden.—The Council on Tuesday considered the amended draft agreement of the London United Tramways Company. The Council will insist upon the insertion of the clause proposed by them *re* the widening of the bridge. As to the purchase clauses in the heads of agreement, they will agree to waive this question on the understanding that the company acceded to such terms as had been asked for, and subject to a similar abatement of 10 per cent. as obtained in the case of Surbiton. It was also resolved to oppose the Bill of the Kingston Corporation to construct a tramway along George-road, Coombe, on the understanding that the tramways company paid all costs as proposed by them under their heads of agreement.

Tramway Receipts.—At the end of the year the receipts from the various electric tramways stood as follows: Aberdeen Corporation, £22,064; Blackburn Corporation, £22,341; Blackpool Corporation, £28,418; Blackpool-Fleetwood, £20,425 (26 weeks); Bolton Corporation, £54,640 (from April 8); Bradford City Trams, £23 377 (from April 1); Carlisle Tramways Company, £14,250 (from June 30); Central London Railway, £122,326 (23 weeks); City and South London, £43,273 (26 weeks); Dover Tramways, £10,618; Dublin and Lucan Electric Railway, £1,590; Halifax Corporation, £30,246; Hull Corporation, £53,781 (from April 1); Liverpool Corporation, £415 378; Liverpool Overhead, £42,571 (26 weeks); Swansea Tramways, £7,093.

South-Western and Isle of Wight Junction Railway.—In the next session of Parliament a Bill will be introduced to incorporate a new electric railway company with a capital of £600,000, with powers to construct a railway under the Solent and thus give a complete land communication between the mainland and the Isle of Wight. The proposed railway will be just over 7½ miles in length. The length of the intended tunnel under the Solent will be about 2 miles 500 yards With the consent of the London and South-Western Railway Company and the Freshwater, Yarmouth, and Newport Railway Company, the traffic from the proposed railway may continue to be worked by electrical power over those systems into Brokenhurst Station and into Freshwater and Newport Stations.

Glasgow.—The Lord Provost of Glasgow and the members of the Corporation Tramways Committee last week inspected the new power station at Pinkston, Port Dundas, which is to supply electricity for the entire tramway system of the city. These works are the largest of their kind in the United Kingdom or the Continent. The whole of the tramways will probably be ready before the opening of the international exhibition in May. Lord Provost Chisholm unveiled a memorial tablet to commemorate the erection of the station. It was stated that the last week's receipts of the Corporation tramways amounted to £9 530, an increase of £1,023 as compared with the corresponding week of 1899, and of £283 in comparison with the preceding week. During the seven months of the present financial year the takings have amounted to £283,088, an increase of £6,697 over the corresponding period of the previous year.

Paisley District Tramways Bill.—This Bill and another are the only opposed Scotch Bills. The extra parliamentary panel of persons qualified by experience of affairs to act as Commissioners under the Private Legislation Procedure (Scotland) Act, 1899, has been nominated by the Chairman of Committees of the House of Lords and the Chairman of Ways and Means in the House of Commons, acting jointly with the Secretary for Scotland, in terms of the Act, and is formed as from Jan. 1, 1901, as follows: Sir Ralph Anstruther, Bart., Balcaskie, Pittenweem, Fife; Sir James Bell, Bart., Ardoch, Braco, Perthshire; Sir Thomas Gibson Carmichael, Bart., Castle Craig, Dolphinton, Peebles; Sir Thomas Glen Coats, Bart., Ferguslie Park, Paisley; A. R. Duncan, Esq., Parkhill, Arbroath; John Blackburn Ferguson, Esq., Balgarth,

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Ayr; A. Gordon of Newton, Esq., Newton, Aberdeenshire; A. Barns Graham of Lymekilns, Esq., Craigallion, Milngavie; Sir William Henderson, LL D., Devanha House, Aberdeen; Sir James Low, Kincraig House, Dundee; J. Dennistoun Mitchell of Carwood, Esq. Carwood House, Biggar; William John Mure, Esq., C.B., Broxmouth, Dunbar; Sir Reginald Ogilvy, Bart., Baldovan, Dundee; Sir David Richmond, Broompark, Pollokshields; W. Robertson, Esq., Benachie, Dunfermline; Sir M. Mitchell Thomson, Bart., 6, Charlotte-square, Edinburgh; the Honourable C. Trefusis, Fettercairn, Kincardineshire; Graeme Whitelaw, Esq., Strathallan, Perthshire; David Wilkie, Esq., Ardmore, Kirriemuir; Edward Wilson, Esq., Woodthorpe, Greenock.

Aberdeen.—The Tramway Committee of the Town Council made their annual inspection of the depôts and plant of the department last week. The committee also made a minute examination of the pits used for repairing the cars, and of the new fender, or lifeguard, which has been fitted on to one of the old horse cars. They also inspected the new patent London "dry seats." These seats are constructed to accommodate only one person at a time, and are hung on a pivot. The reverse side is uppermost, and is exposed to the weather. When the seat is touched by the passenger, it revolves round, and the dry side comes uppermost. The committee were highly pleased with the seat, and were of opinion that it would be most suitable for the outside of the cars. Several of the committee expressed the opinion that, as the Queen's Cross depôt was the most central, repairing workshops in connection with the department should be erected at it. Mannofield depôt was next visited. Here also is a large extent of spare ground, on which, if necessary, extensions of the depôt could be carried out. The committee next went to the Dee Village site of the new electrical station, where a good deal of discussion took place as to whether ground should be left for the proposed workshops in connection with the tramway department, and it was arranged that the Gas and Electric Committee and the Tramways Committee should meet together and endeavour to come to some amicable arrangement with regard to the matter. A sub-committee of the Tramways Committee have agreed to recommend, with regard to the proposed tramway from Castle-street by way of Constitution-street to the Corporation bathing station and the sea-beach, that a double line should be laid all the way to the beach.

Scarborough.—The Bill to incorporate a new company by the name of the Scarborough Electric Tramways Company, which has been lodged for introduction into Parliament next session, seeks parliamentary powers to lay down over 8½ miles of tramways within the borough and parish of Scarborough. The proposed main system will commence in Scalby-road, and will follow a route of just over four miles to Sandside, along the Royal Albert-drive to Westborough. The proposed tramways are to some extent dependent on the construction of the marine drive authorised in 1889, and the carriage road and approach thereto authorised by the Scarborough Corporation Act, 1900, whilst a short spur line of one furlong in length from the main system to the seaward end of the West Pier is only to be constructed with the consent of the Scarborough Harbour Commissioners. Another short line, of five chains in length, from Eastborough to West Sandgate, is "not to be constructed" until a proposed new street is made between Eastborough and Sandside. The projected tramways are intended to be worked by electricity, and for this purpose it is sought to acquire lands on the south west side of Peasholme-road for the erection of a generating station. The Bill provides that the Corporation shall exempt the company from all tolls payable in respect of the passage over the Marine drive authorised in 1899, provided the company light by electricity not less than 50 arc lamps along the authorised drive, and on Sandside and Foreshore-road, as the Corporation may select. If required by the Corporation, the company may provide closed wagons for the conveyance of fish from the West Pier to any railway station in Scarborough, and provision is made for using the tramway for the carriage of animals, goods, and minerals. The capital of the proposed company is to be £120,000, with the right to raise a further sum of £40,000 by the exercise of borrowing powers. An important provision in the Bill proposes to amend the Tramways Act of 1870, with respect to the acquisition of the undertaking by the local authority, by making the period after which the Corporation may purchase 50 years instead of 21 years.

Brighton.—At the Town Council meeting last week the following report of the resident engineer was confirmed: "As instructed by you, I met the resident engineer of the lighting department last evening, and discussed in detail the best and most economical means of obtaining electricity for the tramways, having in view the fact that a duplicate plant is absolutely necessary for tramway purposes, and also having regard to the fact that, in probably about three years' time from the present date, the whole of the current required for lighting purposes will be generated at the Corporation's new works at Portslade. The system that I proposed—namely, to instal plant in duplicate at the North-road electricity works—viz., one unit of 325 kw. capacity, and two units of 175 kw. capacity each, with engines, switchboard, etc., as hereunder detailed, will meet the requirements of the tramways department. Capital expenditure to be met by the electricity department—*i.e.*, site for installation, to be obtained by purchasing one of the cottages adjoining the North road (station) electricity works, £1,000; engines and dynamos 650 kw. capacity, made up in interchangeable units to meet tramways requirements, £6,500; foundations for engines, dynamos, etc., and building, one storey high, with lantern roof light, £500; switchboard complete, including Board of Trade panel, £700; steam-pipes and condensers, £1,500; boilers, £2,500; negative booster, £500—total, £13,200. The above plant to be exclusively for tramway purposes, the generators to be compound machines wound for 500 to 550 volts. We are agreed that by the adoption of such a system as above provided for, in lieu of a system embracing a battery sub-station, will effect a saving of something like £10,000 capital outlay as shown on paper by my estimate. We are also agreed that an equitable arrangement for the charge for current by the lighting department, inclusive of all charges, will be met by the maximum demand system as follows: 5d. for the first hour, per unit; 1d. afterwards per unit on the output of the tramway consumption, based on 325 kw. for 365 hours per annum as maximum demand. The tramway department to undertake that when the Portslade station is installed that they will take over their portion of the plant at North road works, or in the event of the plant being sold to bear the whole of the loss incurred in regard to such sale, but the option as to whether the plant shall be sold to lie solely with the tramways department. P.S.—Provided, further, that in respect of the spare set engine and dynamo (325 kw. capacity) that will not be running, the Tramways Committee shall meet the charge based on the capital value of such set for interest, sinking fund, and depreciation, also maintenance and repairs."

Leigh.—At the last meeting of the Town Council a report by the town clerk, borough surveyor, and electrical engineer upon the advisability of constructing tramways within the borough was considered. The borough of Leigh has now grown to such dimensions as to make it desirable for the public convenience that tramways should be provided, and the report pointed out that it was better for tramways to be both owned and worked by local authorities than by private companies, as the profit was not divided between private individuals, but went into the communal exchequer in relief of the rates, and where the local authority owned the electric light undertaking, as was the case at Leigh, the establishment of an electric tramway undertaking was mutually beneficial to the two concerns. As to the means of traction and the mode of construction, electric tramways on the overhead trolley system had after the most exhaustive enquiries, been pronounced by a large majority of authorities to be one of the most efficient systems, in addition to being the cheapest of efficient systems both in respect of initial cost and the cost of working. The cost of laying and electrically equipping a mile of single track in Leigh at the prices current at the present time is estimated at £8,165, and the cost of working tramways in Leigh would be 6·53d. per car mile. The streets of Leigh along which tramways could probably be profitably worked are (1) from the junction of Bradshawgate, Market-street, Railway-road, and King-street, along Bradshawgate, Queen-street, Chapel-street, and Manchester-road, to Green-lane End, or, perhaps, to the cemetery; (2) from the same junction along King-street, Twist-lane, Fire-lane, and Plank-lane to Plank lane Collieries. The cost of laying and electrically equipping these tramways would be about £45,771. 17s. 6d. Reckoning from what had been done at Dover, which was a town of a similar size to Leigh, the annual expenditure, including interest and instalment on a loan of £45,800, calculated at 3¼ per cent., and repayable in 25 years, and working expenses, would be about £8,140. 13s. 4d., and if the receipts were anything like those at Dover they would amount to over £10,000, which would leave a substantial profit on the year's working. The committee resolved to recommend the Council (1) to obtain statutory powers to enable them to construct and work tramways within the borough; (2) to request the South Lancashire Tramways Company to withdraw from the South Lancashire Tramways Bill the portions of the said Bill which relate to the tramways now proposed to be constructed and worked by the Leigh Corporation. A deputation from the South Lancashire Tramways Company was then admitted, asking the Council to delay confirmation of the minutes for a fortnight, as the company would be large ratepayers in Leigh through having their generating station in the borough, and they wished to formulate some suggestions. After discussion it was resolved to accept the company's suggestion and delay the confirmation of the minutes until the next meeting.

Willesden.—A poll has this week been taken on the Willesden Tramways and Improvements Bill. It appears that the question is not being fought on very fair lines. The Council issued a circular to the ratepayers of Willesden, in which they asked that the following statement might be considered: "(1) The electric lighting scheme which the Council are carrying out, irrespective of the above Bill, is expected (as in the case in all other districts) to show a deficiency in the first two or three years' working. This deficiency will be reduced if the Bill is passed into law, as it contains a clause suspending payment of any portion of the capital borrowed for three years, by which time the installation will be in good working order. (2) If the electric tramways as proposed by the Council are authorised, the deficiency before referred to will be further reduced by reason of the greater output and consequent lessening of the cost of generation of electricity. (3) The Bill authorises the borrowing of a sum of £80,000 only, and not the large sum which has been stated by the opponents of the Bill. This sum is for tramways and road improvements, and the amount borrowed will be repaid by instalments in the usual manner. The suspension referred to in paragraph 1 also applies to the tramways. (4) The Council believe (and in which belief they are fortified by the report of the electrical and tramway expert they have consulted—viz, Mr. E. Manville, M.I.C.E., of the firm of Messrs. Kincaid, Waller, and Manville,

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Great George-street, Westminster), the tramways will show an immediate profit. (5) The tramway clauses are permissive, and the powers to construct are operative for several years. (6) The Bill contains (apart from the tramways) a large number of powers which, if granted by Parliament, would, as is generally admitted, tend to promote the health and well-being of the parish, the nature of which can be ascertained by a perusal of the resolution as to the promotion, which will appear on the voting paper." In conclusion, the Council, who, as representatives of the ratepayers, have only their interests to study, asked that the acts as set forth in this letter might be carefully considered, and that their constituents would then vote as their judgment dictates. On the other hand, there is the Willesden Ratepayers' Association, whose circular was headed "A £250,000 scheme," and the following statement, *inter alia*, was made: "The cost of the electric generating works and of the tramway scheme equipment is placed by the Council at £143,624 and £53,247 respectively. No provision has been made in these estimates for the cost of alteration or widening of the roads, nor for the compensation to be paid to owners for acquiring property for these purposes and the necessary parliamentary and other expenses in connection therewith. These cannot safely be estimated at less than another £50,000, making a total of £246,871." In the poll the tramways have not been dissected from the remainder of the Bill, so the Council have taken a poll on the whole. The voting papers were collected on Tuesday, so it is possible the result will be known soon. Our local correspondent anticipates a majority against the Bill, and believes that if the voting is against the District Council, the portion of the lines which were deleted from the Middlesex County Council's scheme, at the wish of the District Council, will be reinstated in that scheme.

LIGHTING AND GENERAL.

Aldershot.—The electric lighting scheme will cost about £18,000.

Hull.—The electrical engineer's salary has been raised by £45 per annum.

Shrewsbury.—Further extensions of the electric lighting have been agreed to.

Limerick.—The Shannon electric scheme is being investigated by the Corporation.

Tring.—The postal authorities are laying telephone wires from Groves-road to New Mill.

Crook.—Messrs. Pease and Partners will start part of the electric lighting about the 17th inst.

Worksop.—The Urban District Council have obtained a loan of £5,000 for electric lighting purposes.

Share Market.—Electric shares participated in the general dulness, with hardly a bargain doing during the week.

Accrington.—It is proposed that a portion of Blackburn road shall be included in the scheme for electric street-lighting.

City of London Electric Lighting Co.—Warrants for the payment of interest on the 5 per cent. debenture stock have been posted.

Portsmouth.—The Town Council have adopted the committee's report in favour of the establishment of a municipal telephone exchange.

Wednesbury.—The introduction of electric lighting is again being discussed. The Council have already power to provide an electric plant.

Pacific Cable.—The Agents-General of New South Wales and Victoria have been appointed representatives of Australia on the Pacific Cable Board.

Nottingham.—The town clerk's report on the Derbyshire and Notts Electric Power Bill has been referred to the Electric Lighting Committee.

Kingston.—The question of the electric lighting of the work house came before the last meeting of the Board of Guardians, and was again adjourned.

Worthing.—It is proposed to charge 6d. per unit for light and 3d. for power, with certain discounts after the first hour. Nothing is, however, definitely decided.

Crewe.—The electrical engineer has reported that 90 applications for electric light installations have been received, being equivalent to 3 500 8-c.p. lamps.

Crompton and Co.—The directors have declared an interim dividend at the rate of 6 per cent. per annum for the half year ended Sept. 30, payable 28th inst.

Darwen.—The Town Council have decided to apply for power to borrow £13,000 for increasing the plant and the utilisation of condensers at the electricity works

Belfast.—The electrical engineer has reported to the Borough Council regarding his visit to the Paris Exhibition for the purpose of examining the electrical exhibits.

Ludlow.—The Town Council have decided to consult Mr Parker, of Hereford, about an electric light scheme, which will include the destruction of the town refuse.

Personal.—Mr. A. P. Dryburgh, of Doncaster, has been appointed assistant electrical engineer at the Grimsby electric lighting works, at a salary of £120 per annum.

Watford.—The application by a company for a provisional electric lighting order for a part of Northwood, in the Watford rural district, has been assented to by the Council.

Batley.—Sanction has been received to the borrowing by the Corporation of £25,402 for electricity works, and tenders for the supply of engines, dynamos, etc., will now be called.

Stafford.—Sanction has been received by the Town Council to the raising of a loan of £10,000 for electric lighting purposes on condition that the roof of the accumulator house be slated.

Beckenham.—The Urban District Council have decided to apply to the Local Government Board for sanction to a loan of £20,000, the estimated cost of the proposed electric light extensions.

Barnstaple.—In consequence of the failure of the National Telephone Company to connect with Ilfracombe, the Town Council have refused to entertain the special terms for connecting the borough offices.

Stock Exchange.—The Stock Exchange Committee have been asked to allow Commercial Cable Company's further issue of £177,951 sterling 4 per cent. 500-year debenture stock to be quoted in the official list.

Ayr.—In connection with the proposed extension of the electricity works, the Town Council have resolved to purchase the property of Major Paterson adjoining the works, the price to be fixed by arbitration.

Large Wire Contract.—An order for 1,000,000lb. of wire has just been completed at Ansonia, Connecticut for an electric line on the trolley principle in India. The wire is now awaiting shipment.—*Daily Mail.*

Horsham.—The Local Government Board enquiry in reference to the application of the Urban District Council to borrow a sum of £15,500 for the purposes of electric lighting was held on Wednesday by Colonel Smith.

Grimsby.—Alderman Dobson last week switched on the current at the electric station. After the customary speeches those present made a tour of inspection over the station, under the guidance of Mr. Vignoles, the resident engineer.

Brighton.—The Town Council have confirmed the resolution of the Lighting Committee to apply to the Local Government Board for sanction to borrow a sum of £13,200 for the purposes of the electricity undertaking of the Corporation.

Middlesbrough.—Ten thousand lights have been applied for, irrespective of the Corporation buildings and the streets, and additional plant is required. It is proposed to supply power during the day at an all-round figure of 2d. per unit.

Colwyn Bay.—The Electricity Committee of the District Council have instructed Messrs. Lacey, Clirehugh, and Sillar to prepare specifications and plans for extension of plant, which has become necessary owing to the increased demand for current.

Maidenhead.—A public meeting was held last week for the purpose of discussing the question of the lighting of the town by electricity, for which object the Town Council have obtained powers to raise a loan of £25,000. The meeting was adjourned.

Chertsey.—The Urban District Council have agreed to the Woking Electric Supply Company's order, and have also approved of the transfer of the Staines, Egham, and Chertsey electric lighting order to the Thames Valley Electric Lighting Company.

York.—At a meeting of the City Council on Monday it was stated that the net result of the first nine months' working of the electric light installation was a profit of £142 This was the best result obtained by any of the new corporation undertakings of the year.

Perth.—The works in connection with the public installation of the electric light, the total amount of tenders accepted in respect of which is £35,000, is rapidly approaching completion, and it is expected that the new illuminant will be available in about two months' time.

Hebden Bridge.—The Halifax Tramways Committee are willing to supply electricity at the point of delivery at Hebden Bridge at the following charges: 2¾d. per unit up to 15,000 units taken per annum, 2½d. per unit between 15,000 and 30,000 units, and 2¼d. per unit over 30,000 units

Blackburn.—The Town Council have decided to increase the salary of Mr. Giles, the electrical engineer, who is an applicant for a position at Salford from £500 to £700 per year, conditional upon his remaining four years, with a further £150 per year in respect of the electricity and tramways extension.

Wigan.—Colonel Durnford, R.E., has held an enquiry into the application of the Corporation to borrow £16,500 for electric lighting purposes. It was explained that the application was in anticipation of a number of applications for current in the streets not already provided for. There was no opposition.

Post Office Telephones.—The Post Office telephone system will, it is hoped, be available for use in the City area in June next, but in view of the large amount of work still to be done in connection with the establishing of the system, much time must elapse until the whole metropolitan area can be supplied.

Salisbury.—The National Telephone Company have returned the draft agreement between the Town Council and the company in furtherance of their proposal to place their wires underground throughout the city, with several important alterations. The matter has been referred to the General Purposes Committee.

Darlington.—A sub committee has been appointed to watch the Cleveland and Durham County Electric Power Bill. The following appointments have been confirmed: Mr. Charles A. Frost, assistant engineer at the electric lighting station, at £120 per year; and Mr. T. W. Hewitt, junior assistant engineer, at £78.

Theft of Electricity.—The charge against an electrician of having abstracted electricity belonging to the Liverpool Corpora-

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tion, in connection with which the magistrates who tried the case a fortnight ago were unable to agree, was dismissed last week, the Bench being unanimous in the opinion that the allegation was not proved.

Barnet.—At the last meeting of the Urban District Council, it was proposed that the clerk be instructed to take the necessary proceedings against the North Metropolitan Electrical Power Company for recovery of penalties for breaches of contract, but the motion was allowed to stand over until the company had been conferred with.

West Hartlepool.—The electric light has now been brought into use for private consumers, and the work of erecting the arc lamps in the main streets is rapidly proceeding, and the street-lighting will be commenced in a day or two. There was no formal ceremony connected with the switching on of the current for the private supply.

Blaydon.—The District Council will discuss next month the proposal of the Newcastle and District Electric Lighting Company, Limited, to supply electricity for the district. In all probability the price will be something like 5d. a unit for the first 200 hours, and about 3d. per unit for the next 200 hours, and 2d. per unit for the remainder.

Sunderland.—A plan by Mr. J. F. C. Snell and Mr. J. W. Moncur for an electric power station in Farrington-row has been adopted by the Building Committee of the Corporation. The building will be 52ft. in height to the eaves, and will contain boiler-house, engine-house, workroom, messrooms, etc., and will be provided with a chimney 220ft. in height.

Cuckfield.—There was much complaint at the last meeting of the Urban District Council as to the supply and quality of gas at Cuckfield, electric lighting, acetylene installations, and the appointment of a public tester of gas being among the things talked about. The result was once more a strong protest to the gas company as to the public lighting.

Thornaby.—The sub committee appointed to consider the question of the borough establishing its own gas and electric light undertakings have reported upon the subject to the General Purposes Committee, who had deferred the matter for future consideration. A petition against the Cleveland and South Durham Electric Power Bill has been sealed.

Tunbridge Wells.—Sanction has been received to the borrowing for electric lighting purposes of £5,000. Notice is to be served upon the National Telephone Company to cancel all wayleaves for poles and wires on Corporation property, and verbal intimation given that, if the company wish any concession with respect to wayleaves, the committee will consider any application they have to make

Tynemouth.—The work of preparing for the installation of the electric light in the borough is now well advanced, and it is expected that within a few days the light will be in actual use. The Tynemouth Gas Company are evidently not alarmed by the new competitor, as they are at the present time duplicating their works. The price of gas has also been increased by 4d. per 1,000 cubic feet.

Buxton.—Nineteen tenders have been received for the electric light installation at the town hall, and a deputation will visit some of the places mentioned as wired by one of the firms tendering, and report as to the quality of their work. Application is to be made for sanction to the borrowing of £700 to cover the estimated cost of wiring and fitting the town hall and of the electric bells for firemen.

Luton.—An agreement between the Corporation and the National Telephone Company for various connections was submitted to the Town Council last week. The period was five years, and the payment £39. The members thought that the town hall should be in communication with the exchange, though the Clerk said that meant £8 more. The agreement was, therefore, referred again to the committee.

Stourbridge.—Application is to be made to the Board of Trade for leave to extend by two years the period during which the Council's provisional order may be utilised, and the applications of the Midland Electric Corporation for powers in the Council's area are to be opposed. An application of the Mond Gas Company to supply their gas within the area of the Council's district is also to be opposed.

Halifax.—The salary of Mr. Parsons, assistant electrical engineer, has been increased £25 per annum, and the salary of Mr. F. Spencer, tramways manager, is to be advanced by £50 per annum on Feb 1 next, with a further advance of £50 on Feb 1, 1902 subject to his entering into an agreement to remain in the service of the Corporation for a period of two years from Feb. 1 next, the Corporation to have the right to use the patents obtained by him without payment of royalty or other charge.

Ross (Gloucestershire).—At the last meeting of the Urban District Council consent was given to the drafo provisional order for the electric light scheme for Ross, promoted by Mr. John Parker, of Hereford. Twenty five years has been fixed as the period after which the town authority could, if they desired, purchase the company's effects. There was nothing in the drafo order as to the charge per unit, but Mr. Parker said it would probably amount to 6d. or even less. The price would be regulated by the demand

Appointments Vacant.—The Council of the borough of Reigate invite applications for the appointment of a resident electrical engineer, at a salary of £200 a year.—The Urban District Council of St. Annes-on-the-Sea require a fitter-driver and a jointer at 35s. per week each.—The tramways department of the Glasgow Corporation require a first-class mechanical engineer to take charge of the steam plant and general oversight of their power station. Full particulars of these vacancies appear in our advertisement columns.

Southwark.—At the meeting of the Borough Council on Wednesday the Electric Lighting Committee reported upon the result of advertising for tenders for counter-E.M.F. cells. Particulars of tenders appear in another column. Extensions to the electric lighting plant, at an estimated cost of £12,661, were also recommended. It was agreed to take over from the contractors certain arc lamps and switches. It was proposed to call for tenders to provide another 400-kw. unit, with two boilers and additional plant, at the earliest date possible.

Derby.—At the meeting of the Lighting Committee last week, the Electrical Engineer said there was a paragraph in the special report of Sir William Preece, which he adopted as the best recommendation on the matter. This paragraph said, "I am of opinion that a satisfactory start can be made in private lighting at an expenditure of £21,500. If the amount were increased to £25,000 it would be sufficient to cover the tramway requirements." It was decided to ask the engineer for a report on the application of the tramways company. The Town Council has increased the salary of Mr. Wilmshurst by £50 per annum.

St. Albans.—A long debate upon the proposal to introduce electric lighting in the city took place at a special meeting of the Council last week. It was reported that, in response to an advertisement inviting offers as to the terms on which companies and others would be prepared to take over the electric lighting provisional order of 1898, replies had been received from the Electrical Power Distribution Company, Limited, the British Schuckert Electric Company, and the St. Albans Gas Company. On the recommendation of the sub-committee, it was agreed that Mr. Robert Hammond be retained to advise on these matters.

Hendon.—The Urban District Council have resolved (1) that a copy of Mr. Hammond's supplemental report and specification with reference to the lighting of the district by electricity be furnished to the Hendon and Child's Hill Ratepayers' Association as requested, and that an abstract of the supplemental report be advertised in the local papers; (2) that application be made to the Corporation of Hampstead, the Charing Cross, Euston, and Hampstead Railway Company, and the North Metropolitan Electric Supply Company enquiring whether they could undertake the supply of electricity to the Council for a term of years, and, if so, at what rate.

Nernst Electric Light, Limited.—An adjourned ordinary general meeting of the shareholders of the Nernst Electric Light, Limited, will be held at the Westminster Palace Hotel, London, S.W., on Friday, 18th inst., at 2.30 p.m. The adjourned extraordinary general meeting of the Company will be held immediately on the conclusion of the adjourned ordinary general meeting for the purpose of considering and passing a resolution altering the articles of association. Should the resolution be passed by the required majority it will be submitted for confirmation as a special resolution to a second extraordinary general meeting which will be subsequently convened.

Electric Storage Batteries.—We are informed that Mr. L. Broekman has removed his offices from 34, Victoria-street to 12, Dartmouth street, Queen Anne's-gate, S.W. We learn that the agency for Epstein accumulators, as now made by the sole licensees (Messrs W. O. Rooper and Co., of Stafford), form the principal speciality of this firm, who also supply light secondary cells for traction purposes train-lighting, and automobiles. These cells, in which the positive or working plates are of Planté formation, while the negatives consist of metal gauze treated by a special process, have now been developed to a high degree of perfection, making it possible to supply them on a commercial scale.

Ilford.—The Lighting and Tramways Committee of the Urban District Council have obtained Mr. Bartley Dennis's opinion as to the Council's liablity to bear the expense of providing metallic circuits to the railway company's electric signalling apparatus throughout the Ilford district. Mr. Hawtayne has been asked to give the Council a definite assurance that the working of the scheme will not injuriously affect the railway company's signals. The Great Eastern Railway Company has been informed, in reply to their objection, that the Council are advised that there is no reasonable probability of their scheme when actually working injuriously affecting the railway signals at all. There are 11 selected candidates for the post of resident engineer.

Manchester.—The City Council on Wednesday adopted a recommendation of the Electricity Committee to authorise application to be made to the Local Government Board for sanction to the borrowing of £500,000 for electricity purposes. The sum will provide for (1) the balance of the three-phase mains required in the city up to the sub-stations nearest to the city boundaries; (2) low-pressure feeders; (3) tramway feeders not yet laid in the city, Moss Side, Withington, Levenshulme, and Heaton Norris; (4) new distributing mains in the city, Moss Side, and Levenshulme, and in all the compulsory streets of Heaton Norris; (5) conductors for potential wires, street-lighting, and for the laying of such telephone cables as had not yet been put down; (6) a sum to cover the provision of new services in the city and in Moss Side etc.; (7) a sum to cover meters in the city and Moss Side, etc.; (8) a lump sum to cover small extensions in various streets as they might be required from time to time in the city and Moss Side, etc. The committee thought it necessary that they should be in a position to extend their operations rapidly, because otherwise they would fall in obligations to which they were pledged and would be landed in a dilemma.

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Tewkesbury.—At the quarterly meeting of the Gloucestershire Standing Joint Committee, on the application from Westbury-on-Trym for the police station there to be connected with the telephone coming before the meeting, it was asked if at the same time Tewkesbury could be connected. It appears that there is a telephone office at Tewkesbury, which is closed after eight o'clock at night until the next morning, and it is during the night that the police wish to use it. The Chairman said the chief constable should make enquiries on the matter.

Leeds.—An electric launch will shortly be seen running on the Waterloo Lake, Roundhay Park. It will be 55ft. long, and will accommodate about 70 persons. The Thames Electric and Steam Launch Company are the designers and builders. A partner of Messrs. Greenwood and Batley, Limited, speaking at the Leeds Chamber of Commerce monthly meeting last week, said that his firm found electric power exceedingly economical as compared with steam, and they were taking away driving by steam power wherever possible. At the same meeting another large employer of labour said that before long they in the West Riding would be relying very considerably upon electricity, whether used in one works or in different parts of the works by means of different motors.

Stockton.—The electric lighting mains are to be extended along Bridge road to the road leading to the tramway depôt, at a cost of £500, and also an extension main laid from Dovecot-street through West-row to Yarm-lane. With regard to the Cleveland and Durham Electric Power Bill, the Gas Committee reported at the last meeting of the Corporation that the town clerk (Mr. M. B. Dodds, J.P.) had laid before them a report on the Cleveland and Durham County Electric Power Bill, in which he advised that the local authorities within the district of supply already holding electrical powers should be invited to confer, with the view of combining to oppose the Bill in order to obtain the insertion of protective clauses. This suggestion, it was agreed, should be adopted.

Exeter.—The surveyor has been instructed to obtain estimates of the cost of lighting the various courts of the city by electricity instead of gas, and to consider the advisability of lighting Queen's-crescent, York-road, by electricity. The Electric Light Committee estimate the cost of placing two lamps, each with two incandescent lights, in Queen's-crescent at £4. 10s. each per annum, exclusive of the cost of providing and fixing the necessary posts, etc. The committee are prepared to undertake the lighting of any courts on the line of existing mains, but they do not at present recommend the laying of special mains for the purpose. Since the last meeting 483 lamps of 8 c.p. have been connected, and applications from 13 consumers for extensions equivalent to 280 lamps of similar capacity are in hand.

London Gazette.—A receiving order has been made out *re* H. Hudson, 67, Thurnscoe-road, Bradford, on debtor's petition. The first meeting in the estate of the above will be held on Jan. 15, at 11 a.m., at the official receiver's chambers, 31, Manor-row, Bradford, and the public examination on Jan. 23, at 10 a.m., at the County Court, Manor-row, Bradford.—An application has been made for the discharge of A. G. Inrig (carrying on business under the style of Globe Electrical Company), 46, Whitepost-lane, Victoria Park, London. The day fixed for hearing is Jan. 24, at 11 a.m., at Bankruptcy-buildings, Carey-street, E.C.—The last day for receiving proofs in the estate of G. T. Godfrey (trading as Godfrey Bros.), Boundaries-road, Balham, London, is Jan. 22. Mr. P. Ravenscroft, Jewry House, Old Jewry, London, E.C., is trustee.

Yorkshire Power Bill.—At the monthly meeting of the council of the Leeds Chamber of Commerce last week a deputation was received from the promoters of the Electric Power (Yorkshire) Company, who sought the support of the Chamber in their forthcoming application to Parliament. Mr. Lupton, addressing the meeting, pointed out that the maximum prices authorised in the Bill were: up to 5,000 units, 3d. per unit; from 5,000 to 10,000, 2¾d. per unit; from 10,000 to 20,000, 2½d. per unit; from 20,000 to 50,000, 2d. per unit; from 50,000 to 100,000, 1½d. per unit; from 100,000 to 200,000, 1d. per unit; and over 200,000, ¾d. per unit. There was also a provision that when 8 per cent. dividend had been paid, a discount of 20 per cent. must be allowed on that scale. It was resolved to support the Bill in question.

Bolton.—With reference to our note last week with regard to the result of the interview between the deputation from the Bolton Trades Council and the Electricity Committee of the Bolton Corporation, with respect to certain alleged grievances of their employés, a subscriber writes: "It was not on the grievances of their employés that the meeting took place, but to submit a complaint from an unemployed wireman who had been refused employment because he was a member of the trades union. This man declared the truth of his assertion, which was, however, denied by the official concerned, and hence the decision of the committee giving that Scotch verdict of not proved." We printed the report as we received it from our local reporter, and had neither reason to doubt its accuracy nor motive to willingly distort the same.

Yarmouth.—Sanction has been received to the borrowing of the whole of the sum applied for for extensions of the plant, mains, and buildings, amounting in two sanctions to £27,000. The 150 kw. alternator, for which the Local Government Board had previously given their sanction, has been fixed, but for the ordinary lighting works of the town it appears imperative that the two additional boilers, the extensions of the buildings and switchboards, forming part of the sanction, at an estimated cost of about £5,000, should be provided at once. The building is to be enlarged to 105ft. 10in. instead of 84ft. 8in., the additional cost being about £150. Tenders will be at once obtained for the two boilers, the two continuous current dynamos, and the building extensions, making the engine room 101ft. 10in. long, as suggested by the borough surveyor.

Insulators.—We have received from Mr. F. Winter, of 8, Red-cross-street, E.C., a catalogue of the goods for which he is agent in this country, and which are manufactured by the Harburg India Rubber Company, of Hamburg. From the illustrations we see that tramway insulators have been most carefully specialised by this firm in order that strength and good insulation may be obtained at the same time. A strain insulator, No. 206, is an instance of the new types introduced by the firm, and it is claimed for this that it is considerably stronger than the ordinary globe strain insulator now so commonly in use. The insulator in question consists of a rectangle of steel surrounded by insulation. Over the two short sides of this rectangle are slipped the attachments for the straining wires. The firm also make a speciality of anti-vibration supports of rubber.

Entertainment at the Arc Works, Chelmsford.—At the recent annual treat to the wives and children of employés at the Arc Works, about 900 guests spent an exceedingly happy time. The arrangements made by Mr. H. C. Hawkins, assisted by the committee of the Arc Works Club, were well carried out. The hall was decorated with flags, and on one side was ranged a row of 10 huge "Christmas trees," given by Mr. Arthur Pryor, of Hylands. They were festooned with silver ropes, ornamented with Chinese lanterns, and laden with 1,250 presents. The gifts were for children of 10 years and under. Tea was served, at which the Arc Works staff, foremen, etc., assisted in waiting. After tea the tables were cleared away, and in a very short time the mothers and their charges were provided with seats to witness a variety entertainment, and the proceeding concluded with the distribution of the presents from the Christmas trees, the children also receiving gifts of sweets as they left the hall.

Dorking.—At a recent meeting the Council in committee reported the receipt of a letter from the West London and Provincial Supply Company, Limited, stating that they could not see their way to agree to the alternative of 8d. per hour for the first 100 hours' lighting of each quarter and 2½d. thereafter for various reasons. It would not pay the company to supply current at a price averaging less than 6d. per unit all round. The letter further stated that the company agreed as to heating, cooking, and motive power, and also to the conditions named as to free wiring, meters, transfer, re-transfer to Council, and approval of scheme, on the understanding, as regards the last, that the scope of Mr. Trentham's duties in respect of their work should be limited to seeing that the terms of the transfer were duly carried out by them, and that the arrangements they proposed were such as to enable them to fulfil properly the obligations imposed upon them by the provisional order. The Council passed a resolution adopting the terms named by the company.

Newcastle-on-Tyne Electrical Contractors' Association.—A new association, to be called "The Newcastle and District Association of Electrical Contractors," has recently been formed, with Mr. R Robson as hon. secretary. The objects of the association are as follows: (*a*) to endeavour to settle disputes between electrical contractors and other persons; (*b*) to aim at obtaining uniformity in contracts, and estimates as regards specifications; (*c*) to combine together for mutual protection in cases of strikes and lock-outs; (*d*) to prevent any contractor taking an apprentice from any other contractor without his permission (an apprentice to mean one under the age of 21 years); (*e*) to keep a register of men employed, with notes as to their ability, wages, etc.; (*f*) to adopt a uniform rate for extras for out-of-town work; (*g*) to adopt a minimum rate to be charged for time work; (*h*) to prevent manufacturers supplying those not in the trade with goods at trade prices, without reserving a discount for the contractor who fixes them. The offices of the association are at 36, Northumberland-street, and all communications should be addressed to Mr. R. Robson.

Montrose.—The Lighting Committee reported at the last meeting of the Town Council that, after a long discussion on various schemes for the electric lighting of the streets, they unanimously agreed to recommend the adoption of a plan which provided for 20 arc and 10 incandescent lamps. The meeting agreed to discuss the subject fully in committee, when it was suggested that as little delay should take place as possible, as the Electricity Committee could not proceed to lay the mains until this was settled. It was decided to dispose of the matter on the receipt of Mr. Lackie's revised report. The Streets and Roads Committee reported that the convener and the surveyor met the manager of the electricity company, who informed them that the company were to lay their cables near the channels instead of under the pavements, as previously intended, and that there could be no charge made for the wayleave, as the company had powers in their provisional order to open the streets after giving due notice, the company, of course, repairing the roadway to the Council's satisfaction. The company will charge the Town Council 4d., whereas other users will be charged 6d. per unit.

Glasgow International Exhibition.—The main buildings for the Glasgow International Exhibition being now practically complete, the lighting arrangements are engaging chief attention. As has been already intimated, the contractors for the electric installation are Claud Hamilton, Limited, and Messrs. Lowden Bros., Glasgow, and both firms are at present busy carrying out

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the work. The electricity department of the Corporation has agreed to supply a large triple cable, about a quarter of a mile in length, for use in the grounds, on condition that the laying down and removal of it is paid for by the exhibition authorities. The British Aluminium Company offered on loan 10,000 yards of overhead wire for arc cabling, and the offer has been accepted by the Electric Lighting Committee The central portion of the grounds are to be lit by incandescent compressed gas, this work having been undertaken by the Welsbach Incandescent Gaslight Company, who propose to erect and maintain free of cost a series of lanterns, ranging in power from one to five light, the only stipulation being that the exhibition supply and erect the requisite columns. This condition has been accepted, and an order for the columns placed with Messrs. McDowall, Steven, and Co., Glasgow.

Uxbridge.—At the last meeting of the Urban District Council the Clerk read a letter from the clerk to the County Council of Middlesex, calling the attention of the Council to the following clause in the Northwood Electric Light and Power Company's order, and asking what action the Council proposed to take in the matter: "The undertakers shall be empowered for all or any of the purposes of the order to open, break up, stop up, etc., any public and private streets, and railways, watercourses, bridges, etc., either above or under ground, or otherwise." Referring to the above extract in his letter, Sir Richard Nicholson wrote: "I do not recall ever having seen a general power asked for to 'stop up' roads, rivers, etc., and in connection with the word 'watercourses' the committee should be reminded that the Rivers Penn and Yeading Brook, important tributaries of the Rivers Colne and Crane respectively, cross the entire area of supply from east to west. This fact, taken in conjunction with the power sought to 'stop up' any watercourses, appears to me one calling for serious consideration. With regard to the word 'otherwise' in foregoing excerpt, I am as much at loss to understand its meaning as in the case of No. 160." It was decided that the clerk should communicate with the company, and if the answer was unsatisfactory, then with the Board of Trade.

Fulham.—The consulting engineer submitted the following report on Wednesday: "Progress of Work.—Under this heading I have to report that since the date of your last meeting the British Insulated Wire Company, sub-contractors to the General Electric Company, have been making progress with the cable work in the streets. I have just been advised that at the beginning of next week they will be ready to test the final batch of cables to be laid under the streets. The General Electric Company have also been making good progress with the cable connections in the central station, and are about to make a preliminary test of the steam alternators and exciters in the station. I have to report that one or two cracks have appeared in the brickwork of the south-east block of the destructor cells in the boiler-house. They are both at the end of the block and over the clinkering doors I do not attach much importance to these cracks, but they will have to be carefully watched to see whether they enlarge, and doubtless Mr. Ferguson will pay close attention to this." The Resident Engineer also reported that since the last meeting of the committee applications equivalent to 570 8-c.p. lamps had been received, bringing the total applications (118 in number) to the equivalent of 10,091 8 c.p. lamps. Up to Dec. 31, 1900, 599 loads of refuse had been destroyed, and he had arranged for the disposal of 400 loads of clinker at 6d. per load.

Battersea.—At a meeting of the Council on Wednesday the Lighting Committee reported that they have appointed Mr. J. E. Livsey chairman of the committee for the ensuing three months. The committee had also considered a letter from Mr. G. L. Gomme, clerk, London County Council, dated Dec. 22, adverting to the conference which took place in June, 1898, between representatives of the London County Council and London local authorities with reference to certain proposals then before Parliament for the establishment of undertakings for the supply of electricity in bulk to local authorities or companies who might require it, stating that the Highways Committee of the Council still have the matter under consideration, and asking whether the Borough Council agree with the principles laid down in the conference resolutions or whether they consider it desirable, having regard to the changes in the government of London since the conference was held, that another conference should take place upon the subject. They recommended that the London County Council be informed that the Borough Council agree with the principle laid down in the resolutions of the conference, and do not, therefore consider it desirable that a further conference should take place. On the question of installing the electric light in private premises upon the prepayment and easy payment, etc, system of supply, the committee, having regard to the result of enquiries made and to the delay which would necessarily take place if the Council waited until they obtained power to carry out the work themselves, recommended that alternative schemes be invited for the fitting up of consumers' premises for electric lighting free of all initial cost to the Council or the consumer. Two telescopic ladders, for use in connection with the arc lamps, are to be procured at an estimated cost of £50, and advertisements issued inviting tenders for street lamp columns, etc., the contract for which will expire on March 25 next.

Swansea.—At the meeting of the Electric Lighting Committee held last week with reference to the electric lighting of the harbour by the Corporation, the Engineer reported that the docks were lighted on two systems, and both were totally distinct from the one adopted at the generating station of the Corporation. They were also systems which could not be worked with success by the Corporation, and to change them for the one they had adopted would mean a considerable capital outlay on the part of the Harbour Trust. They would have to replace the whole of the lamps, a good deal of the material used at present would have to be consigned to the scrap heap, and there would have to be other alterations He did not think the trustees would consider a proposal of this sort. In this matter he differed from the position taken up by Messrs. Kincaid, Waller, and Manville, which was due in his judgment, to the fact that he was on the spot, and had an opportunity of knowing local requirements of which they would have no knowledge. Coming to the question of cost, he again was not in accordance with the consulting engineers of the Corporation. In the first year's working of a station he considered that it would be impossible to supply the Trust with light at 1½d. per unit: it was too much to expect, and under the most favourable considerations he did not think it could be done under 1½d. per unit. He had estimated that it cost the Trust 1½d. per unit to supply their own light, although they did not agree with him as to that. If they wished to get them as customers it would be at a loss for the first year's running and he suggested that they offer current at 1½d. per unit, which would mean a direct loss of about £300 to the Corporation for the first year. Considerable discussion took place on the report, and the matter was adjourned. At the same meeting it was reported that there were applications from private consumers for 7,500 lamps, and this would within the next few days be increased to 12,000 or 13,000.

Messrs. Richards and Co.s Power Plant.—The well-known firm of Messrs. Geo. Richards and Co., Limited, machine tool makers, Broadheath, near Manchester, have just completed some important alterations, by which almost the whole of their system of power has been converted from steam to gas. The principal reason for making the change arose in consequence of the uncertainty of the local water company being able to continue a regular and constant supply of water. The fear of a stoppage led the firm to consider how the difficulty could best be met, and it was wisely determined to enter upon a system of reconstruction. A new gas generating plant of 320 h.p. has been erected by the Dowson Economic Gas Power Company, Limited, London. This is in every respect a compact and efficient plant, and, so far as it has been tested, the results have been found as satisfactory as could be wished for. Four new gas-engines, by Andrews, of Stockport, have been put down. The largest is one of 100 b.h.p, which drives a dynamo, through which the power is transmitted by six electric motors to all parts of the spacious machine tool department. The second engine is one of 80 b.h.p., and it will be used exclusively for driving the pulley shop. A third engine, of 42 b.h.p., will provide the necessary power for the heavy erecting and testing shop, while a separate one of 26 b.h.p. will drive the machinery used in connection with the foundry. The directors do not propose to dispense with the use of steam entirely. One steam-boiler of 100 h p. will be retained for the engine driving the dynamo supplying the current for general lighting. The exhaust steam is utilised in the winter for heating the large workshops and offices. Altogether, some 800 lamps are required in the establishment, where between 400 and 500 hands are constantly employed. The two dynamos mentioned are by Royce, Limited, of Manchester. The lighting and power switchboards have been supplied and erected by Cowans, Limited, Manchester. The whole of the alterations have been carried out at a cost of about £4,000, and their importance will be seen when it is stated that the directors expect to effect a saving of £1,000 annually. The firm has just ordered a five-ton electric crane from Berry, of Swinton, for use in the foundry.

PROVISIONAL PATENTS, 1900-1.

DECEMBER 24.

23543. Improvements in plates for secondary or storage cells. William Edward Ayrton and Arthur William Fithian, the City and Guilds Central Technical College, Exhibition-road, London.

23549. Improvements in and relating to telegraphic transmitting apparatus. John Nevil Maskelyne, jun., and Alexander Marr, 70, Market-street, Manchester.

23566. Third-rail insulator and support. William Courtenay, 33, Cannon-street, London. (Complete specification.)

23571. Improvements in apparatus for indicating and/or recording the speed of electrically-propelled vehicles and/or the distance travelled thereby. John Somerville Highfield and Stanley Beeton, 6, Bank-street, Manchester. (Complete specification.)

23583. Improvements relating to supporting devices for electrically insulating telegraph and similar wires. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Renault, United States.) (Complete specification.)

23584. Improvements in and relating to arc lamps and the like. Walter Rowbotham and Kate Amelia Rowbotham, 43, Stanmore-road, Edgbaston, Birmingham.

23586. A fusible electric circuit-breaker for fire-alarm purposes. Richard Pearson, 53, Chancery-lane, London. (Complete specification.)

23592. A method of and apparatus for actuating devices on public electric supply or distribution systems. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, London.

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23593. A method of and apparatus for actuating devices on public electric supply or distribution systems. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, London.

23610. Improvements relating to signalling jacks for multiple telephone exchanges. Lars Magnus Ericsson, 4, South-street, Finsbury, London. (Complete specification.)

23611. Improvements relating to maximum electric meters. Fritz Lux, jun., 45, Southampton-buildings, Chancery-lane, London.

DECEMBER 27.

23617. Improvements in or connected with overhead electric tram or railway cars or locomotives. Gregory John Moschos, 15, Water-street, Liverpool.

23647. Improvements in the electrolytic deposition of metals. Herbert Champion Harrison and Joseph Day, Compton Villa, Paragon-road, Weston-super-Mare.

23649. An improved electric bell. Sigi Kraus, 63 High Holborn, London. (Complete specification).

23675. Improved process and apparatus for obtaining electric current. Oscar Britzke, 322, High Holborn, London.

23688. Direct electromagnetic traction with electromagnetic railway car. Antonio Pacinotti, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, Sec. 103, July 10, 1900, being date of application in Italy.)

DECEMBER 28.

23700. Improvements in electrical couplings. John Bernard Langford, 133, Goldhawk-road, Shepherd's Bush, London.

23726. Improvements in and relating to automatic switches for telephones. Edward Miller, 27, Chancery-lane, London.

23729. Improvements relating to secondary batteries. Baron Henry Fexier d'Arnoult, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 22, 1900, being date of application in France.)

23733. Improvements in indicators for fire-alarm telegraphs. Leonidas Gorham Woolley, 322, High Holborn, London. (Complete specification.)

23735. Improvements in electro-mechanical apparatus for preventing collisions of railway trains. William Phillips Thompson, 6, Lord-street, Liverpool. (Matteo Aliberti and Genisio Boni, Italy.)

23743. Improvements in battery cells. Edward Tiquet, 4, South-street, Finsbury, London. (Complete specification.)

23748. Improvements in windings for use in polycyclic electric current systems. Engelbert Arnold, Ole Sivert Bragstad, and Jens Lassen La Cour, 47, Lincoln's-inn-fields, London.

23749. Improvements in means for the distribution of dependent polycyclic currents. Engelbert Arnold, Ole Sivert Bragstad, and Jens Lassen La Cour, 47, Lincoln's-inn-fields, London.

DECEMBER 29.

23773. Improvements in switches for starting and controlling electric motors. John Henry Cowell, Drumcraig, Newton Abbot, Devon.

23774. Improvements in apparatus for producing interchangeable numerals, letters, words, and the like by means of electrical lamps. William Johnson and Joseph Makin, Bank-buildings, George-street, Sheffield.

DECEMBER 31.

23852. Improvements in devices for indicating and measuring pulsatory or varying magnetic fields. Gustav Dietze, 72, Cannon-street, London. (Complete specification.)

23866. Improvements in electric distribution systems. Edward M. Hewlett, 83, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 28, 1900, being date of application in United States. (Complete specification.)

23875. Improvements in dynamos, motors, and motor-generators. James Lawrence and James Ernest Spagnoletti, 53, Chancery-lane, London.

23877. Improvements in and relating to insulators for electrical purposes. Claude William Atkinson, 1, Queen Victoria-street, London.

23890. Improvement in or relating to insulating and protective coatings especially applicable to electric conductors. Albert Wilhelm Peust and Adolf Apel, 322, High Holborn, London. (Complete specification.)

23892. An improved magneto-electric device for igniting explosive mixtures. Friedrich Sturm, 6, Lord-street, Liverpool. (Complete specification.)

23896. Regulating device for electric motors. La Société d'Etudes "Voitures Electriques de Paris," 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 25, 1900, being date of application in France.)

23903. An electrical glass furnace. August Voelker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 1.

5. Electric refrigerators or apparatus for cooling air vapour or liquids by means of electric currents. Henry Andrew Kent, 59, Mydleton-road, Bowes Park, London.

17. Improvements in electric glow lamps. George Henry Smith, 37, Daniel-street, Cathays, Cardiff.

18. Improvements in electric switches. George Whittaker Holt, 36, Temple-street, Birmingham.

31. Improvements in switches for electrical purposes. Alfred Watson, 180, Hockley-street, Birmingham.

34. Improvements in electrical wall plugs, plug connections, and the like for electrical purposes. George Sperryn and William Henry Wood, 104 Colmore-row, Birmingham.

42. Means for the generation of electrical energy by the liquid oxidation (or other non-ignition decomposition) of coal or carbon, and for the utilisation of the electricity and chemical and/or other combination produced thereby. Robert Harty Dunn, Wearyall, Glastonbury, Somerset.

56. Improvements in the electrolytic deposition of metals. Herbert Champion Harrison, The Limes, Upper Richmond-road, Putney, London.

63. An improved coin-feed apparatus for telephones and other purposes. Compton John Bayard and Arthur Edwin Lamkin, 17, Wedmore-gardens, London.

65. A safety appliance for overhead electric wires. Peter Logan Raeburn Fraser, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

74. Improvements in switches for controlling electrical circuits. Andreas Peter Lundberg and Gustaf Charles Lundberg, 477, Liverpool-road, London.

96. Device for regulating electric motors. Maurice Monthiers, 53, Chancery-lane, London.

JANUARY 2.

131. Improvements in electric light switches. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London. (Complete specification.)

134. Improvements in gearing for electric clocks, checking instruments, and for indicators and the like. James John Stockall, sen., 50, Ferme Park road, London.

157. An improved electric motor. David Perrett, 45, Southampton-buildings, Chancery-lane, London.

165. Improvements in electric telegraph transmitting apparatus. George Keith Buller Elphinstone, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Jan. 19.

1899.

25422. Systems of electrical distribution and circuit-breakers for use therein. Stillwell. (Date applied for under International Convention, May 24, 1899.)

25641. Electro-mechanical accumulators. Schlomann and de Castro.

1900.

1168. Registering apparatus and circuits for telephone measured service. Kingsbury. (Western Electric Company.)

2543. Primary batteries. Emily Haidee Maquay. Administratrix of the late Samuel William Maquay.)

3561. Electric ignition for internal-combustion motors. Crossley and Atkinson.

3913. Metering of electricity. Wright and Reason Manufacturing Company, Limited.

3968. Recording instruments for electric telegraphs. Muirhead and Edgar.

4105. Crossings and the like on electric tramways. Mills. (Bonnet, Paufique, et Linière.)

8475. Alternating electric current motive apparatus. British Thomson-Houston Company, Limited. (Steinmetz.)

13976. Armatures for dynamo-electric machines. British Thomson-Houston Company, Limited. (Steinmetz.)

13974. Bonds for electric railway rails and other conductors. British Thomson-Houston Company, Limited. (Lovejoy.)

15168. Commutaters for electric machines. British Thomson-Houston Company, Limited. (Dempster.)

15379. Regulating dynamo-electric machines. British Thomson-Houston Company, Limited. (Steinmetz.)

15382. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Green and Callan.)

15921. Electric cut-outs. British Thomson-Houston Company, Limited. (Emmet.)

16049. Electric commutators. British Thomson-Houston Company, Limited. (Emmet.)

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16228. Regulating electric alternators. British Thomson-Houston Company, Limited. (Rice.)

16760. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

16763. Controlling electric meters. British Thomson-Houston Company, Limited. (Day.)

16946. Electromagnets. Wetter. (Elektrizitäts-Aktien-Gesellschaft, vormals Schuckert und Co.)

19615. Electromagnetic blow-outs for electric cut-outs. British Thomson-Houston Company, Limited. (Hewlett.)

19916. Electric controllers. British Thomson-Houston Company, Limited. (Case.)

19914. Electric meters. Edison.

20507. Sparking plugs for electrically-fired internal-combustion engines. Hall.

21292. Means for obtaining magnetic adhesion of locomotives or motorcars in electric railways. British Thomson-Houston Company, Limited. (Union Electricitäts-Gesellschaft.)

21293. Insulated electric conductors and method of making the same. British Thomson-Houston Company, Limited. (Steinmetz.)

21443. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

21449. Interrupting devices for electric circuits. British Thomson-Houston Company, Limited. (Rice.)

21459. Safety cut-outs for electric circuits. Sachs.

21460. Lightning arresters for safety cut-outs for electric circuits. Sachs.

21538. Plates for electric batteries or the like. Boult. (Jackson.)

21642. Electric fuses. Ward.

To be published on Jan. 26.

1900.

138. Method of telegraphing, indicating time, or actuating mechanism electrically. Loubery.

184. Method of determining the voltage obtaining at a near or distant part of an electric circuit, or the average voltage obtaining at several parts thereof, and apparatus therefor. Field.

1573. Rubber-insulated electric cables. Heyl-Dia.

2473. Electric arc lamps. De Marçay.

2662. Brush-holders for dynamo-electric machinery. Lancashire Dynamo and Motor Company, Limited. (Wood and McLeod.)

2880. System of and means for regulating electric meters and the like. Cooley.

3524. Features of the anodes in electrolytic apparatus. Thompson. (Becker.)

3534. Electric supply meters. Evershed and Vignoles, Limited, and Evershed.

4358. Electric bell pushes. Swindell.

5183. Electric locks. Newton. (Carlston.)

13198. Electric traction with surface contacts. Cruvellier.

13968. Systems of electric motor control. British Thomson-Houston Company, Limited. (Davis.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Jan. 5	896	794	+ 102	—	—
Birmingham Trams.	,, 5	4 076	3 927	+ 148	—	—
Blackburn Corp'rat'n	Dec. 14	432	327	+ 104	22,341	19 902
Blackpool Corporatn.	Jan. 3	221	141	+ 80	—	—
Blackpool-Fleetwood	,, 5	193	141	+ 52	—	—
Bolton Corporation..	,, 6	1,800	—	—	—	—
Bradford City Trams	,, 6	842	337	+ 505	—	—
Bristol Tramways Co.	,, 4	3,684	2 766	—	—	—
Carlisle Tr'mw'ys Co	Dec. 15	121	—	—	4 260*f*	—
Central London Ry.	Jan. 5	5,847	—	—	—	*e* —
City & South London	,, 6	2,018	1,144	+ 874	—	—
Cork E. T. and L. Co.	—	—	—	—	—	*c* —
Dover Tramways ...	,, 5	180	158	+ 22	—	—
Dublin & Lucan E.R.	—	—	—	—	—	—
Dublin U.T., elec. cars	,, 4	1,982	1,619	+ 364	—	—
Dublin S.D. Electric	,, 4	421	326	+ 95	—	—
Dundee Tram Co. (*b*)	Dec. 6	480	352	+ 128	—	—
Glasgow Corporation	Jan. 5 1	1,534	9,820	+ 1,714	—	—
Halifax Corporation	Dec. 30	784	513	+ 271	30,246	23,947
Hull Corporat'n E.S.	Jan. 5	1,622	682	+ 940	— *a*	—
Liverpool Corporat'n	D.c. 22	9,053	7,213	+ 1,840	406 243	351,154
Liverpool Overhead	,, 30	1,397	1,305	+ 92	42,571	41,655
St. Helens Tramways.	,, 19	—	—	+ 205	—	—
Sheffield Corporation	Jan. 6	2,878	—	—	—	—
Southampton Trams	,, 3	657	339	+ 317	—	—
Southport Corporat'n	Dec. *8	366	329	+ 37	—	—
Swansea Tramways..	Oct. 5	447	263	+ 184	7,093	4,462

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *e* From July 30. *f* From June 30. * Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	10½-11½
—— 40,001-70,000	5	—	10½-10¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	—	105-106
British Electric Works, Ordinary, 50,001-95,000	1	..	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅛-¼
—— 4½ per cent. First Mortgage Debentures	100	—	96-97
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¼-4½
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2½
—— 4½ per cent. Debenture Stock	100	..	108-111
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103 xd
Callender's Cable, Debentures	100	—	109 113 xd
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5½-6¼ xd
Crompton and Co.	3	—	3¼-4
—— 5 per cent. Debentures	—	—	99-103
Edison and Swan United, Ordinary	3	—	1⅝-2½
—— 5 per cent. Debentures	5	—	3½-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	88-90
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	—	98-100
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1½-2½
—— 7 per cent. Cumulative Pref.	2	—	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5½-5¾
—— 4½ per cent. Debentures	100	—	108-113
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21½ xd
—— 6 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	38-42
—— 5 per cent. Bonds	100	—	100-103 xd
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-5¾
Willans and Robinson, Ordinary, 1-20,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 20,001-60,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	103-105
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	100-103 xd
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6¼-6¾
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5¼-5¾
Chelsea Electricity Supply	5	—	6½-7
—— 4½ per cent. Debentures	100	—	104-112 xd
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	122-127 xd
County of London and Brush Provincial, Ordinary	10	—	8¾-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	106-109 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¾-5
—— 4½ per cent. First Mort. Deb.	100	—	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7¼-8¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1½-2
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	93-101
Metropolitan, Ordinary	10	—	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113 xd
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99 xd
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1½-1¾
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	..	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	5	—	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	..	8¾-9¼
—— 3½ per cent. Deb.	100	..	98-101 xd
Westminster, Ordinary	5	—	12½-13½
—— 20,001-109,487	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9-9½
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, deferred	5	—	4-4½
City and South London, Consolidated Ordinary	100	—	52-56
—— Ordinary	10	—	4½-5½
—— 4 per cent. Debenture Stock	100	—	115 120
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	18½-19½
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9¾-10½
British Electric Traction, Ordinary	10	—	12½-13½
—— 6 per cent. Cm. Pf. 20,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4¼-4¾
—— 5 per cent. Deb. Stock, Red.	100	—	103-106 xd
—— Prov. Cert., all paid	—	—	94-97 xd
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10½
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	—	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	10½-11½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	102-105
Telephones.—			
National Telephone, Ordinary	5	—	4¼-4½
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	11-12
—— 5 per cent. Non Cum. Third Pref.	5	—	4¾-5¼
—— 4 per cent. Deb. Stock, Red.	100	—	99-102 xd
—— 3½ per cent. Deb. Stock, Red.	100	—	94-97 xd
Oriental Telephone and Electric Company	1	—	1-1½

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NOTES.

Electrical Engineers Volunteers. — We understand that likely young men who are perhaps more on the side of mechanical than purely electrical engineering, would be welcomed in the corps. No doubt there will be room for men of the mechanical type in the contingent going to South Africa, and we are perfectly sure such men are likely to obtain good posts in the colonies if they choose to stay there at the cessation of hostilities.

American Electric Railway Scheme.—What is described as the longest electric railway in the world is proposed in Montana, from Billings to Great Falls. The length of this line, if constructed, will be 200 miles, and it is intended to operate it entirely by electric power supplied from generating stations on the Missouri and Yellowstone Rivers. Considerable traffic in coal, ores, and other heavy freights, it is expected, will be forthcoming when the line is built, and it will hold the unique position of being the first railway with such traffic to be worked entirely by electricity.

Automobile Exhibition.—The third annual exhibition of motorcars, motor-cycles, and accessories, arranged by the Automobile Club of Great Britain and Ireland, will be opened at the Agricultural Hall, Islington, on Saturday, May 4, for one week. It is expected that the exhibition will show a great advance on its predecessors, and it is practically certain that over 1,000 vehicles will be exhibited. So far space has been allotted to nearly 100 firms, and the whole of the ground floor space has been fully let. Demonstrations this year will be continuous throughout the day.

Electric Transmission in France.—We understand from *L'Industrie Electrique* that a large new scheme for electrical transmission is suggested in connection with the town of Roanne. In this case the water power would be obtained from the River Loire by the construction of a canal parallel to the course of the river, over a distance of about 7½ miles. The fall in this section of the river is so great, that by the construction of the canal an available head of 135ft. would be obtained even when the river was low. It is estimated that sufficient water could be taken from the river to generate 100,000 h.p.

The Energy of Coal.—It is difficult to educate the untechnical mind to understand that all coal used for steam raising is not of equal value. For instance, there has recently been a considerable stir in the Colchester Corporation because the Electric Lighting Committee accepted a tender for coal at 24s. 8d. when they had one at 24s. 1d. before them for consideration. It is stated in the report of the meeting that the coal had been tested, and we presume that the engineers reported in favour of the dearer coal on the ground that it would give them considerably more output per ton. It is absurd, therefore, to find the councillors at variance over such a small matter, and one which they are evidently unable to understand.

Electric Tramways at Cardiff.—The reorganisation of the electrical staff in Cardiff is being rapidly arranged by Mr. A. Ellis, who is having new offices secured in which the whole of the office work in connection both with electric lighting and traction will be done. Another sign of the progress made with the tramways is the laying of the first rail by the Mayor, who happens also to be the chairman of the Tramways Committee. There is a vast amount of hard work to be met before the whole of the tramways in Cardiff, together with the new lines authorised, can be worked as one system with electric power, and we trust that the various committees and engineers will work together in harmony so that all unnecessary delays may be avoided.

Proposed Statue of Dr. Gilbert.—A full-length marble statue of Dr. William Gilbert, who is happily described as the father of electrical science, is shortly to be erected at the instance of the members of the medical profession at Colchester. Dr. Gilbert was physician to Queen Elizabeth, and his work "De Magnete," published in 1600, laid the foundations of electrical science. The statue which is to be erected in his honour will be placed in a niche in the main façade of the new town hall at Colchester, a handsome building now in course of erection. The cost of the statue will be not less than £150, and towards this sum £130 has already been subscribed entirely by the medical men of the borough and its immediate neighbourhood.

Ocean Telephony.—On Monday last practically all the London daily papers had a note to the effect that the *Electrical Review* of New York had announced that Dr. M. J. Pupin had secured a customer for his patents for ocean telephony. These rights are said to be acquired by the American Telephone and Telegraph Company for a lump sum of £40,000, together with an annual remuneration of £1,500. From the information received we gather that a series of relays is contemplated at intervals along the cable. The idea itself is exceedingly old, and we have yet to learn how the inventor has succeeded in overcoming what have hitherto been the insuperable difficulties in connection with such relay working. It is to be noted that no less than eight relays per mile are suggested.

After-glow in Vacuum Tubes.—Mr. Percival Lewis has recently been experimenting largely on the fluorescence and after-glow phenomena which take place when an electrical discharge is passed through a vacuum tube showing traces of nitrogen, or even when the tube is filled with nitrogen. The full particulars of his experiments will be found in the *Annuaire Physicale.* The author finds that the after-glow is entirely due to small traces of oxygen present in the nitrogen. He concludes that this oxygen is liberated by the discharge from the small quantity of water vapour which is held by the glass. In proof of this he found that if the discharge tubes are first tried by heating sodium in them, he could get neither the fluorescence when the discharge was taking place nor the after-glow which was otherwise observed.

Depilation by High-Tension Currents.—As the result of experiments, Dr. Schiff and Dr. Frend reported an interesting action of high-tension currents on the skin at a recent meeting of the Vienna Society of Physicians. The authors' conclusions are published in the *Lancet*, from which it appears that when the hairy skin is exposed for 20 minutes to the silent discharge of the negative pole of a powerful Ruhmkorff coil, such as is used for the production of the Rontgen rays, the hairs commence to fall out, the hair-bulbs become atrophied after the third exposure, and some days later the portion of the skin which had been exposed becomes perfectly bald. The hair follicles become red and inflamed after the first two exposures. These observations seem to prove that depilation can be produced by the action of high-tension currents, and that the depilatory effect of exposure to the Rontgen rays may be accounted for in this way.

Institution of Electrical Engineers.—We are pleased to note that, in response to the petition of the members of this Institution residing in Birmingham and the district, the Council have created a Birmingham local section. Dr. Oliver J. Lodge, F.R.S., has been appointed chairman for the current year and Mr. Henry Lea, M.I.C.E.,

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vice-chairman. The committee consists of the following gentlemen: Dr. W. E. Sumpner, Prof. R. Threlfall, Messrs. Alfred Coleman, F. Brown, Alfred Dickinson, G. S. Ram, W. Wyld, and J. C. Vaudrey, and the hon. secretary (Mr. D. K. Morris). There is no special subscription, and the membership of the local section includes every member of any class of the Institution residing in Birmingham and the counties of Warwick, Stafford, and Worcester. The inaugural meeting will be held on Wednesday, the 23rd inst., when Dr. Lodge will deliver an address. Prof. Perry and Mr. W. G. McMillan, the secretary of the Institution, will be present on this occasion.

Automobiles.—The Automobile Club is doing good work in the defence of the users of self-propelled vehicles in this country. Their idea of inviting the various county councillors who object to reasonable speeds being obtained by automobiles to actually ride on the same, and so learn by personal experience that these speeds are safe, is a most excellent one. Up to the present over 300 gentlemen throughout the country have accepted the invitation of the club to witness trials which are to prove that the self-propelled vehicle of to-day is much more under control than any horse-drawn carriage can possibly be. Another scheme which the club has on foot, and which is fixed to come off on the 26th of next month, is an exhibition which is to be given to constables and the members of the executive of the County Councils' Association. It will be remembered that this association is promoting a Bill in Parliament with the object of limiting the speed of automobiles. We trust the invitations to this demonstration will be accepted, so that at any rate the promotion of the Bill will not be continued through ignorance of what can be done in the way of controlling such vehicles at speeds even higher than are allowed at the present time.

Electromagnetic Separators.—The use of magnetic separators for the concentration of iron ore is by no means novel, as they have been successfully employed in various parts of the world in order to decrease the large amount of useless material which under ordinary conditions finds its way into blast furnaces. We notice, however, a new application suggested for these separators by Dr. Elmer-Gates, of Washington. In connection with the dredging for gold which is now carried on in many parts of the world, it is often found that the gold-bearing sand contains a considerable portion of magnetic iron ore. In the ordinary means of washing, in which the gravity of the gold is relied upon to separate it from the sand, this magnetite is not easy to get rid of owing to its somewhat high gravity. According to our American contemporary, *Electricity*, Prof. Gates proposes to use the electromagnetic air separator to treat the gold-bearing sand before it comes through the ordinary process. In this way he claims that the after-troubles are reduced enormously, and that more gold is obtained because the magnetite is first removed. The cost of treatment is said to be only 1½d. per ton of sand treated. The iron ore so obtained might be considered a product worth having, but this, of course, is a matter for local consideration.

Electrical Definitions.—One of our North Country towns has recently been disturbed by allegations against the municipal electricity department. One outcome of the same has been a rearrangement of the members of the Electricity Committee and certain resignations. Perhaps it would not be incorrect to state also that the new leaders on the committee have a decided leaning towards the untechnical staff of clerks, as dealing generally with matters most easily understood by gentlemen of little electrical experience. Unfortunately, some technical knowledge is required even when dealing with estimates for new materials, as the following will show: At a Council meeting the electricity estimates were being discussed, one subject being "feeder cables and potential wires." A councillor asked the question, "What does potential mean?" Not one of the Electricity Committee felt called upon to answer the query on personal knowledge, and so a message was instantly sent to the above clerks, which caused consternation in their ranks. Not one could answer the momentous question, when a happy thought struck one of their number—consult a dictionary. This was done, and the meaning of potential wires was given to the Council as "Powerful wires, or wires existing in possibility, not in act."

Electricity Thefts.—We understand that a law has recently been passed in New York by which the theft of electricity from public mains becomes a penal offence. Up to recently it was a debatable question in the States, as it has also been in Germany, whether legal proceedings could be properly taken against a consumer who fraudently obtained electricity. Under the new statute in the New York State all interference with the meters will bring the person causing it under the law. Any person who makes connections to electric wires in such a way as to draw electricity from the mains without it first passing through the meters is equally liable. We understand that the Edison Electric Company, Limited, of New York, has had experience of a number of cases in which the meters have been tampered with. The most ordinary way consisted of bridging the meter in order to make it read low, while the connecting of a wire on the street side of the meter was also largely practised. One device which we had not heard of being tried in this country consisted in the boring of holes in the top of the meter and then inserting a wire to move the index hand backward. The new law will enable the company to proceed more rigorously against the offenders, who, after all, are only a small proportion of the consumers supplied.

Magnetic Declination.—With the issue of Jan. 11 the *Colliery Guardian* has issued a good map of the British coalfields, on which are given approximate lines and scale of magnetic declination. These lines are obtained from the great magnetic survey which has been made of late years by Profs. Rücker and Thorpe. Results of these surveys will be found, with many explanatory maps, in Vol. 188 of the *Philosophical Transactions*. In reproducing from these results, the editor of the *Colliery Guardian* has neglected small local variations on the ground that the mean values given of the lines are quite sufficiently accurate for practical use. The largest deviations from the mean values are not great, except in the neighbourhood of Birmingham and Derby, where they may be so much as ½deg. to ⅓deg. less than those indicated on the map. Reference is made in the description accompanying the map to the regular decrease in the annual value of the declination, which amounts to about seven minutes. There is outside this the daily fluctuation, which amounts to from five to fifteen minutes, according to the season of the year. The mean positions are, as a rule, found at about 10 a.m. and 6 p.m. The use of this information to engineers in coal mines is obvious, and the editor kindly offers to give more exact information, where possible, to any colliery engineers who write to him on the subject.

Proposed Memorial to the Late J. B. Lindsay.—The Dundee Technical Institute propose to erect a memorial to the late James Bowman Lindsay. This will take the form of a granite monument in substitution for the headstone which at present marks the place where the remains of the great scientist lie buried in the Dundee Western Cemetery. Speaking at the institute on Friday last, Sir John Leng, M.P., paid a high tribute to the memory of

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Lindsay. If not the first, he was certainly one of the first, not merely to suggest, but to exhibit wireless telegraphy, as well as to predict the wonders of electric illumination and power. He did not acquire fame or fortune like Arkwright, Stephenson, or Brunel. In some respects, Lindsay was born before his time—certainly before the modern time, when the commercial value of a scientific discovery is immediately estimated, frequently exaggerated, and commonly exploited for Stock Exchange purposes. One explanation of his failure to gain scientific renown was that he unwisely divided his attention between science and carrying out a philological idea which overtaxed his mental and exhausted his physical strength.

Electric Expresses.—The Emperor of Germany has always taken a keen interest in all developments in technical science, and by his kindly notice does much to further the commercial prosperity of his country. For instance, we learn that he has recently had submitted to him a lecture by the managing director of the Allgemeine Electricitäts-Gesellschaft on the possibility of electric traction on railways. In the course of an interview with this gentleman (Herr Rathenau), the Emperor was further informed of the combination of financiers and electrical firms who are taking up the matter. The experiments being carried on in connection with this syndicate have already been referred to in our columns, but it is worthy of notice that the Emperor of Germany has promised to do all in his power to promote the success of such undertakings in which it is desired to provide express services between the principal towns in Germany. The speeds hoped for on these lines are from 125 to 160 miles per hour. The electric cars, which would be used, would be all self-contained, and a frequent service of single cars would be organised. The accommodation of each car, it is estimated, will be about 50 passengers.

Electric Submarines.—The technical news available concerning the last trials in France of the submarine vessel, the "Morse," is exceedingly limited. We gather from indirect evidence, however, that the French engineers now recognise that they have much to learn from the designers in the United States. As now arranged, the "Morse" is wholly dependent on the electrical energies stored in secondary cells which it carries. While used for coast defence its range may be quite sufficient to render it useful in actual warfare, but if through any cause it should be compelled to go so far afield that its accumulators became exhausted, it would then be utterly at the mercy of the opposing fleet. The range of such a vessel will thus be dependent on the upkeep of its accumulators, which, as electrical engineers know, is not an inexpensive process. In the "Holland" the accumulators are only used to propel the boat when going beneath the surface. At other times the boat is propelled by an oil-engine, which can also be used to charge up again the accumulators. This seems to us to be the much more reasonable plan, and one which the French will do well to copy in their new submarine vessels. It is worthy of note also that in all the accounts of the trials of the "Morse" which have appeared recently in the papers, no mention has been made of the speed which was attained, nor of the accuracy with which she was steered.

The Ganz Traction System.—At the beginning of the week, Sir William Preece and Mr. T. Parker started for Budapest in order to report on the electric traction system which has been developed by the firm of Ganz and Co., of that town. The object of the visit is to make a report to come before the directors of the Metropolitan District Railway. The Ganz system of electric traction was referred to at the recent discussion on electric locomotives for main-line traffic read by Mr. W. Langdon before the Institution of Electrical Engineers. In it three-phase currents are employed at high voltage, no less than 3,000 volts being used on the overhead wires above the track. The novelty in the system is the employment of two motors in series when starting up. The first motor has its field connected with the collectors from the line wires. The rotor of this motor is connected to the field of the second motor, whose rotor can be regulated in the usual way. In consequence of this, much greater power can be attained when starting, as the frequency of each unit of the combination is half that of the supply. In the same way, when it is desired to stop the train by reversing connections, energy can be restored to the line until the speed has dropped to half of the maximum. We presume that the above engineers will inspect the experimental line which Messrs. Ganz and Co. have established in Budapest. This has given such satisfaction that considerable lengths of railway in Italy are being converted for electric traction.

Probable Anglo-Belgian Telephone Cable.—In his reply to the recent deputation from the Liverpool Chamber of Commerce in regard to delays in Continental telegrams, the Postmaster-General gives good ground for hoping that in the near future England and Belgium will be in direct telephonic communication. The Telegraph Administration of that country first raised the question whether, in the interests of commerce, a telephone cable, rather than a telegraph cable, should be provided. Experiments have been conducted with a view to ascertain the best type of cable for such a purpose, the distance between the two countries being greater than in any other case where a submarine telephone cable has been laid. In the course of these experiments the Department have laid a cable between this country and Ireland of an entirely new type, but although it gave great promise of success, it has not in actual practice proved to be suitable for telephone purposes. The matter is still being investigated, and the Postmaster-General trusts he may be in a position, in co-operation with the Telegraph Administration of Belgium, to provide a Belgium telephone cable. With regard to the proposal to establish direct telegraphic communication with Munich, Lord Londonderry cannot find that any promise was held out that a wire would be given to that city, and the traffic at the present time, he states, is quite insufficient to justify the expense. As to the proposal to construct new cables to Germany and the Netherlands, Lord Londonderry says the cable to the Netherlands has already been laid, and is in full operation. The cable to Germany was agreed upon in the early part of last year, and the necessary land lines to place it in communication with London have already been constructed in this country. The Anglo-German cables are the joint property of the two countries, and on this occasion it is the turn of Germany to make the contract for manufacturing and laying the new cable, which is expected to be put down in the spring of this year.

French Cables.—The Bill which has been introduced by the French Government to authorise the construction of a submarine telegraph which shall be wholly under the control of France, is an example of the exact estimates which can be given without conveying any conviction to the technical mind. If the Bill passes, a complete and independent system of cables and land lines clear of all English connections will be constructed. But we have not yet seen an estimate as to how far the cost of upkeep of these cables is to be met by the traffic to be secured. Under this Bill the following lines are proposed to be constructed, and in each case the cost is given exactly to one

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franc. In reducing it to English money we have neglected the last three significant figures. In the Atlantic, a cable from Rochefort to Dakar, 2,224 miles, to cost £810,000; Dakar to Buenos Ayres, 5,874 miles, £1,788,000; Dakar to Kotonou and Libreville, 2,168 miles, £531,000; Libreville to Mossamedes, 1,074 miles, £301,800; making a total for the Atlantic, with £40,000 for a cable steamer to effect repairs, of £3,470,800. In the Indian Ocean the Támatáve to St. Denis lines, 381 miles, to cost £933,000. In the Chinese Seas, Saigon to Shanghai, and Port Arthur and Taku, 2,865 miles, £800,000; Saigon to Batavia, 1,291 miles, £378,000, making a total for the Chinese Seas, with £28,000 for a cable steamer, of £1,206,000. In the Levant, Bizerta to Sebastopol and Bayrouth, 2,173 miles, £392,500, making, with a cable ship costing £28,000, a total of £420,500. The land line would comprise a line from Macao to Canton, Taku to Tien-Tsin, and Ergasteria to Athens. The total cost of this network is estimated at £6,030,300. This, however, is but a first instalment, the Bill foreseeing that in the future it will be requisite to establish other lines, which would cost an additional sum of about four million sterling. We doubt, however, if there will be any serious attempt made to pass the Bill, which is said to have been proposed from political reasons only.

Motor Slip. — Mr. E. Hospitalier, in *L'Industrie Electrique*, refers to an interesting method of ascertaining optically the slip which is taken in an alternate-current induction motor. The principle of the method is the same as that to which we have often referred, of ascertaining if one alternator is not parallel with another. In this case, however, it is proposed to use incandescent lamps to light up the disc which is mounted on the motor spindle. On this disc, black and white segments are painted of a number double of that of the poles of the motor. The actual light given by the incandescent lamp is not constant, although it appears so to the eye. If, then, the motor were absolutely synchronous with the alternator, the optical effect would be the same as though the disc were not revolving. In the case of the induction motor, where the revolving part has a certain amount of slip depending upon the load, the effect is to produce an apparent slow rotation of the disc. The number of revolutions which the disc appears to make can then be counted, and this number is the equivalent of the difference in angular velocity between motor armature and revolving field. We should have thought the effect would have been much more easily seen if an arc lamp had been employed. Another suggestion is made in which the same means would be employed to determine the irregularity in running of an alternator throughout one revolution. As is well known, the uneven turning moment of an engine results in a displacement of the alternator armature from the position which it would occupy if the motion were absolutely uniform. This displacement causes strains in the system, and large synchronising currents if the displacement is much. The method suggested of ascertaining the irregularity consists in having a synchronous motor with a flywheel, which would be driven at a high speed by the alternator. Owing to the flywheel action, this motor would run practically at constant speed. On its axle would be mounted the black and white disc referred to above, which would be lighted from an incandescent lamp in the alternator circuit. The effect of irregularity in the alternator driving would then produce an apparent motion to and fro of the white spaces in the disc. The method has been tried on an alternator with a frequency of 40 periods per second, and while the vibration to and fro could be seen it was not easy to measure the actual displacement. It is suggested, however, that with alternators designed for lower frequency actual measurements might be obtained by this method.

The Central London Railway.—The interesting correspondence is still continued in the *Times* as to the responsibility of the above railway for the damage it has done to the surrounding property. Thus Mr. M. Powell, writing to the *Times* on the 11th inst., asserts that the company have no power to take the subsoil of the public streets gratis. He adds that in their Bill they proposed by a certain clause to have such power. In consequence of this gentleman's opposition with others, however, the clause was struck out, and the company only obtained the right to enter upon, take, and use the subsoil. Under this clause, which is the same as is always used with respect to surface land, the correspondent holds that the company must pay compensation before they can lawfully enter on the land. How far Mr. Powell may be right in his law we have not the legal knowledge to decide, but we think he is wrong on the question of fact. The Central London Railway Company has not paid to the freeholders anything for the use of the subsoil, except in those cases in which it has had to buy house property in order to construct railway stations. The great advantage of the method of construction employed in these deep-level lines is that no land has to be bought so long as the tubes are kept under streets and not under houses. The vibration troubles which have been caused by the Central London trains have in many instances been exceedingly serious. The Board of Trade committee which is now looking into the matter will report, we are afraid, against the company, but the legal question will then still have to be settled. The vibration, however, is not due to a cause which could not be prevented, as it is largely the result of the use of heavy electric locomotives instead of distributing lighter motors throughout the train. The great weight of these locomotives produces a pounding action on the rail joints, the destructive effect of which increases as the joints give way. Perhaps the least costly experiment to try, in order to avoid present troubles, would be to provide cast joints between the adjacent length of rails instead of using the present method of connections. The first sitting of the committee appointed by the Board of Trade to consider to what extent the working of the traffic on the Central London Railway produces vibration in the adjacent buildings, was arranged to be held last Friday, but it was postponed until this week. It has not yet been decided whether or not the public will be admitted to the meetings.

Telpherage. — It will be remembered that in the early days of electrical engineering in this country some interesting and successful experiments were made on telpher lines with electric traction. We believe that the first ideas on which these lines were built and equipped were due to the late Prof. Fleeming Jenkin, and three or four lines were made which did commercial work for a number of years. The electrical equipment of these was, of course, limited by the then knowledge of the construction of electric motors, which can be made much more serviceable at the present time. We notice that the Consolidated Telpherage Company, of 20, Broad-street, New York, has taken up this work, and is achieving considerable success in the transportation of raw materials automatically. The great difference in the connection between the telpher lines equipped by this company and those in use in England some 15 years ago, lies in the fact that there is now no reversal of current when the electric motor gets over the supporting points of the line. On the old English system, each section of the line between any two posts was always of the opposite potential of that of the two sections which were before and after it. There was a collector both

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at the front and rear of the line of skips. The length of the train was so adjusted with respect to the constant length of the section of the line that the rear contact was always on a section at the opposite potential of the section on which the front contact rested. This involved an interruption in the current as the contacts passed over the supports of the line, and this interruption was objectionable. In spite of this, as we mention above, good work was done. In the new system of organisation by the American Company, the wire supporting the load is used as the return wire, while over it is strung the trolley wire which feeds the motors. In all the illustrations which we have seen of the system the skips are each equipped with motors, and there were no trailers, as were absolutely required in the English system. The weight to be carried in the one carriage can be as high as 1,500 tons, and the system seems eminently satisfactory for a large number of purposes. Amongst these is the transportation of clay in brickfields, and all like undertakings in which comparatively small quantities of heavy material have to be moved regularly over a varying distance. The telpher line is much more easily extended to meet the workings than is the case in a number of types of railways, especially when serious changes of level are met with.

Telephones in France.—In the December number of the *Journal Télégraphique*, which is published in Berne by the International Telegraph Bureau, an interesting *résumé* will be found of the history of the development of the telephone industry in France. Unfortunately, the article referred to is not concluded in the issue in question, but the early history is completed, and it is of special interest to British towns which propose to establish municipal exchanges. The writer of the article contends that France has always taken the lead in telephone matters, and that Paris was the first town in the world to have a complete network for the interchange of telephonic messages. Again, the Paris-Marseilles line was for a considerable time the longest line in the universe. The line between Paris and Brussels was the first telephone connection between two different countries, while the first submarine telephone cable was laid between France and England. In the early days it was recognised that telephones came under the telegraph monopoly, and accordingly only limited concessions were issued in 1879 to permit of private individuals establishing telephone exchanges. Three persons applied, and under the licenses granted they organised telephone exchanges in Paris, Lyons, Marseilles, and Bordeaux. These three concessions were afterwards united and owned by the Société Générale des Téléphones. The concessions were renewed for five years in 1884, but the whole undertaking of the company was purchased by the Government in 1889. The terms of the concessions as regards royalties were exceedingly like those between the National Telephone Company in this country and our own Government, in that 10 per cent. of the gross receipts had to be paid to the Government. When the telephones were taken over by the French Government, considerable extensions and improvements were made, and in the article there will be found a brief *résumé* of these, together with the terms that various classes of consumers have to pay. The progress made as far as Paris is concerned is indicated by the following figures. When the system was taken over in 1889, there were 6,255 subscribers. This figure had increased up to 28,679 in 1899. The number of connections made between subscribers, which, of course, is the same as the number of conversations which took place, amounted to no less than 112,000,000 in 1899, as against some 31,000,000 in 1891. Some interesting information is also given with respect to the growth of the telephone industry in the provinces. It is most characteristic that the telephone has been most successful in those towns which were not exploited in the first instance by the old telephone company. This is shown by comparisons made between some 21 of the larger towns. The comparison is made on the number of inhabitants in each case for every telephone subscriber. We presume that the continuation of this article will complete the information as to the present equipment of trunk lines for the inter-urban telephone service in France.

Electrolysis and Water-Pipes.—In the spring of last year we had to refer to a paper by Mr. D. H. Maury, which was read before the American Waterworks Association, on "Electrolysis of Underground Metal Structures." Amongst the instances given by the author of damage caused by the leakage currents from the earthed returns of electric tramways was a collapse of a standpipe at Peoria, Illinois. We are pleased to see Mr. A. B. Herrick has looked into the particulars of this collapse, and in an able article in the *Street Railway Journal* he shows that Mr. Maury was not correct in his conclusions. From the illustration which is given by Mr. Herrick, we gather that the standpipe in question was situated 60ft. from the line of electric tramways from which the leakage was supposed to take place. A 16in. water-main passed from the standpipe directly under the track, and it was assumed that this pipe acted as the return for the currents which caused the damage. The inner surface of the iron plates forming the standpipe were deeply corroded, and it was to this corrosion in the inner surface that the collapse was due. In order that this might be the case, the current had to pass through the 60ft. at least of earth, up through the concrete base, into the middle of the standpipe. After doing so, it had to neglect entirely the 16in. main, which undoubtedly was the path of least resistance between the railway and the standpipe. The current then had to pass from the inner surface of the standpipe to the exposed end of the 16in. water-main which supplied the same. The current had also to pass from the inner surface of this standpipe to the projecting length of the connection inside the same through the water, although there was the direct metallic connection between the two. Mr. Herrick measured the actual resistance of this metallic circuit, and found that it was only $\frac{1}{890000}$ of the resistance of water. In other words, the national laws of electricity would have to be distorted in order to account for the depreciation of this standpipe from electrolysis. Having thus disposed of the forced assumption that in this case the earth currents from the tramway lines were to blame, Mr. Herrick explains that the real cause for the corrosion may be accounted for from the fact that the standpipe structure was supplied from a different source than the inner pipe above referred to. The iron of the standpipe contained much phosphorus and carbon, and was hence exceedingly liable to be corroded by water. The author's conclusion is that a large number of instances of corrosion are now being laid to the charge of stray currents from electric tramways which, in fact, are entirely due to the ordinary corrosion which takes place in metal structures when no stray current of electricity is passing into or out of the same. He also shows, in view of the high resistance of the soil round the standpipe in question, that any measurements as to the potential difference between metallic structures in the ground are not at all useful in determining whether electrolytic action to an appreciable extent is actually taking place. What one requires to know is whether a considerable current is passing between the two conductors in question.

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PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 43.)

No. 3.—Cable Testing.

Although in some central stations the mains engineer is not called upon to do his own testing—there being a man, designated "test clerk," specially told off for this work—still it is essential that he should have a good knowledge of the various methods in use for testing, and of the instruments necessary for these tests. If there is such a test clerk, the engineer should impress upon him the necessity of taking extreme care of his instruments, seeing that they are always carefully handled and properly packed away after tests have been taken. If, on the other hand, the engineer does his own testing, he should as nearly as possible always handle the instruments himself; he will thus get to know the ways of his instruments, and his tests will always be reliable.

It is not intended here to propose new formulæ or new tests, but simply to record some few tests which are known to be of use, and which, in the case of fault localisation, have been proved to be successful. For the general study of testing and for general reference, the engineer is advised to use some of the well-known text-books on the subject, such as Kempe's "Handbook of Electrical Testing," and C. Raphael's "Localisation of Faults on Electric Light Mains."

The first tests, then, which concern the mains engineer are those tests taken at the works of the cable makers, according to the specification for the cables Chief engineers vary very much in their views with regard to the necessity for these tests at makers' works. Some test only a percentage of the total drums; others test all, except for the bending test, which is usually only taken once at the commencement of an order. It rarely happens nowadays that a cable is allowed to leave the works in a faulty condition, whether tests are imposed or not, as the maker generally has to give a certain guarantee, and also has his reputation to think of. However, it is much better for the peace of mind of all concerned that the cables—probably all of them—should be tested before they are buried in the ground; at least for insulation between one conductor and another, and between conductors and sheathing; also the high-voltage test for breaking down is a most important one—probably the most important. Some specifications impose a breaking-down test before armouring and one after armouring, but this seems to be hardly necessary, and all tests might be left till the cable was entirely finished with the exception of capping up.

The tests, then, which are usually made are for insulation, inductive capacity, copper resistance, and the high-voltage test. For all tests but the latter it is usual to specify the temperature at which the tests are to be made, therefore if the tests are not made at this specified temperature they should be corrected to it. The cables are usually tested standing in a tank of water in which they have been immersed for 24 hours immediately previous to the tests; the temperature can therefore be easily taken As to the order in which the tests should be made, it would probably be better that the high-voltage test should be taken first, as then the effect of the high pressure would be taken into account. The method of taking this test is to apply generally for a quarter of an hour a current at high voltage to the conductor, or conductors, each in turn, the others being connected to the sheathing, which, of course, puts them at earth potential through the water in the tank. The pressure applied so is generally four times the pressure at which the cables are intended to be used. The current applied is generally generated at low pressure and transformed up by two or more steps till the required pressure is obtained. By the use of a large choking coil on the primary or low-voltage circuit, the pressure can be applied and taken off very gradually. This gradual application and withdrawing of the pressure must be strictly adhered to, otherwise many cables may be spoilt which would have stood the test well had the pressure been properly applied. Any cables which do break down under this test usually go during the first five minutes. But very few cables do break down.

The next test to be considered is the test for insulation, this being taken between one conductor and another and between each conductor and earth. Readings on the galvanometer scale should be noted after electrification for one minute and after two minutes, the reading after one minute being the one from which the test is to be calculated. The two minutes' reading is used for ascertaining the rate of fall of the current, which in a good cable is very even. It will be found that temperature plays an important part in this test, much more for some dielectrics than others. Vulcanised bitumen is very much affected by changes of temperature, the insulation resistance, of course, falling as the temperature increases. Very few cables have to be rejected on account of low insulation resistance, most of them passing with a large margin.

The third test is the one for capacity. This is not often taken, as in many cases the engineer in charge of the generating plant, especially where the supply is at a high pressure, and therefore comparatively small current, would wish the cables to be of a higher inductive capacity than they are, so as somewhat to minimise the effect of suddenly applied loads. And again, it is very doubtful if the same tests would obtain after the cable has been laid and jointed. What seems to be of most consequence is the variation between the capacity of one conductor and another in the new three-phase cables. It can easily be understood that this might mean a great deal. When this test is taken, however, if it is to be used for comparison of one drum with another, temperature must be noted, but if only for comparison of one conductor with another in the same cable it need not be noted. The charge deflection should be read on a fairly open scale, and compared with the deflection obtained from a standard condenser of known capacity.

A very important test is the last—the test for copper resistance — for it depends upon the percentage of pure copper what loss will be sustained as waste energy in the mains, and in a large system of supply this is an important item. This test is usually made by a fall-of-potential method. The fall of potential is taken across a known resistance and then across the cable; the unknown resistance can then be calculated. The instrument most liked for this test is the potentiometer, as it is direct reading. In taking this test, the ends of the cables under test should be sweated solid and sweated to the leads, as it is most important that good connections should be made. Dipping the cable ends into mercury-cups is not advisable, as frequently beads of the mercury find their way along the strands of the cable, afterwards doing great damage to the joints on the cable, besides so good a connection cannot be obtained. In the test for resistance, it is important to note temperature, as, unlike insulators, the resistance of conductors increases as the temperature increases; therefore, the test taken at the absolute temperature must be corrected to the specified temperature.

The bending test, before mentioned, is usually taken on one drum of cable out of the first batch made for a new contract It consists of the bending of a piece of cable—say about 4ft long—which is cut off the drum selected, round a drum of specified diameter three times in one direction and three times in the opposite direction, the piece of cable being straightened out after each bending. After the bending, the cable is placed in a tank of water, the tank being earthed, and pressure is applied to the conductor (the ends of the cable, of course, being out of the water): the pressure so applied is gradually raised until the insulation gives way. This breaking down pressure is noted, and if above the specified pressure the cable is allowed to pass. The diameter of the drum, of course, varies with the size of the cable; for a single-conductor cable of 1in. core the diameter would probably be specified as 2ft. 6in. The cables having satisfactorily passed the specification tests can forthwith be dispatched to the job and laid as convenient.

The next tests which are nearly always taken are taken after laying, and consist of insulation and high-pressure tests. The latter is often omitted from low-tension cables, although to ensure good working these should always be so tested to at least a pressure of 1,000 volts. High-tension cables should be tested with a pressure equal to double their intended working pressure As before stated, high pressure must be applied and taken off the cables by very easy stages. Cables often break down through cutting off the testing pressure quickly while at its maximum through induced

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currents, which are often discharged at a very high voltage. Even when testing with a pressure of only 4,000 volts, a spark at the far end of the cable can often be observed at the moment of breaking the circuit; the spark will in many cases be as long as 1in, thus showing that the voltage was very high.

To make these high-pressure tests, it is usual to tap the low-pressure distributors at some convenient place and to raise the pressure by means of transformers, having inserted a variable resistance in the low-pressure circuit. A water resistance will be found to answer admirably, as the pressure can be raised by dropping in small quantities of sulphuric acid until nearly at the required pressure, which can then be attained by closing the plates slowly. This method, of course, can only be adopted where the supply current is alternating. Where the supply is continuous current, a special motor-generator will be found to give good results if properly designed. This would, with transformers, be mounted on a strong enclosed truck, and would be moved by horses. The generator should be designed to give a pressure of about 500 volts alternating, and should have a resistance inserted in its field capable of small variations; pressure can then be raised or lowered very gradually. The transformers for use with this generator should be capable of carrying a current of at least three amperes on their secondary or high-pressure windings. The instruments required for this test are a voltmeter and an ammeter on the low-pressure circuit, and a portable voltmeter to be connected at the far end of the cable under test. If, when applying this test, the current measured by the ammeter is found to be increasing, and at the same time the voltage decreasing, a breakage may be expected on the cable under test. If such occurs, it will often be found on examination to have been caused by a pin point of brazing metal or solder where one of the strands in the conductor has been joined. Or if the cable has been lying in the ground for some considerable time before testing, water may have entered through a fracture or pinhole in the sheathing.

The test for insulation, which is usually taken previous to the high-pressure test, may be taken with a Kelvin testing set, although a mirror galvanometer is to be preferred From the absolute test so taken the insulation resistance per mile can be calculated. If this comes out fairly near to the specified resistance per mile of the cable before laying, it may be taken for granted that the cable has been carefully laid. The insulation resistance of the cable so tested should be carefully booked for comparison with periodical maintenance tests to be taken when the cable has been put into general use. Only so are galvanometer tests of use, it being well known that although a cable has broken down through pressure while in work, it may yet give a very high insulation resistance if tested with a galvanometer, thus showing clearly that single galvanometer tests do not show the actual value of the cable.

These maintenance, insulation, resistance tests should be taken as far as possible on all cables in use. Feeders especially should be so tested at least once a month, and distributors, because they are often being tapped, should be tested more frequently; the tests in both cases being accurately recorded. It will always be found that insulation resistance tests come out lower in summer than in winter, due probably to end effects. This matter will be again mentioned under the heading of "Sub-Stations." For these maintenance tests an ohmmeter with a generator is often used, but cannot be recommended where reliable results are desired, it being much better to use a galvanometer set, such, for instance, as a Kelvin, a Nalder, or a Silvertown.

(To be continued.)

THE ELECTRIC LIGHTING OF THE LIVERPOOL ROYAL INFIRMARY.

BY E. S. BRADBURNE, A.M.I.C.E.

Ever since the Royal Infirmary was built, 13 years ago, the wards have been lighted by means of gas standards placed down the centre of the room—a method of illumination which did not provide for the close examination of patients during the night when performing surgical dressings, nor did it enable any of them to have the pleasure of reading in bed. The substitution of electric lights in the wards is undoubtedly a great advance in the system of lighting, besides ensuring greater cleanliness.

The installation, consisting of 254 lights, is the generous gift of Mr. G. H. Melly, of Liverpool, who entrusted the design and carrying out of the work entirely to Messrs. H. T. Boothroyd, Hyslop, and Co., of Bootle. This firm has made many distinct improvements upon the methods usually adopted for the lighting of hospital wards. When carrying out the work, every precaution had to be taken to protect the wires from damage by water, as the walls, consisting of

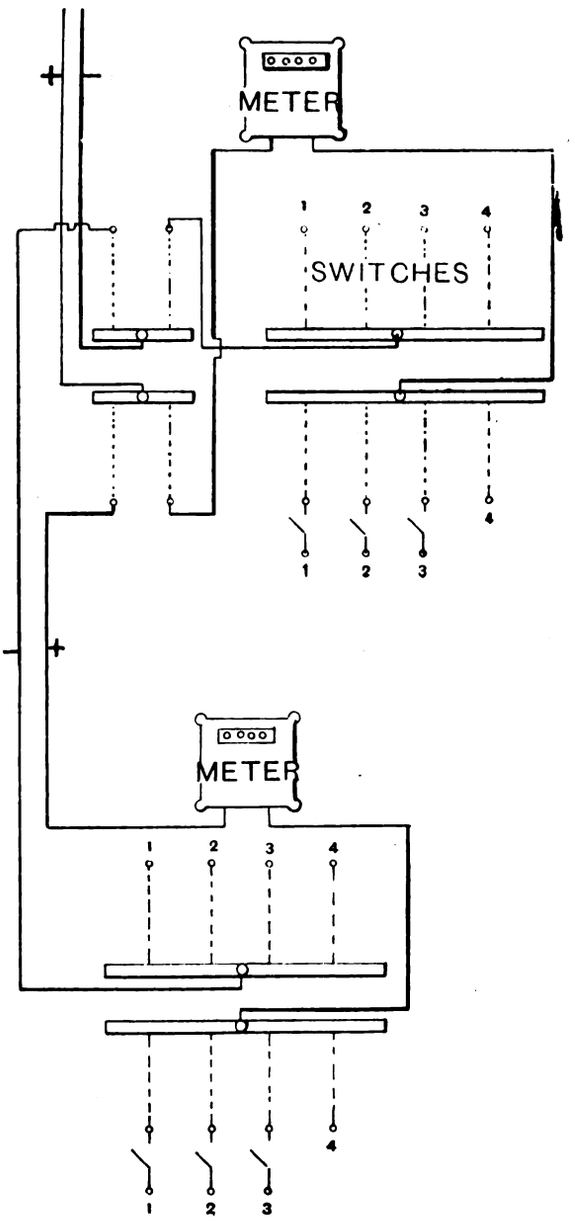

FIG. 1.—Diagram of Connections to Distribution Boards at the Royal Infirmary, Liverpool.

enamelled white bricks, are washed down once every year with a solution of caustic soda and soft soap; also all the fittings had to be so designed as to attract the minimum of dust. The wires were therefore run in Simplex brazed conduit, secured off the walls by brass saddle pins driven into the joints of the bricks. In the corridors the conduit was secured with saddles on to beech battens.

The supply is taken from the Corporation mains at 230 volts, the wires being run throughout the building on the distribution-board system. A main cable supplies current to one main D.P. distribution fuseboard on the top floor. These circuits are used to supply current to the 12 wards—six on the first floor, and six directly over on the second floor. Two remaining circuits are at present left vacant with a view to future extensions. The distributing cables are run in casing along the air-shafts in the roof, and carried down the wall in steel conduit to a distribution switchboard at the

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right-hand side of the entrance to the ward. Each fuseboard is protected by a glass-fronted teak case, lined with asbestos, with lock and key.

Fig. 1 shows the arrangements of the circuits from each of containing 32 beds has 16 lights, eight on each side, and four ceiling lights down the centre of the room. In the photographs (Figs. 2 and 3) it will be noticed that the porcelain switch and ceiling rose are fastened on to a com-

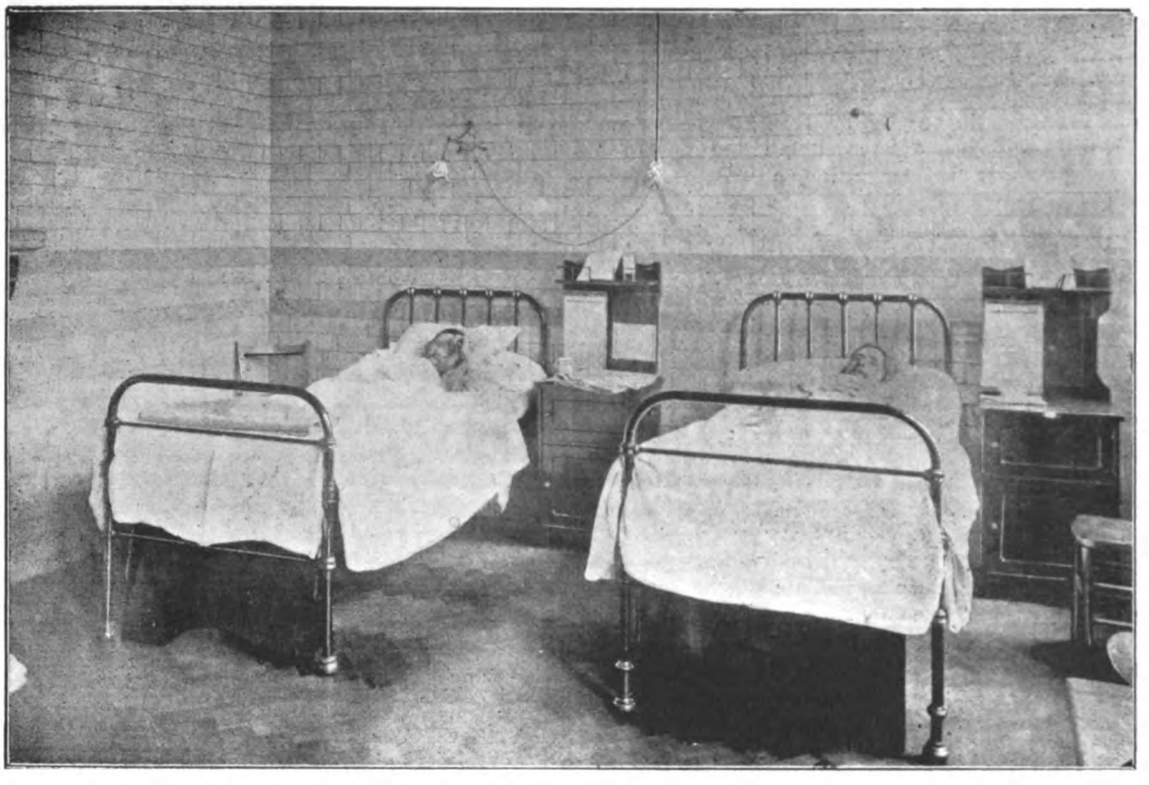

FIG 2.—View of Two Beds with One Light which can be placed over either Bed.

these boards; it will be observed that the current for the lights in each ward passes through a meter. The three switches on each board are for controlling the side and ceiling lights respectively, there being also a separate switch for each bined base of special design in brass having a foot cast on, by which it is secured to the wall. Connection is made to the lamp bracket by flexible wire of sufficient length to enable the bracket to be carried to the adjoining bed. The

FIG. 3.—View of a Ward in the Liverpool Royal Infirmary. By the second bed will be noticed one of the Electric Fittings used as a Standard Lamp.

light in the ward. The lighting circuits in the upper wards are run in casing over the ceilings, a pair of tappings being taken off for each light, and led down through the ceiling in a steel conduit to a combined switch and ceiling-rose fitting fastened on to the wall over each alternate bed. A ward portable lamp brackets are very ingenious, being available for use as a pedestal light or as a wall bracket by hanging it on to a screw button, and movable to any angle to suit the patient's convenience.

The circuits for lighting the lower wards are run under

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the floors, a pair of tappings being taken off for each light and carried up through the floor in iron gas-pipe specially strong to stand accidental knocking when moving the bed to a combined switch and ceiling-rose fitting. In order to avoid any trouble from water running down through the floor where the pipes come up the following plan was adopted: The floors of the wards are made of coke breeze and cement, with a layer of oak parquetry on the surface. The holes for the pipes through the coke breeze and cement were drilled ¾in. diameter, and subsequently enlarged to 1½in. to a depth of 1½in. through the oak parquetry. The pipe was then secured in position and the hole caulked with oakum to a depth of 1in, the remainder being filled in with a patent composition which always retains a certain amount of elasticity. Every point in the building was wired for 16-c.p. lamps, with the exception of the ophthalmic department, where 32-c.p. lamps will be used. The circuits for this department and the out-patient's rooms are controlled by a D.P. fuseboard, taking its supply from the fuseboard of the ward above. Combined switch fittings, similar to those in the wards, are supplied in the six ophthalmic rooms, the ceiling rose being substituted by a H.V. wall plug, thereby enabling any type of lamp up to 32-c.p. and bracket to be easily connected.

The number and position of the lights at present installed are: in the 12 wards, 40 ceiling lights and 140 side lights; in the 14 isolation wards, 22 side lights; in the six private wards, seven side lights; small operating theatre, three ceiling lights; Thornton ward, four bracket lights; out-patients' department, five ceiling lights; ophthalmic rooms, nine side lights; dispensary, seven ceiling lights; recreation theatre, 12 ceiling lights; three clinical rooms, three side lights—a total of 252 lights.

In the switchroom a galvanic and faradaic board has been provided, the voltage being reduced by using 32-c.p lamps. All the ceiling lights are rise-and-fall pendants of the ball absorber type and work on the principle of the differential pulley; they are much lighter than the earlier type, due to substituting wooden pulleys for lead ones. All the conduit in the building is painted with white enamel to match the walls, thus making it hardly noticeable; the finish of the lamp brackets being a dark bronze, and the general appearance of the whole installation very pleasing to the eye. It is hoped that this system of hospital lighting will be adopted in other buildings of similar type, and be carried out in an equally efficient manner.

The Liverpool Royal Infirmary is to be congratulated on its latest acquisition.

SOME OF THE REQUISITES OF MODERN LIGHTING GENERATOR SETS.*

BY H. G. REIST.

At the Washington meeting of the A. S. M. E. in May, 1899, a very interesting and stirring paper was read by Mr. Stanwood on "Standards for Direct-Connected Generator Sets." So far as I know, this was the first time that the desirability of the engine and dynamo builders getting together and trying to make their designs interchangeable as far as practicable, was brought before the public. Its importance was at once realised, and action taken towards improving matters by the appointment of a committee and inviting other organisations interested to co-operate. I understand these committees are taking up the standardisation of speeds of engines as well as the proportioning of certain parts that affect the two pieces of machinery, such as dimensions of base and the diameters of the engine shafts.

It will not be possible to fix absolute speeds for engines used for directly driving alternate-current machines, because currents of various frequencies are used for different classes of work, and dynamos must be built with an even number of poles, or, better yet, with a number of poles that is divisible by 4. The ordinary frequencies used are 25, 40, and 60 cycles per second in this country, but in Europe the usual frequency is 50 cycles. To illustrate the variation in speed necessary for the various frequencies: for 60 and 40 cycles, a speed of 220 revolutions per minute may be used, but for 25 cycles the speed must be 187 or 214—preferably the former. Similarly we can make 60 and 40 cycle dynamos to operate at 100 revolutions per minute, but the 25-cycle machines must be driven at 94 or at 107. In working over a list of speeds for the various frequencies, it will be found that a mean speed may be selected which in no case need be much departed from, so that it seems perfectly practicable to select a range of speeds for the various sizes of engines at which they may be run without any changes, except an adjustment of the governor. Then, by a careful selection of sizes best ranged in geometric progression, it will be feasible to keep down the number of machines very greatly, leading to duplication, thus to the practicability of making special tools for more of the parts and also to stocking parts, and the ability of making quick deliveries.

We have given considerable thought to the selection of a range of sizes, and have come to the conclusion that if the units were so spaced that each one has a 50 per cent. increase over the one below it, there will be a sufficiently large number of machines to meet all ordinary conditions. This conclusion is also sustained by having had a practical application in lines of generators and motors spaced about in this way, and it is a rarity that it becomes necessary to go to the expense of developing anything in between. This method of determining sizes will necessarily make some of the machines on the list with odd ratings, but this will occur in any case—in many instances with either the engine or generator, since the one is rated in horse-power and the other in kilowatts.

A list of sizes of generators and speeds that has been proposed is shown in the following table:

Kilowatts.	Speed.	Kilowatts.	Speed.
60	250—276	450	125—133
90	240—257	450	94—100
133	214—225	675	133—138
200	187—200	675	120—125
200	150—150	675	90— 94
200	107—112·5	1,000	120—125
300	150—150	1,000	82— 85·5
300	125—138	1,500	107—112·5
300	106—109	1,500	75— 80
450	150—150		

The variation in speed given allows the same engine to drive generators for the three frequencies standard in this country. It will be noted that, with very few exceptions, the total variation in speed is less than 10 per cent.—in most cases being only about 2½ per cent. from a mean speed. For each capacity given, except the smaller ones, several speeds are proposed to accommodate the different types of engines.

In all reciprocating engines there is an intermittent speed, due to the crank, the speed gradually increasing during a stroke until such a time when the power applied is less than the mean power absorbed, after which the speed gradually decreases until steam is again admitted. It will thus be seen that with a single-crank engine there is during each stroke—*i.e.*, each half revolution—a period of increasing speed—then, again, one of decreasing. With two cranks at 90deg. there will be four such periods during each half-turn. With cranks set 120deg. apart there will, of course, be six such periods. The amount of fluctuation in speed is dependent on the number of cranks, the weight of the reciprocating parts, the length of the connecting rod, the proportioning and adjustment of the valves, and the weight of the flywheel. It is desirable to keep the variation within certain limits, on account of the parallel operation of generators, but more particularly to assure the satisfactory operation of synchronous apparatus, such as synchronous motors and rotary converters, from such circuits.

When two generators are running in multiple their mean speed will be the same, but as the speed is variable as mentioned there is an instant during which one of the generators runs a little faster than the other. It will be seen that its potential wave will then get ahead of the wave produced by the other machine, and in consequence current will flow into the second machine and tend to drive it as a motor. A little later, when the engines are a little

* Paper read at the annual meeting of the Engine-Builders' Association of the United States.

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further along in the turn, the conditions will be reversed. This will produce cross currents between the machines, which should be avoided. It might be prevented with duplicate sets if the engines were synchronised—*i.e.*, if they were run with the cranks of the machines in the same relative position. The angular velocity of one engine is then the same as that of the other engine at all times. But this is not a practical method of operation. This fluctuation is also liable to make synchronously-driven electrical machinery drop out of step. In practice the allowable variation is usually given in displacement in degrees of any point on the rotating mass from what it would have if the motion was perfectly uniform, which gives a value that is independent of the number of cranks of the engine. Steam-engines intended for direct connection to dynamos should not have an angular deviation in degrees of more than 2½deg. to 3deg. of phase; or dividing the number by one-half of the number of poles of the generator to be driven, will give the allowable angular deviation in terms of degrees of the rotating mass. Thus, a 40-cycle machine should be driven by an engine whose motion is so uniform that a point on the rotating mass will not vary more than $\frac{2{\cdot}5}{20} = \frac{1}{8}$ of 1deg. from the position it would have if the motion was perfectly uniform.

In order to obtain this result, it is necessary to have a flywheel of sufficient size, the weight of which depends on many things relative to the proportioning of the engine, and cannot be given except for special cases. It is desirable for many reasons to so design the engine as to get along with as small a flywheel as possible. If the weight is too great, serious trouble may be experienced in trying to operate the machines in multiple, because the governor cannot control quickly enough and the machines will be sure to hunt. The connecting rods should not be made too short, as this will distribute the load unequally so as to require a heavier wheel than otherwise, to keep within assigned limits of variation.

From various sources I have obtained data regarding the flywheel effect necessary to meet the above degree of regulation, and think a safe figure for well-proportioned engines is expressed by the formula:

$$\text{Weight} = \frac{C \times KW. \times 100^2 \times 5{,}000^2}{R.P.M.^2\ (\text{speed in ft. at rad. of gyration})^2}$$

in which C is a constant having the following values:

—	Horizontal single-crank.	Horizontal cross-comp.	Vertical cross-comp.
25 cycles	65	40	60
40 cycles	104	64	96
60 cycles	156	96	144

I believe the values in this table are very safe, and it will probably be possible to meet the given conditions with a wheel considerably lighter in weight.

It would naturally be expected that a three-crank engine, with cranks placed 120deg. apart, would require a lighter flywheel than one with two 90deg. cranks, but in working out the forces of compound three-cylinder engines it has been found that the weight of the reciprocating parts and the distribution of the load between the various cylinders predominates, so that no appreciable better results are obtained than from a two-crank cross-compound engine.

Ever since alternating-current machines have been built parallel operation has been discussed. At first it was tried with very great caution, but it is at present the usual method of operation, and experience has taught us that any two alternators of the same frequency and potential will operate in multiple satisfactorily if they are allowed to do so by the prime motors. No trouble is experienced in operating machines in multiple when they are driven by water-wheels. There are also many installations of steam-driven alternators (ofttimes of different types) — both belted and direct-coupled — operating satisfactorily in multiple.

The principal trouble experienced in the parallel operation of alternators is due to the variation of the speeds of the machines with reference to each other, producing oscillations in the relative motions of the two alternators. This produces cross currents and variations in the cut-off of the engines. The engines will then race or hunt.

In some cases the amplitude of these oscillations is limited in extent, while in others their force is liable to accelerate with more or less rapidity until the machines drop out of step. In some cases the machines may run in parallel for a considerable period of time, when, by some change of conditions, oscillations will begin which may throw the machines out of step in a few seconds. The power to produce these impulses or oscillations comes naturally from the steam, and they are caused by the intermittent action of the engine governors, which in their efforts to adjust themselves to compensate for the speed variation cause a periodic delivery of steam. The delivery of steam by jerks keeps up the oscillation in the same manner as the pendulum of a clock is kept going. This trouble can be stopped in most cases by the use of a dash-pot to dampen the action of the governor. The ordinary dash-pot is a device well known to engine builders, and was used to prevent racing in engines long before the parallel operation of alternators was practised. It is possible by its means to run the engine with closer regulation of speed between no load and full load than otherwise, although the governor will not act so quickly, so that there will momentarily be a greater variation of speed than if the dash-pot was not used. But experiments have shown that the dampening effect need not be so great in ordinary cases as to impair the speed control seriously. The frequency of this variation seems to be affected by many conditions, such as the flywheel effect of the rotating masses on the engines, the period of the engine impulses, the synchronising power of the dynamo, and probably by the flywheel effect of any synchronous machinery driven by the current from the dynamos.

The degree of retardation of the governors required for proper parallel operation must depend upon the combination of these effects, and is consequently difficult to predetermine. It will therefore generally be advisable to adjust the governors by experiment, and for this purpose engines should be fitted with adjustable dash-pots of ample size, so that the governors may be retarded to any desired degree. The amount of retardation needed may be judged from the following example.

Two 1,000-kw. 72-pole machines running at 100 revolutions per minute from horizontal engines, with cranks quartering, were found to oscillate badly at the rate of about 50 beats per minute when in parallel. The addition of dash-pots entirely cured the trouble. After the addition of these dash-pots, when full load was suddenly thrown on, a period of about seven seconds elapsed before the governor reached its final load position. During this period the speed fell 3 per cent. and then increased again 2½ per cent., the full load speed being ½ per cent. less than the no-load speed. This arrangement gave good parallel operation, and was adopted.

There are, however, cases where a simple retarding device is not sufficient without seriously affecting the governor of the engine. A special form of dash-pot has been devised for such cases, being so constructed that it is almost rigid for very sudden changes, but if there is pressure for an appreciable time, the length of which may be varied by adjustment, the dash-pot allows an easy and rapid motion. Such dash-pots have been applied in cases where the conditions were such as to produce very serious trouble without them, and have produced absolute stability.

Engines that are directly coupled to alternators that are to be run in parallel should be provided with means by which the speed may be adjusted within a small range without throttling while the engine is running. Such a device is very useful in bringing the machines together, while throwing them into parallel, when one machine is loaded and the other is idle. Without this it is necessary to throttle the steam for the engine without load to bring it to the speed of the loaded machine. This device is also very useful to divide the load between the machines, since, however carefully they may be adjusted, high temperatures or some other local conditions may throw them slightly out of adjustment.

New Zealand Electrical Syndicate.—A drawing for the redemption of £1,500 of the first mortgage debentures will take place at the offices of the Company to-day at 2.15 p.m.

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ELECTRICAL ENGINEERS (R.E.) IN SOUTH AFRICA.

(*Concluded from page 58.*)

After arriving at Pretoria, the engineer-in-chief found quantities of electrical work for the corps, as all the forts which defend the town had been fitted up with various electrical apparatus, not only for electric lighting, but there were signal signalling, telephone, and other wires, which required to be sorted, labelled, and their uses understood. The oil-engines which supplied the motive power for driving the dynamos had purposely been damaged by the Boers, and had to be repaired and set to work. The small and inefficient searchlights which had been used by the Boers were replaced by a system of incandescent lamps placed so as to illuminate certain points which were liable to be threatened by the enemy during night attacks. This work at the forts, which was of a very interesting nature, was followed by teaching the garrisons how to use and maintain the electrical apparatus in working order. Other parties of our men were employed in fitting-up electrical lighting in various public buildings which served as supply stores, and in the large hospitals which were then being started inside and outside Pretoria. In some cases these new installations were worked from the public supply of the town, in other cases separate generating machinery—*i.e.*, steam-engines, dynamos, and systems of conductors—had to be put down for each job. The plant for this was made up from material found at or near Pretoria, most of which was in a damaged condition and had to be almost remade before it could be usefully employed. During this time, as the whole of the Rand district surrounding Johannesburg is supplied with electric light and power partly from a distant generating centre at Brak Pan, the Military Governor of Johannesburg asked for and obtained the services of Captain Leaf as his electrical adviser, and from time to time various works were supervised by him and by other officers of the corps, so that the electrical plant of Johannesburg and district was gradually got into order. It will be interesting to those who have read Rider Haggard's novel, "Jess," to know that our camp at Pretoria was close to the site of Jess's cottage. Its position was well chosen; we had a stream of water handy for washing out our engines, and we were close to the railway and railway workshops. Thus, we were in a most convenient position for repairing the various pieces of apparatus that we were installing in the forts and public buildings. Amongst others, the Government printing works of Pretoria, worked by their own electric generating plant transmitting power to motors driving each set of printing machinery, was put in order and worked by us.

Early in July the Electrical Engineers were several times called upon to extricate an engine which was proposed to be used to haul 12-ton 6in. quick-firing guns to various positions near Pretoria. This engine and a gun was hauled out of a drift almost in the middle of Pretoria, into which it had sunk in the course of an experimental run. A few days later, after the driver of this engine had placed the gun in position near Deerdepoort, he took his engine down to a spruit in order to fill up his water-tanks, but approached too closely to the soft ground, so that the engine turned over on its side and could not be got out until we were sent for. Great praise is due to Captain Lloyd and Captain Leaf and the detachment engaged on this work, which was carried on throughout the night. The way in which the Electrical Engineers handled the engines and gun made it evident to the officer commanding the artillery that the Electrical Engineers were so capable that he placed the engine and the two guns in their charge, and the subsequent work of placing these—the heaviest guns ever taken into the field—was carried out by the officers and men belonging to the corps. On July 24 a 6in. quick-firing gun, weighing with its carriage 12½ tons, was hauled to the top of Quagga Kop, seven miles to the west of Pretoria, and 1,300ft. above it. The average slope up which the gun was hauled was 1 in 10, but there were some parts of it which were steeper. On Aug. 1 a similar gun was hauled up a slope averaging 1 in 6, and in some places 1 in 5, to a redoubt on the top of this hill, about five miles east of the town. A few days later two large traction engines belonging to the director of steam transport were put under our charge, under the officers of the Electrical Engineers, and with these and the other three engines, making five traction engines, a regular daily service was organised, and stores of every description were transported to various points, chiefly to the westward of Pretoria, the longest run being to Commando Nek, 26 miles distant, where a depôt was formed for flying columns. The service on this road lasted for many weeks—in fact, up to the time the corps started for England—and was carried out without any mishap or loss, although during the whole of the time the line was threatened by the Boers, and we were informed that sniping frequently went on, but as far as we were concerned no one was hit. A new system of escorts was adopted; sufficient men to form two or more escorts being put under the command of the officers of the corps and encamped with us. The anxieties connected with this service were greatly reduced by an excellent system of signalling the position of the trains, which was introduced by Captain Lloyd.

Early in June a part of the detachment left at Bloemfontein left under Lieutenant Stubbs and worked under the Army Telegraphs repairing telegraphs and erecting new lines. They trekked the whole journey from Bloemfontein to Pretoria, only arriving at Pretoria towards the end of July. After their arrival at Pretoria Lieutenant Stubbs's party were employed for some time on new telephone lines connecting the forts with the town, and later on took another party down westwards to Standerton. Towards the latter part of August a party of Electrical Engineers, under Captain Lloyd, were sent up to Brugspruit with a set of searchlight apparatus and accessories, which was erected, and the light shown from the top of the shaft of a colliery near Brugspruit Station, the dynamo being driven from the mine engine. Captain Lloyd returned to Pretoria and left the detachment for some weeks under the command of Lieutenant Bigg, and there is no doubt that the presence of this searchlight greatly reduced the liability of night attacks from a strong commando under Erasmus, which threatened the Pretoria and Delagoa Bay Railway at this point. On Sept. 4, one of the engines, with dynamo and 16 arc lights, were taken down to Machadodorp by Captain Leaf and a small party of Electrical Engineers, and at this point an installation was erected to supply light to the various running sheds and loading stages, as at that time convoys which supplied three columns with food had here to be loaded. On Aug. 31 Sergeant-Major Brown, R.E., and Corporal Dalton were attached to Lord Kitchener's staff to use their bicycles and field telephones as required at the front. Up to the time of the arrival at Pretoria, as the officers and sappers were constantly employed on railway work, little opportunity was given for the sappers to use the bicycles; but after arrival at Pretoria they proved to be of the greatest value, for as the work at the forts and buildings was scattered over a large area it necessitated the officers and men moving rapidly from point to point, and the whole of the bicycles were in full use, so by their aid the 20 men who rode them were almost doubled in value.

On Sept. 17 the writer, accompanied by Captain Leaf, was sent down by Lord Roberts to the low country to the east of Machadodorp, in order to report whether any of the traction engines could be efficiently used there. At this time Captain Bain also came down to Waterfal Onder in charge of the railway telephone work, and Lieutenant O'Shaughnessy was in command of the more advanced telegraph work near Koomati Poort. Early in October Colonel Crompton was ordered to England by Lord Roberts, in order that his recent experience might be utilised in designing traction engines for military purposes. Captain Lloyd reassumed command. From this date the work went on uninterruptedly until the later end of October. The unit by this time was in a very scattered condition, the large number of jobs being carried out all over the Transvaal and Orange River Colonies demanding small detachments at various places. It was whilst in charge of his Standerton detachment that

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Lieutenant Stubbs so nearly lost his life. His duties necessitated a journey by rail on a line known to be threatened by the enemy. At a point on the line near Vlaklaagte, a few miles north of Standerton, something was observed on the line which looked rather like dynamite. Lieutenant Stubbs went forward to examine, and was immediately fired on by a large party of Boers concealed about 300ft. off. Trying to regain the engine, he was hit again and again, until at last he rolled into the ditch by the side of the line. The train was captured, and all not killed or wounded were taken prisoners. The train was then blown up and burnt. Lieutenant Stubbs has now returned to England and, I believe, is doing well. You will all be glad to hear that, according to reports in the Press, he has been recommended for the Victoria Cross

Towards the end of October orders were received from the engineer-in-chief to concentrate the unit and hand over the majority of the stores so as to be ready to move homewards on receipt of further orders. The various detachments were gradually collected, and on Oct. 25, exactly four months since they arrived in Pretoria, the unit steamed south for Bloemfontein. Seven men were left behind in Pretoria to take their discharge there; four of these had been given civilian employment under the Imperial Military Government, and three were taken up by private employment on the Rand. A 48 hours' journey took us to Bloemfontein, where we completed the handing over of equipment and packing for our final departure. But even during this time the "handy man" was not allowed to be idle. Six to eight miles of telephone line connecting outlying camps were laid under Captain Bain's direction, whilst Captain Lloyd was sent off to Norvals Pont to report on an electric light installation at the hospital there. He also had to report on the future lighting of the railway depôt at Bloemfontein from the new town central station. Had not orders for the unit to move south finally for Cape Town been received, it is probable that the men would still be discovering fresh jobs to turn their hands to.

Yet one more check was met ere the unit finally arrived at Cape Town. No transport was absolutely ready, and so, to avoid the possibility of the hardened and fierce warriors striking terror into the hearts of the peaceful inhabitants of Cape Town, the bloodthirsty Electrical Engineers were kept for three days in the safe camp of Stellenbosch, and not until Saturday, Nov. 17, did they reach the port, where the train took them right alongside the "Norham Castle." After an uneventful and extraordinarily fine passage the ship was brought alongside the quay at Southampton on the evening of Dec. 6.

In concluding his lecture, Colonel Crompton pointed out that the work done by the Electrical Engineers Volunteers was not of the blood-and-thunder style, but was much more in the nature of carrying out the useful and necessary work they were intended to do. They went out to do services that their training in civil life best fitted them for, and they dropped into those positions very comfortably. It was not for them to speak of the dangers they encountered, but the Boers were always there, and enteric fever, of course, was very much about. They had lost some men by fever, he regretted to say, but it was due to the intelligence of the engineers themselves and to the care of the officers that their losses were so surprisingly small—smaller than any corps that went out to South Africa. The men strictly obeyed orders as to what they should do to prevent sickness, and he believed that it was to the excellence of these arrangements that they owed their safety.

Prof. JOHN PERRY, who occupied the chair, in proposing a vote of thanks to Colonel Crompton for his lecture, said he had heard five different accounts of the fight at Leuwspruit, but not one of them was like that given by Colonel Crompton that night, for he had not made half enough of it. He (Prof. Perry) could assure them it was the liveliest time on record experienced by any of our men in South Africa. It was unnecessary to say any more. What he had said at the reception at the Covent Garden Opera House entirely covered the ground, and he had to announce that the Council had decided to issue to each member of the Electrical Engineers a copy of the short address he gave on that occasion on vellum paper, with the seal of the Institution affixed.

A hearty vote of thanks was then accorded Colonel Crompton.

Mr. ALEXANDER SIEMENS proposed the following resolution: "That the Institution of Electrical Engineers offers the most cordial congratulations to the members of the Electrical Engineers (Royal Engineers) Volunteers forming the Electrical Engineer unit of the South African Army, upon the patriotic devotion that they have shown in placing themselves and their technical skill at the service of their country, and upon the successful termination of their arduous and self-denying labours during nine months of active service in the field." No words of his, he said, could support that resolution better than the lecture they had just heard, but he agreed that Colonel Crompton had given much too mild an account of the hardships endured, the skill shown, and the work carried out by the Electrical Engineers Volunteers in South Africa.

Mr. HIRST, in seconding the resolution, said that at the beginning of this war they all thought that the overwhelming weight of this Empire would quickly crush all resistance out of their foes. But the unpreparedness with which they started this war gave them—the Electrical Engineers—a chance of showing what excellent organisation could do. At the present time they were all anxious that this war should be finished, that they might start that bigger battle for the industrial supremacy of this country. In the future he thought electrical engineers would be looked upon as the leaders of the nation. On account of the work they had done in South Africa, they were singled out—hall marked, he might say—for the rest of their lives for all the important and remunerative positions that the science of electricity was bringing forth, and it was their duty to try and help them to get these positions of honour, not only for what they had done, but also for the glory and prestige they had shed on this Institution.

The motion was carried with acclamation.

Prof. PERRY thought that those members of the Institution who happened to be employers ought to remember that some members of the South African detachment of the Electrical Engineers Volunteers might be out of employment.

Mr. J. W. SWAN then proposed: "That the Institution of Electrical Engineers desires to express its deep sorrow with, and tender its heartfelt sympathy to, the relatives of the four men of the Electrical Engineers Volunteers who lost their lives in South Africa."

Sir HENRY C. MANCE seconded the resolution, which was carried unanimously.

The proceedings then terminated.

THE USE OF ALUMINIUM AS AN ELECTRICAL CONDUCTOR.

On Thursday last week, Mr. John C. B. Kershaw, F.I.C., read a paper on this subject before the Institution of Electrical Engineers. In the introduction he says that the high price to which copper has been forced in recent years by a combination of natural and artificial causes—a combination which it is unnecessary to discuss in his paper—has led to a renewed interest in aluminium as a substitute for copper in electrical power transmission schemes. Ten years ago the price of aluminium was 8s. 4d. per pound, and its use as a substitute for copper for electrical purposes (even with the latter metal at £80 per ton) was therefore economically impossible. It is only within the last few years that the improvements in the process of manufacture, in their relation to the quality and price of the metal produced, have brought aluminium within the practical range of the electrical engineer as a substitute for copper. Whereas in 1891 the production in metric tons of 2,204lb. was 233, the price being 6s. 3d. per pound in the U.S.A., the production in 1899 was estimated at 5,000 tons, the price having fallen to 1s. 4d. per pound. In comparing the price of aluminium with that of copper when used for conducting purposes, it is necessary to make allowance for the fact that the specific gravity of aluminium is

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rather less than one-third that of copper, and that its conductivity for wires of equal sectional area is only from 50 to 63 per cent. that of the more common metal. The following formula is useful for calculating the relative prices of equal lengths of bare conductors of the two metals of equal electrical capacity: $\frac{S \times P \times c}{s \times p \times C}$ In this S, P, and C represent the specific gravity, price, and conductivity of copper, while s, p, and c represent the corresponding values for aluminium. Taking the most reliable values for the physical constants of the two metals—viz., S = 8·93, C = 100, P = £91 per ton; s = 2·68, c = 59, and p = £224 per ton—we obtain this result: $\frac{Cu}{Al} = \frac{798}{1,000}$—*i.e.*, £798 expended upon copper will equal £1,000 expended upon aluminium. Aluminium is therefore the dearer metal; but special rates are offered where large quantities are taken. In the United States large quantities of the new metal have been sold at £135 per ton. Using the formula as before, the cost ratio for conductors of equal length and equal carrying capacity becomes $\frac{Cu}{Al} = \frac{1,325}{1,000}$, and copper is seen to be the more costly material.

In America at present there is no talk of using aluminium for insulated conductors, the greater sectional area of the metal for equal carrying capacity (1·68 : 1·00) rendering it impossible to use it for such covered conductors until it has fallen to a much lower price relative to copper. Among the bare aluminium transmission lines already completed on the other side of the Atlantic are those at the Niagara Falls, those of the Hartford Electric Light and Power Company, the Snoqualmie Falls Power Company, the Blue Lakes Power Company, and the Telluride Power Company. This last-named company generates current at Provo, in Utah, and distributes it over an 80-mile circuit to the mines at Mercur and at Tintic; 2,000 h.p. was originally transmitted at 40,000 volts, but plans for increasing this amount of power are being proceeded with, and it is intended later to use a pressure of 60,000 volts. In this country the Northallerton Electric Lighting Company have four miles, and the British Aluminium Company, at their Foyers works, have several miles of aluminium in use for various purposes; and the Post Office authorities are making experimental trials of the metal for long-distance telephonic communication.

On the question of the durability of aluminium and other metals under atmospheric exposure, in order to obtain independent and reliable figures concerning the effects of exposure upon aluminium, the writer has, since October, 1899, been carrying out two series of observation in the North of England. The samples of aluminium used are in rod and wire form, and were kindly placed in the writer's hands by Messrs. T. Bolton and Sons, of Oak-Amore Wire-works, and by the British Aluminium Company. The methods of observation adopted in the experiments were these: The rods and wire were cut into 2ft. lengths, and were mounted upon glass insulators in two frames, so that their position was parallel one to the other, and horizontal with regard to the ground. Each length of wire was carefully marked and weighed before commencing the exposure, and the weights recorded. The one frame with its nine insulated sample wires was exposed upon the roof of a building in St. Helens, Lancashire, from Oct. 11, 1899, to Aug. 23, 1900; and the second frame was similarly exposed at Waterloo, Lancashire, for the same period of 10 months. St. Helens is now singularly free from chlorine and hydrochloric acid gases. Waterloo is on the Mersey, six miles north of Liverpool, and its atmosphere is that of an ordinary West-Country seaside town plus much sand. At the end of the 10 months the wires were removed from the frames, cleaned from the soot and dirt of all kinds which had accumulated upon them, and after thoroughly air-drying were reweighed. They were found to have nearly all gained in weight during the 10 months exposure, the gain varying from nil up to ·83 per cent. on the weight of the original wire. The majority were badly pitted, and dirt had settled in their corrosions, and could not be removed by scrubbing. One wire showed a gain in weight of ·27 per cent., another ·51, another 54, and two ·83 per cent. The weights of these aluminium rods and wires were, however, of very little use in determining how far they had suffered by the exposure. Two samples of aluminium wire were, therefore, submitted to conductivity and tensile strength tests with this result: The conductivity of the original wire was 51·3, after exposure at Waterloo it was 51·4, and at St. Helens 46·6. The tensile strength of the original wire was 13·16 tons per square inch, but after exposure at Waterloo it was 12·06, and at St. Helens 11·15.

The following figures were sent to the writer with regard to the conductivity of the aluminium wire supplied for electrical purposes. A rod composed of 98 to 99½ per cent. aluminium had a conductivity of 60 to 62 per cent. that of copper, and a tensile strength of 16 to 18 tons per square inch; a wire of 99 per cent. aluminium, 65 per cent. that of copper and 13 to 16 tons per square inch; and a wire of 99 per cent. aluminium, 1 per cent. Fe, 62 per cent. that of copper, and 16 to 18 tons per square inch. In the cases of samples 2 and 3, however, it was found that in place of conductivities of 65 and 62 per cent., they only possessed conductivities of 51 per cent. and 54 per cent. respectively. Pure aluminium, however, has a conductivity 63 per cent. that of copper, and the low conductivity of these samples can only be explained by the presence of iron, or other metals, introduced to increase their strength.

Turning to the tests again, both at Waterloo and at St. Helens the galvanised iron wires lost in weight, the losses in the latter case being serious, and amounting to 1·44 and 2·13 per cent. of the original weight of the wires. In this case almost the whole of the zinc had been dissolved away by the action of the acid gases, and the exposed iron was badly oxidised. The two Waterloo samples were, on the other hand, bright and clean, and to the eye did not appear to have suffered. It is, perhaps, unwise to found any general conclusions upon the results of these observations, since they refer to two districts only. It would, of course, be interesting to have similar series of observations established in London and in one or more of our large cities with a manufacturing population, say Manchester, Glasgow, or Sheffield; but at the moment the writer is unable to establish these. The investigation, however, proves that the aluminium wires at present sold for conducting purposes in this country are not perfectly resistant to atmospheric corrosion, and that in the atmosphere of a town where sulphurous acid gas exists as an impurity in the air the metal is very badly attacked. Though St. Helens is certainly an exceptional town, it is probable that in any large town burning a large amount of coal, either for domestic or for manufacturing purposes, the atmospheric conditions will approach those obtaining there, and that the various metals will be attacked to a somewhat similar degree. Under such conditions all metals used for overhead conductors are subject to attack, and aluminium is unsuitable for use, owing to the pitting which occurs. In such towns it is advisable to use copper for all overhead wires, and the proposal to use aluminium, especially for overhead trolley lines, must be condemned. In country districts or in small towns, where the impurities present in the air are reduced to a minimum, all metals experimented with seem to be fairly durable, but the slight pitting of aluminium which occurs—even in such an atmosphere—may prove serious; for by allowing the lodgment of small particles of foreign matter it may in time lead to the disintegration of the whole mass of metal. Upon this point the researches of Ditte are important. The observations are being continued at the two localities named, and on a future occasion the author hopes he may have the pleasure of presenting further figures on this subject for consideration.

DISCUSSION.

The President opened the discussion by remarking that he had heard that Lord Kelvin was making some pretty large experiments at Foyers in Scotland, on this interesting subject.

Mr. J. Gavey said that for the last 12 months or so the Post Office authorities had had under consideration the desirability of carrying out certain experiments with aluminium wire. The reason why they had been deferred for so long was that there had been

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a difficulty in obtaining a suitable soldered joint Now, however, in order to carry out the experiments, they had arranged to cut the wire in long lengths. Some 20 miles of line had been erected. Some 15 miles of this were in the Pottery district, near Hanley, so that a severe test as regarded corrosion might be had. The wire handled very well, but he must say that the first experiments had not been very promising. The wire was put up early in December, and within about a fortnight a heavy gale of wind blew over the country, and there were something like eight or ten breaks in the spans that were erected. The wire weighed 75lb. to the mile, the strain working out at 12·48 tons per square inch section. He did not want to make too much of this failure, for perhaps it was a little too early to come to any conclusion upon the subject. In this particular case there might have been parts of the wire either very much crystallised or different in character from the remainder of the line. Carrying back their experience to the use of hard-drawn copper wire, they met with considerable difficulties in obtaining exactly the quality of wire they wanted. The English manufacturers, however, came to the front and did succeed in meeting the requirements of the Post Office, and in the same way, he believed, manufacturers of aluminium wire, when a little more experience had been obtained, would meet with similar success. Other trials of aluminium wire had also not proved very promising. He had had a conversation with the president of the Pacific Telegraph and Telephone Company the other day, who told him that that company had arranged a considerable length of aluminium wire for telephone purposes. The line, however, had been subject to similar breaks to those experienced in the Post Office trials.

Mr. J. Swinburne thought that in the paper before them there was one very important point not very fully dealt with, and that was as to the purity of aluminium. His experience was that a very small proportion of any foreign metal in aluminium would probably lower the conductivity, and consequently throw the price ratio wrong. A very little purification, on the other hand, would probably prevent corrosion. The three general impurities to be found in aluminium were sodium (which was the worst of all), iron, and silicon. Aluminium was continuously being improved, and considerable headway was being made as regarded purity. The next difficulty, which had already been referred to by Mr. Gavey, was the question of soldering. Nearly all the aluminium alloys were unstable, and if an equal proportion of each were used the result was very curious—the metal would probably crumble to pieces without being touched. It was easy enough to solder aluminium, but the difficulty was that it did not last. His opinion was that as aluminium alloy was unstable when it contained a large quantity of aluminium, a solder which generally had some other metal than aluminium in it must have between it and the aluminium a surface or layer of alloy which was unstable. The author had said that aluminium was hopeless for insulated conductors, but in that he could not agree. In the near future, he thought, aluminium might be extremely important in covered (insulated) conductors in large engineering schemes.

Mr. Kershaw said he would send what he had to say in reply to Mr. McMillan for publication in the *Journal*.

GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of this section held on the 9th inst., Mr. R. F. Yorke read some practical notes on water power for electrical purposes. The first division of the paper is given to the means by which mechanical energy is obtained from water. The author deals first with waterwheels, which he points out have a somewhat limited use, and, as a rule, a low efficiency, and afterwards with turbines. These latter he divides into the two usual classes—*i.e.*, impulse and pressure turbines. He recommends the Pelton wheel as the simplest and cheapest form of turbine when the supply of water is regular and the load fairly constant. These wheels are also of particular service when high falls of water have to be dealt with. When speaking of the Vortex type of turbine, which was first devised by Prof. James Thomson, the author referred to one turbine working in an 80ft. head which has done good work for the last 42 years. When using this class, it is usually possible to have the dynamo directly coupled on to the turbine shaft. It is important however, for obtaining a regular speed that the head on the turbine should be constant. When a constant speed independent of the head is required, Mr. Yorke recommends the Jonval type. He quotes an instance at Chevres, where the turbines of this type have been so successfully designed that they have been able to maintain a constant speed of 80 revolutions with as large a variation of head as 50 per cent. As a contrast to this, the author quotes a case in which a 20 per cent. reduction of head rendered the turbine quite useless. In the section of the paper devoted to details in the equipment of turbines a useful hint is given that suction pipes should not be laid on the incline owing to air collecting in them, which is apt to destroy the vacuum. He recommends instead that if a vertical drop into a tail race cannot be obtained, the suction pipe should be laid at first horizontally and then vertically downwards. The intakes for water-power schemes, which utilise mountain streams, have to be carefully arranged to prevent *débris* being carried into the pipes after heavy rains or during the melting of snow. To avoid this, the author recommends what he calls the level tank system. With this a dam is constructed in the usual way to collect the water coming down the burn, and a small subsidiary tank is constructed on a level with the dam. A large pipe, protected by a coarse strainer, is then taken from the main dam into this tank, which passes only the actual quantity of water required for the turbine. The slow velocity of the water in this pipe and in the tank then allows any sand or *débris* to be deposited. The author's division of water-power schemes into three groups is made on the double ground of the financial results to be expected and the quantity of water available. The first of these comprises those water-power undertakings which have obviously an insufficient supply at frequent intervals, and which it would cost a large amount to develop. The next division contains those schemes which by careful design might repay the outlay required to develop them, while the third clause contains those places in which the local conditions are so extremely favourable that an obvious advantage is to be gained. As the author points out, all depends upon the capital outlay required, as if the first cost is not to be great, water power is superior to any other as the means of driving electrical machinery. With automatic lubrications of the dynamos and also of the turbine bearings, the author contends there is no reason why a water-power plant should not be left to run all night without attendance. This is actually being done in certain installations under his charge, and he proposes that the dynamos should be used to charge accumulators during the night, which on discharge can work motor circuits during the day. The accumulators in this case are kept in good condition by being thoroughly well used. He also considers that the lifetime of the same is enhanced by charging it half rate. One has to take exception to the author's general remarks to the effect that in Scotland up to the present time there is not a single instance of water power being used on a large scale for the purpose of electric generation and transmission. While at the Falls of Foyers no power is being transmitted, the generation system is on a scale which will compare with water-power systems abroad. He concludes by pointing out that a number of urban district councils in Scotland could well be supplied with electric lighting and water-power installations which would give more economical results than if steam-engines were employed. In an appendix to the paper Mr. Yorke gives some valuable formulæ on the design of lades for conveying water for power purposes when the quantity required varies between predetermined limits. These, and the data concerning horse-power with a given quantity and head, and also the sizes of the iron pipes required, will be found exceedingly useful for reference.

Discussion.

Mr. William McWhirter, in opening the discussion, said he was afraid there was very little to discuss, and were he to say what he felt inclined to say, he was afraid it would perhaps be displeasing alike to the author of the paper and the meeting. It was very natural for anyone who had the *Proceedings* of the Institution at hand to turn back for a few years, and doing this he had been led to read a very admirable paper on turbines in the volume of the *Proceedings* for 1896 In this paper every aspect of the very important question of turbines was entered into. In going over this paper, it had occurred to him that, seeing so many of the members of the local section of the Institution were young men, it would be a very good thing for them to ask the parent Institution to supply their section with a full set of the *Proceedings*, to be readily accessible to all the members and associate members of the Glasgow section. Anyone who had anything to do with turbines must have come to the conclusion that the turbine invented by Sir James Thomson in 1850 or 1851 was a most perfect machine. With regard to the question of pipes referred to by Mr. Yorke, of course everybody

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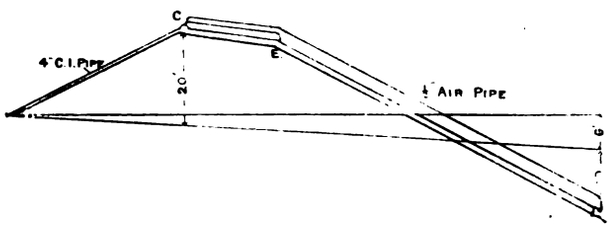
knew that they were a very important factor in any water-power scheme, and were very often neglected or misunderstood. A paper read by Mr. Gale, of Glasgow, before the Institute of Engineers and Shipbuilders some time ago showed that, not in the last, but in the former scheme for bringing a water supply to Glasgow from Loch Katrine, the formula used had been altogether out; and those who wished to go into calculating the dimensions, etc., for water schemes would do well to refer to that very excellent paper. Concluding, the speaker said he had no doubt at all that in the course of the next generation water would be a very important factor, and it would receive from electrical engineers that attention which it had not yet received.

Mr. Ritchie (Edinburgh), on the invitation of the chairman, said he had listened with pleasure to Mr. Yorke's paper, and as a manufacturer of turbines he was naturally interested in the development of water power. There was no one better qualified to treat the matter well in all its bearings than Mr. Yorke, and he believed no other electrical engineer in Scotland had installed so many water-power plants for electric lighting, many of which were of considerable size. Mr. Yorke had spoken on the subject very generally, and he should have liked him to have given them a little more detail in connection with the running of water-power machinery, for the benefit more especially of the younger members of the Institution, who might have some difficulty in grasping principles involved in the application of turbines to electric lighting. In referring to suction pipes for turbines, Mr. Yorke stated that a pipe laid on a slope was a failure in maintaining a good vacuum, and this he had proved, and he thought Mr. Yorke's theory of the air bubbles to be the correct and generally accepted one. He did not agree with Mr. Yorke in regard to governing turbines, thinking that every turbine ought to be fitted with a governor. Great improvements had been made in governors of late, and one of the most improved forms of governing turbines had been at work for the last two months night and day without attention, driving a dynamo for lighting, heating, cooking, etc. The variations of load were considerable, but still there was a very small percentage of rise or fall in the voltage. Mr. Yorke had said there were no large transmission plants in this country, and when compared with those on the Continent and elsewhere, that was true. The largest was in Ireland, where at Milford, on the River Barrow, there were two 50-h.p. and one 80-h.p. turbines at work generating alternating current at 2,500 volts, which was sent into the town of Carlow, 5½ miles distant, where it was used for lighting and also for motors in several small industries. People were now waking up to the fact that even in this country there was some prospect of useful work being got on a large scale from water power. As Mr. Yorke was so well acquainted with the West of Scotland, the district of greatest rainfall, he was somewhat disappointed that he was not able to enlighten them on the prospects there for the utilisation of water power on a large scale. On the Ochils, near Stirling, there was a Girard turbine working under a head of 860ft.. and at Brora, in Sutherlandshire, there was a Pelton wheel working under 950ft. head, and these were only samples of what might be done all over the North and West of Scotland.

Mr. G. T. Blackwood Murray, B.Sc., thought the author had brought forward some very interesting points. He did not think that for long suction pipes the plan suggested by Mr. Yorke—namely, of taking them out horizontally and then vertically downwards—would always be found satisfactory. Although the air given out by the water due to the reduction of pressure below atmosphere would be carried along the level portion, it would almost certainly lodge just where the bend down occurred, as the speed on the air bells upwards in the vertical portion would be greater than the down velocity of the water, unless this latter were made fairly high by reducing the section of the vertical pipes. From experiments he had found that for every size and slope of pipe there was a certain speed at which bells of air travelled along the pipe. It was evident, of course, that unless the speed of the water in the pipe be greater than this speed the air would not be carried forward and discharged, but would lodge or travel back. As an instance of this, Mr. Murray quoted a case in which they put down a siphon to provide an auxiliary supply to a power plant which had, he thought, some novel and interesting features. It would be better understood by a reference to the



accompanying sketch. From the inlet, A, to the outlet, B, the length of the pipe was 480 yards. The siphon was ordinary 4in. cast-iron pipe, and was designed to pass nine cubic feet per minute. The fall from the inlet to the outlet was 16ft. The loss by friction amounted to 6ft. The line A D indicated the hydraulic mean. The height of the highest part of the siphon above the hydraulic mean was 20ft. At the outlet of the siphon they passed the whole of the water through a simple form of ejector or water-jet air-pump. To work this jet pump they had a head of 10ft., as would be seen by reference to the diagram. The "vena contracta" of the pump was 9in. diameter, and the pump gave them a suction of 2lin. of mercury, or equal to 24ft. of water. From the jet pump a ¼in. pipe was led to an air vessel fixed on the highest part of the siphon, and the pump proved far more than sufficient to pump out all the air, either excluded by the water or leaking into the siphon. As a matter of fact, they several times let in a large quantity of air into the siphon, but in a very few minutes the pump had cleared it out, and was working with almost solid water in the ¼in. pipe. With the pump out of action the siphon would only run about five hours; with the pump in action it ran two days, and then stopped. On investigating the cause, it occurred to them that the nearly flat part of the siphon between C and E had not sufficient slope to ensure air bells generated in that part returning to the air vessel. This supposition they confirmed by experiment. To overcome this difficulty, an auxiliary air-pipe was led from E and connected on to the other air-pipe near C. All trouble then vanished. The siphon worked continuously without a hitch. He thought that in many instances where it was at all important to get the full effect of the suction, it would be well worth the engineer's while to fit on a small jet pump, such as was used to keep the suction pipes clear of air and ensure the highest working efficiency. As to Mr. McWhirter's remarks on governing, he would point out that the problem was a far more difficult question than that of simply moving the guide blades. There was the momentum of the whole mass of water driving the turbine to be checked, and if this were attempted too rapidly, hunting was the result.

Mr. W. A Chamen asked if Mr. Yorke would be good enough to explain in his reply whether the turbines at Chevres maintained their load even with so large a variation in the head as 50 per cent. He also asked why, if the air bubbles destroyed the vacuum with an inclined suction pipe, they did not act in the same way with a vertical suction pipe? With regard particularly to the question of governing as applied to turbines used for private house installations, he described the turbine and dynamo plant put down at Braemore, Ross-shire, for the late Sir John Fowler. The head of water available was about 200ft., being obtained from a reservoir away up the side of the mountain right above the house. The turbines were fixed in part of the kitchen premises of the house itself. They were of Messrs. Gilkes's make, and of the Vortex type, three in number, each being of 12 h.p., and running at a speed of 1,200 revolutions per minute, and each being coupled direct to a Crompton dynamo. The governing was managed by a Willans electric governor, consisting of a shunt solenoid working a water relay, which controlled the supply to a powerful hydraulic ram, arranged so as to open and close the guide blades of the turbine, an operation requiring a considerable amount of power. No accumulators were used, and the governing proved extremely successful. There being no accumulators, a novel device in the shape of an alarm clock, arranged to open the connection to a hydraulic cylinder working a sluice valve, was fitted at night-time. When the desired time arrived, the clock turned on the water to the cylinder, which, however, was only allowed to pass very slowly through a small-bore cock and pipe so as to ensure a very gradual shutting down of the plant, giving notice by the dimming of the light to any persons who might be about that the supply would absolutely cease within about a quarter of an hour, thus giving them time to be fully prepared before the final extinction.

Mr. J. M. Munro considered that the most striking feature of the paper—as of water-power plant—was its simplicity. The author's praiseworthy aim evidently had been to encourage even the youngest of his audience by a relation of the simple, not to say obvious, maxims which guided much not unsuccessful practice in water-power engineering in this country. One could have wished, however, for more definiteness in the numerous asides referring to the author's own experience. Some of these were interesting and useful, but less so than if figures had been furnished. In dealing with calculations regarding the best size of pipe, Mr. Yorke recommended a certain velocity of flow in the pipe. There were places where it would pay to greatly exceed the recommended velocity; there were places where its adoption would ruin the scheme. The method used in some offices was this: A diagram was prepared once for all from the familiar formulæ, which diagram showed at a glance the loss of head per yard with any ordinary quantity of water and size of pipe. With this it was easy to compare costs and losses and rapidly to select the right pipe. Some such diagram would have been a useful addition to the paper, and quite in keeping with its scope. The author had had much experience of suction pipes. Perhaps in his reply he would say what was his opinion as to the advantage of gradually widening the lower end of such tubes so as to reduce the velocity of exit. That had been recommended by some engineers, but more figures of actual trial were wanted. The opened soda-water bottle served very well Mr. Yorke's purposes of illustrating how bubbles of air were given off under the reduced pressure in the suction pipe. Doubtless Mr. Yorke had records of pressures in suction pipes as ascertained by gauges at several points under various working conditions. In this matter, as in so many others in his paper, a few figures would have been a useful addition to the statements made. The opinions which Mr. Yorke had given, however, were valuable.

Mr. M. B. Field remarked on the absence of figures in the paper, such as would be of service to electrical engineers generally.

Mr. George A. Clarke, speaking at the request of the chairman, said that in the subject before them there was ample opportunity for engineers, especially electrical engineers, to get a little further ahead than they were. He thought Mr. Yorke had not given them any information as to what could be done in the way of compounding dynamos when the water was a good bit away from the house. He thought if Mr. Yorke had given them more particulars regarding what he had done in getting over the great number of difficulties which always cropped up in water jobs, instead of giving

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them so much elementary matter with regard to waterwheels and turbines, the paper would have been very much more useful.

Mr. Yorke, in reply, thanked the members for the kind manner in which they had received his paper, and he thought all would agree that the discussion had been a most interesting one. Mr. McWhirter was inclined to doubt that it was possible to run an electric light installation working under the continuous system described in the paper, but he could only reply that such a system was and had been in use for a great number of years without any of the troubles anticipated by Mr. McWhirter having arisen. It must be pointed out, however, that when a charging current was spread over 24 hours, instead of the ordinary six or eight hours, the charging current was reduced by one-third or one-fourth, and that it was found that when charging continuously at this low rate the variation in pressure was only slight. On the other hand, the lifetime of the accumulator was greatly prolonged. He was very pleased to hear that Mr. Ritchie and others were quite satisfied with the possibilities of effectually governing turbines. The question of suction pipes was a very interesting one, and, had space permitted, it was one which he should have liked to have dealt with at greater length. Mr. Chamen asked a very natural question as to the reason of air troubles arising with a suction pipe laid on the slope, when no such air troubles appeared when the pipes were laid vertically. His explanation was that when the pipes were laid vertically, the velocity of the downward current of water was greater than the upward velocity of air bubbles, and therefore it was impossible for air to accumulate at the top of the suction pipe. Mr. Murray was under the impression that under his (the author's) system of laying the suction pipes horizontally and then vertically, there would be a tendency for the air to collect at the bend, but in practice he could assure him that such an effect did not occur. Mr. Steiger's paper read before the Institution some years ago, and briefly referred to in that paper, was a very interesting one, and should be read by all those interested in water-power questions; but it was solely dedicated to the question of turbines for low falls. Mr. Chamen asked whether, while maintaining the speed of such turbines as those in use at Chevres, the full power also was maintained. Such was not the case. With a full fall of 30ft. 1,200 h.p. was obtained, and 800 h.p. with a reduced fall of 15ft., the speed of 80 revolutions being maintained. Mr. Field criticised the paper as wanting in figures, but the question had been so very fully dealt with in the engineering and electrical papers lately by Mr. Kershaw that it was unnecessary for him to add more, and he could only refer those anxious for figures to the articles mentioned.

MODERN ELECTRIC LIGHTING PLANT.

BY R. D. SUMMERFIELD.

In the following article the author has endeavoured to give a short description of electric lighting machinery generally as used at the present day, including boilers, engines, generators, and all auxiliary plant connected with them. The subject is such a large one that the limits of an article will not allow of more than a general outline being given of the various plant in use, but enough may be said to give an idea of the kind of machinery being put down, and also to show the direction in which improvement is most likely to take place. The author touched upon this subject in an article published about two years ago,* but the growth of electric lighting is so rapid and improvements so many that he feels he may well go over the ground again.

The following remarks refer principally to English central-station practice, only the more important points about American or Continental plant being noticed. The ideas of foreign engineers, however, are now adopted to a great extent in English practice. In fact, it is probable that in a very few years English, American, and Continental central stations will contain almost exactly similar plant, which, of course, is to be expected when the objects aimed at by all designers are the same.

Boilers. — The Lancashire, water-tube, and modified marine or locomotive type are the boilers in general use, and of these the Lancashire, although the oldest, still seems the favourite, on account of its steady steaming qualities, accessibility for inspection, and low cost in repairs and cleaning. Batteries of these boilers have been put down in many of the latest town-lighting installations, including the large central stations recently erected by the Corporation of Liverpool. Lancashire boilers are now always made of steel, and are generally of large size, 8ft. by 30ft., provided with corrugated furnaces and Galloway tubes, and constructed for a working pressure of 140lb. to 160lb.

* "The Direction of Progress in the Design of Electric Lighting Plant" (*Engineer*, Nov. 25, 1898).

Next to the Lancashire comes the water-tube boiler, that made by Messrs. Babcock and Wilcox being far and away the most popular. This type of boiler possesses the advantages of good circulation and quick steaming, together with safety, a disastrous explosion being almost impossible with a properly constructed water-tube boiler. The writer has known of a Babcock boiler in which the majority of the tubes became red hot owing to shortness of water, yet no explosion resulted, and very little damage, except to a few tubes. Another advantage of water-tube boilers is that they can carry a very high pressure without the use of abnormally thick plates, as the largest parts are only about 4ft. in diameter. The principal disadvantage of this class of boiler is the great cost of keeping them clean, unless exceptionally pure water is used. Their efficiency soon falls unless they are kept clean, and to scrape the tubes out properly is a long job. Straight tubes are, of course, easier to clean and replace than curved ones. In America water-tube boilers are used very largely for electric lighting purposes, a frequent practice being to place one row of boilers directly over another row, the top boilers being supported on steel columns, and the boiler-house thus divided into upper and lower sections to economise floor space.* This arrangement has not as yet found much favour with English engineers, but it is quite likely that with the very large engines now being put down, some of which require half a dozen or more big boilers to supply them with steam, it will be found advisable in many cases to double bank the boilers in order to reduce the length of boiler-house and steam mains.

The only other boilers worth mentioning in connection with English central stations are the "dry-back" type of marine boiler, and the fire-tube, or modified locomotive boiler. Among the latter may be placed the "Economic" boiler of Messrs. Davey, Paxman, and Co., which has many good points, and is now being put down rather extensively, especially in the smaller stations.

The working pressure of boilers is gradually increasing, pressures below 140lb. being now seldom used, while a pressure of 200lb. is not uncommon and Babcock boilers have been constructed to carry a working pressure of 500lb. The steam is now generally superheated, the object being not so much to obtain the greatest efficiency as to provide the engines with dry steam, and thus eliminate the troubles due to condensation water in steam-mains and cylinders. About 100deg. F. of superheat is commonly used, but 150deg. is not unusual. The superheater is sometimes made a part of the boiler itself, or it is made separate and placed in the main flue, or heated independently.

Another boiler accessory which will soon be considered only next in importance to the boiler itself, is a feed-water heater and purifier. Engineers are beginning to realise the great saving which may be effected in fuel, cleaning, and repairs by using nothing but pure water in their boilers, with the result that several processes for purifying feed water have been brought out in the last few years. Some of these processes depend on the action of reagents, which precipitate the impurities before the water enters the boiler; in other cases, the reagent is put into the boiler itself, a practice which should never be allowed, as the impurities are precipitated by the heat of the water without requiring any assistance from the reagent, which only becomes a source of trouble in the boiler. The best and most simple form of purifier is that which depends on the action of heat alone to precipitate the impurities held in solution in the feed water, and several heaters of this description are already on the market, although it can hardly be said that any of them have proved altogether satisfactory. They are not as a rule large enough to purify all the water passing through them, and the facilities for cleaning are not great enough, which is a very important point, as the efficiency of a purifier depends chiefly on its cleanliness. As the water in this class of purifier must be kept at a temperature of not less than 300deg. F., they form excellent feed-water heaters as well.

Most large batteries of boilers are now fired mechani-

* In the new power station of the Metropolitan Street Railway Company of New York there are three rows of Babcock boilers, one over the other.

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cally, and some engineers even instal mechanical stokers with batteries of three or four boilers, which the author considers a mistake, as no saving is effected unless the services of more than one fireman can be dispensed with. For batteries of more than, say, six boilers, mechanical stoking is undoubtedly more economical than hand firing, besides possessing the advantages of a uniform and easily regulated rate of fuel combustion, the avoidance of rushes of cold air into the furnace, and consequently the production of very little smoke. Besides the saving in labour, mechanical stokers effect also a considerable saving in fuel, as by their means smaller and cheaper coal can be used than would be possible with hand-firing, and the evaporative value of coal does not vary at the same rate as its price. The great disadvantage of mechanical stokers is that they cannot be forced to meet a sudden demand for steam—a frequent contingency in many overloaded stations. Mechanical stoking depends for its success on the provision of ample boiler power.

Engineers are by no means agreed as to which is the best type of stoker, but it seems to be a very general opinion that "coking" stokers are most suitable for water-tube boilers, and "sprinkling" stokers for Lancashire boilers. Of the former type, the most frequent examples met with in this country are the Vicar's stoker and the Babcock and Wilcox chain grate, while the sprinkling type is represented by the Bennis and the Proctor stokers.

Boiler-House Plant.—Under this heading may be placed the boiler feed pumps, coal and ash handling apparatus, mechanical stoker, driving gear, forced-draught fans, etc. It is a growing practice to drive all auxiliary machinery in a central station by electric motors in place of small steam-engines, as the latter are seldom economical in the use of steam, take up more space than a motor, and require more attention when running. Steam-driven feed pumps are especially wasteful, and many engineers now drive their pumps by slow-speed motors through single-reduction gear, and claim an all-round saving over steam. Mechanical stokers are now generally driven by motors.

The coal and ash handling apparatus is a very important item of the plant in a large central station, and one which deserves most careful consideration. In designing a station engineers arrange, if possible, that the coal shall be lifted from the barges or railway trucks, as the case may be, by means of a crane with bucket or grab, or an elevator, into a coal bunker, from which the coal falls by gravity on to a conveyor which carries it to a store directly over the boiler-house. In order to minimise the labour of coal trimming, the floor of the store is often made to slope rather steeply to the centre, so that the coal finds its own way into the chutes which lead to the boiler hoppers. A measuring apparatus, to record automatically the weight of coal supplied to each boiler, is usually provided The ashes are sometimes removed by the same conveyor which brings in the coal, and sometimes by a separate conveyor altogether, but a later practice is to build a narrow-gauge railway in a subway under the boiler fronts. Small tip wagons, hauled electrically, run along the railway, and receive the ashes from the ash hoppers, the bottoms of which slope towards doors in the centre.

An induced-draught fan is often put down now in connection with central-station boilers, and is a very useful piece of plant, enabling the boilers to meet a sudden demand for steam, such as often occurs through fog or thunderstorms, in a manner which would be quite impossible with ordinary natural draught. By putting down an induced-draught fan when the boiler power has outgrown the chimney capacity originally provided, the necessity for a second chimney is done away with, or by installing induced-draught in the first instance, the chimney may be made shorter than would otherwise be necessary, an important point if the ground is not suitable for heavy loads. Induced-draught fans can, of course, be made to give a draught equal to that of a locomotive, but for stationary boilers it is not advisable to use a draught of more than 2in. of water, and even then the firebars may be melted unless the fireman is very careful. A draught equal to 1in. of water is generally quite sufficient, being about twice as much as that induced by a 150ft. chimney under ordinary conditions. Forced draught is not now used, induced draught having been found to be more suitable.

Steam-Mains.—These are always made of mild-steel plate, boiler plate, with lap-welded seams. The pipes generally have narrow flanges welded on the ends, and are coupled up by means of heavy loose steel flanges, the bolts being outside the pipe flanges. The mains are nearly always arranged on the "ring" system, to minimise the risk of interruption to the steam supply; some engineers even go so far as to provide two separate rings with separate connections to each engine and boiler, which, in the author's opinion, is carrying carefulness to the point of absurdity In an article published in *Engineering*, March 10, 1899*, the writer pointed out that a properly constructed steam-main is not nearly so liable to explosion as a boiler, and that the chief trouble occurs at the joints. He, therefore, suggested that a single pipe only should be used instead of a ring main, the joints between the lengths of pipe being riveted instead of bolted. By this means the condensation would be lessened, the trouble due to leaky joints done away with, and the main would be stronger and more elastic. Expansion is provided for in steam-mains by the use of large bends in the form of three-quarter circles, expansion joints being very rightly looked upon as untrustworthy.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, JAN. 18.

University College, London.—Lecture on "Liquid Air," by Dr. W. Hampson; the first of a course of six.

Royal Institution of Great Britain.—At 9 p.m., discourse on "Gases at the Beginning and End of the Century," by Prof. Dewar.

Institution of Mechanical Engineers.—At 8 p.m., annual general meeting. Adjourned discussion on "Power-Gas and Large Gas-Engines for Central Stations," by Mr. Herbert A. Humphrey.

TUESDAY, JAN. 22.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be read and discussed: "The Present Condition and Prospects of the Panama Canal," by Mr. James T. Ford.

Royal Institution of Great Britain.—At 3 p.m., Prof. J. A. Ewing on "Practical Mechanics."

WEDNESDAY, JAN. 23.

Institution of Electrical Engineers (Birmingham Local Section). At 8 p.m., inaugural meeting. Address by Dr. Oliver Lodge, chairman.—Students' Section: at 7.30 p.m., meeting. Papers on "Electro-Chemical Exhibits at the Paris Exhibition," by Mr. Maurice Solomon; and "Accumulators at the Paris Exhibition," by Mr. J. H. West.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "The Proposed High-Speed Electrical 'Monorail' between Liverpool and Manchester," by Mr. F. B. Behr. Sir William Preece will preside.

THURSDAY, JAN. 24.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Adjourned discussion on "Capacity in Alternate-Current Working," by Mr. W. M. Mordey.—Dublin Section—At 7.30 p.m., ordinary meeting at the Royal Dublin Society.

FRIDAY, JAN. 25.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Sewage Treatment," by Mr. C. Johnston.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting, Westminster Palace Hotel. Paper on "Railway Construction," by Mr. A. Ross.

Royal Institution of Great Britain.—At 8 p.m., meeting; discourse at 9 p.m.

Physical Society of London.—At 5 p.m., meeting, at Burlington House. Papers: "The New Physical Laboratories at the Royal College of Science," by Prof. A. W. Rücker, and "Exhibition of an Experiment on the Migration of the Ions," by Mr. S. W. J. Smith.

Electro-Harmonic Society.—Smoking concert at St. James's Hall Restaurant.

North-East Coast Institution of Engineers and Shipbuilders.—General meeting at Newcastle-on Tyne.

SATURDAY, JAN. 26.

Institution of Junior Engineers.—At 7 p.m., anniversary dinner at the Westminster Palace Hotel.

* "Steam-Mains for Electric Supply Stations."

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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THE SYDENHAM BOILER EXPLOSION.

The great importance of the subject of boiler explosions renders it necessary that some allusion should be made concerning the Board of Trade report on the explosion of a boiler at the Springfield works of the Crystal Palace Supply Company on July 23, 1900. It will be remembered that two men lost their lives by this explosion and others received injury. Unfortunately, the report is condemnatory of everyone concerned with this boiler throughout. It "was not properly constructed, and when new was not fit for a working pressure of 140lb. per square inch," the pressure used in ordinary working. The company "did not appoint competent persons to attend to the upkeep of their boilers." The explosion is directly attributed to the failure to make a test suggested by the Boiler Insurance Company, 'for if the test had been applied the fire-box would in all probability have collapsed under it, but in any case it would have deflected to such an extent as to reveal the fact that there was a grave mischief." Although this test was suggested, the insurance company's inspectors "did not properly or thoroughly" examine the boiler. True, there were difficulties in the way, but we think the report, while pointing out the faults all round, ought to have been most severe on faulty construction. Here, again, the builders must be justly dealt with, for they are wholly in the hands of responsible employés. They found subsequently that the person responsible had been somewhat lax in what he passed and what he condemned, and, as might be expected from an eminent firm, promised careful and immediate examination of boilers passed during the period in question. Thus far all is plain if painful sailing, yet there is a history attached to Sydenham not told in this report which, however, may have had something to do in originating or in passing the boilers. If we mistake not, a great effort was made by the company to complete the installation at a particular time in order to benefit by a load to be used at the Crystal Palace. No doubt every effort was made by the contractors to comply with the requests of the company, hence the supervision all round might have been somewhat relaxed. Probably this was really the starting point of the trouble. That explanation, however, does not cover the fault of bad design, nor of careless and imperfect examination. It is to be feared that many owners of boilers depend altogether upon the examination of the insurance companies to tell them of weakness or of danger, and in order to save a few paltry shillings do not of themselves employ competent men, either as workers or as examiners. The tale of Sydenham from beginning to end is one not to be followed, but the crux of the whole matter is whether any other stations are in a similar plight. We have always persisted that the best electrical engineer was he who superimposed his electrical knowledge upon a training in mechanical engineering. It is more or less admitted that the chief at Sydenham was not so much a mechanical as an electrical engineer, and is not this the case in most of our central stations? The vital breakdowns are often purely

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mechanical problems. Indeed, all that concerns boilers and engines, and much that concerns dynamos, is of this character; hence the necessity of a mechanical training. There has not been a sufficient lapse of time during which the industry has existed to develop many faults which must arise as works grow older, but from what is stated in this report, committees and directors ought to see that competent supervision and examination of boilers and other plant is regularly carried out in the works under their charge.

COOPER'S HILL.

"A sudden and arbitrary dismissal of able and distinguished scientific teachers" is Lord Kelvin's opinion of the action of Colonel Ottley, R.E., supported, we presume, by the visitors of the college, in giving three months' notice to a number of members of the teaching staff. Colonel Ottley is a new broom, and new brooms are apt to sweep clean. It may be doubted, however, if in this case the new broom is used beneficially. An enquiry into these high-handed proceedings is asked for, and as it is backed by the powerful advocacy of the *Times* will, we hope, be granted. The teaching profession is the best abused profession in the kingdom—its members are inadequately paid, expected to perform impossibilities, and have few prospects for the future. It is easy to gird at the shortcomings of our teachers, but we certainly get as good as we pay for. Putting aside the question of incompetency, one of the necessities of good teaching is continuity of office. A professor is not like a hedge carpenter, able to get a job at the next farmhouse and independent of his surroundings. Men of ability will not endure the uncertainty attaching to the professor's position if its occupant is to be turned adrift at the will of every newcomer. Every effort should, therefore, be made to obtain just, if not generous treatment, for the men who are placed under these orders. They are teachers, while neither the head of the college nor the "visitors" have any experience of teaching. The experienced men have not been consulted as to the changes required—if any are required—to make the college course more effective. The whole procedure at present appears most unsatisfactory.

ELECTRIC LIGHT IN NORTH LONDON.

In our last week's issue we gave a report of a public meeting held at Enfield in order to consider a Bill which is now being promoted in Parliament by the District Councils of Enfield, Tottenham, Southgate, Edmonton, and Wood Green for the purpose of obtaining powers to establish a joint electric lighting and power distribution system. At this meeting an adverse vote to the scheme was passed. A poll was accordingly demanded. We now learn that the voting papers will be delivered on Thursday, Feb. 2, and collected on Feb. 11.

The agitation has now spread to Edmonton. At the last meeting of the Council a petition signed by nearly 300 ratepayers was received in opposition to the great scheme, and the chairman of the Council was asked to call a public meeting to discuss the question. This meeting was held on Tuesday last, all the members of the Council being present We may mention, in passing, that at the meeting of the Council several members expressed their disapproval of the way the North Metropolitan Electric Supply Company was organising the opposition to the joint scheme. The public meeting on Tuesday was a most unruly one. The chairman of the Edmonton Urban District Council moved that the meeting's consent should be given to the Urban District Council of Edmonton promoting, in conjunction with the other Councils above named, a Bill with the objects mentioned above. This motion was put to the meeting after a considerable discussion on both sides, and was passed by a large majority. Mr. Robert Hammond, who is advising the joint councils on the matter, was present at the meeting, but did not make a speech. Although the resolution was passed by a large majority, a poll was demanded, at which the ratepayers will have a chance of expressing their opinion on the matter. The North Metropolitan Electric Supply Company are strenuously opposing the scheme, as it would practically take away a very considerable portion of their area over which they obtained general distributing powers in the parliamentary session of last year.

THE SYDENHAM BOILER EXPLOSION.

The Board of Trade have issued the report of Mr. Howard Smith and Mr. J. H. Hallett upon the explosion which occurred on July 25, 1900, at the works of the Crystal Palace District Electric Supply Company, Springfield, Upper Sydenham, and in which two persons were killed and five injured.

From the report we learn that the boiler was of the locomotive type and was made by Messrs. Hornsby and Son, of Grantham, in 1891. It was thus nine years old when the explosion occurred. As the first fracture occurred in the crown plate, this portion of the boiler only need be described by us. The crown plate was supported by seven girders, each being formed of two wrought-iron plates 7in. in depth and $\frac{7}{16}$in. in thickness. Between these were secured at each end, by two nuts, cast-iron distance pieces, which had toe-pieces cast on their lower extremities for the purpose of bedding on the end plates by which the girders were supported. Each girder was supported by two suspension or hanging stays. The crown plate of the furnace was secured to each girder by 14 1in. stay bolts.

The explosion was caused by the toes breaking off the cast-iron distance pieces at the fire-hole end of each of their seven fire-box girders. The load which should have been taken by the vertical end plate was thus transferred to its flange, causing it to deflect, the additional load thereby being thrown upon the hanging stays, four of which were previously broken. The rest of them gave way, and the crown of the fire-box having no adequate support collapsed at about the working pressure of 140lb. per square inch. The explosion was a very violent one, the crown of the fire-box being blown out bodily, leaving an opening 6ft. by 3ft. 6in., through which the contents of the boiler issued with terrific force. This crown plate fell some 7ft. away, and caused a considerable depression in the floor. The reacting force swung the boiler round slightly, and then shot it upwards through the roof of the boiler-house, which, together with the upper portion of the outer side wall, was demolished. The boiler then passed across the roof of the engine-house in an oblique line, and finally fell in the garden of a cottage adjoining. The engine-house roof collapsed, and from the photographs in the report one gathers that a considerable amount of damage was done to the plant.

After hearing evidence from all concerned, the above-mentioned gentlemen were asked by Mr. Gough, who represented the Board of Trade, to state how far the makers, the Engine Boiler and Employers' Liability Insurance Company, and the various employés at the station were to blame. Their reply may be contracted as follows: A competent person was not engaged by the Crystal Palace District Electric Supply Company to examine their boilers in June, 1898, and thereafter, and the boiler was not thoroughly examined from time to time by Mr. James Wallace, the fitter, who was not competent to examine it. The boiler was not properly or thoroughly examined by Mr. Charles A. Booth, an inspector to the Engine Boiler and Employers' Liability Insurance Company, on April 17, for he did not gauge the fire-box. The boiler was not then fit for a safe working pressure of 140lb. per square inch. In our judgment proper measures were not taken by the Crystal Palace District Electric Supply Company to ensure that the boiler was being worked under safe conditions. With the exception of the inspections of

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the insurance companies the persons who were employed to examine the boiler were not competent to do so, and Mr. Phillips, the electrical engineer of the company, was not competent to ascertain whether they knew their duties or to supervise their work. One of the directors stated that the company had insured only for the sake of being indemnified from loss occasioned by an explosion. Another director stated that the insurance was effected for the additional purpose of obtaining regular inspections of the boiler. We think that the latter was one of the reasons why the insurance was effected; but it is evident to us that it was not very present to the minds of the directors. We are not at all sure that they relied on the reports of the insurance companies, but, in any case, having regard to the magnitude of the works and to the necessity of a constant supply of steam at high pressure, we are of opinion they should have had in their employ some person really competent to examine their boilers, or should have called in from time to time some such person, and not have trusted entirely to the reports of the insurance companies. We have been asked to say whether the explosion was due to the defective construction of the boiler. We answer this question by saying that but for defective construction, for which Messrs. Richard Hornsby and Sons are responsible, the explosion would not have occurred. We do not, however, consider the faulty construction the real or immediate cause of the explosion. . . . The failure to make proper examinations was, in our judgment, the real cause of the explosion. The explosion was caused by the neglect of Mr. Phillips. He knew there was deflection in the fire-box crown, and not being able to ascertain the cause of it himself, he wrote to the National Boiler Insurance Company to advise him. The advice he received was to have the boiler tested by hydraulic pressure to 280lb. per square inch. For the application of this test Mr. Phillips failed to make arrangements at the time, and the importance of it never seems afterwards to have occurred to him. . . . This neglect, we find, was the main cause of the explosion, for which we find Mr. Phillips to blame, and for which we must hold the Crystal Palace District Electric Supply Company responsible. With regard to Mr. James Wallace, the fitter, we do not find him to blame. He appears to have examined the boiler to the best of his ability. The explosion was certainly contributed to by the neglect of Mr. Charles A. Booth. He made the first thorough examination after the boiler had been accepted for insurance by his employers, and therefore it was incumbent upon him to have made a most careful examination, the more so as the boiler was difficult to examine. We do not, however, wish to express any very strong condemnation of his conduct, but he is to blame for not having detected the deflection in the fire-box. For this neglect we have to find Mr. Booth to blame, and the Engine Boiler and Employers' Liability Insurance Company will, in consequence, be held responsible for that neglect.

INSTITUTION OF ELECTRICAL ENGINEERS.

Capacity in Alternate-Current Working.

BY W. M. MORDEY.

This is an attempt to consider some of the effects of electrostatic capacity in insulated cables for alternate-current working, especially as regards the power and plant. Distinctions formerly drawn between "current electricity" and "static electricity" have left impressions on our minds by no means helpful now. When we come to deal with electrostatic capacity in engineering applications with rapidly alternating currents, we find that so far from being "static" the conditions and effects are those of current or flow, and may most usefully be studied as such. Electrostatic capacity in cables in some respects is an advantage, but on the whole it is a serious drawback in alternate-current work, mainly because it is directly and indirectly a cause of waste of power.

Now that many applications of extra high-tension alternate-current distribution are being promoted, it may be useful to carefully examine what is involved in this property as regards the power and plant required. In attempting to do this I may be allowed to begin at the beginning, as I think this may be useful to many engineers who have not hitherto considered the subject in its relation to economy of working. The capacity of a cable is measured usually by comparing it with that of a standard condenser, using a low pressure and observing the throw of a ballistic galvanometer. The unit of capacity is the farad, but as it is too large for practical purposes, the practical unit adopted is the microfarad, or 1/1,000,000 of a farad. Electric supply cables have a capacity varying from about one-fifth of a microfarad to about one microfarad per mile, according to the size, the form, and the kind of insulating material used. If two cables are connected to the terminals of an alternator, a current to charge the cables will flow into them as the pressure rises in each half period, and back again as the pressure falls. As this occurs usually from 100 to 200 times a second, it is, of course, just as "continuous" as any other alternating current. The amount of this charging current is easily found if we knew the capacity of the cable.

Perhaps I may be allowed to give a practical idea of what a microfarad is in terms of volts, amperes, and periods. The capacity current in amperes

$$= \frac{\text{volts} \times \text{periods per second} \times \text{microfarads} \times 2\pi}{1{,}000{,}000}.$$

Take an illustration from ordinary familiar working conditions in order to fix in the mind a quantitative idea of this:

One microfarad takes 0·6283 ampere at 2,000 volts 50 ⌒.

The above expression assumes that the capacity is independent of the pressure. In order to satisfy myself on this point I was able, by the kindness of Mr. Gray and the Silvertown Company, to make some tests on some rubber cable in the tanks at the Silvertown Works. The alternator ran at 90 ⌒, and the pressure was varied from 2,000 to 5,000 volts. The following readings were obtained:

Volts.	Amperes.
2,000	0·62
2 500	0 75
3,000	0·97
3,500	1·11
4,000	1·29
4,500	1·45
5,000	1·65

These results, which are plotted in Fig. 1, show that the current is simply proportional to the pressure, and, therefore, that the capacity is not affected by the pressure.

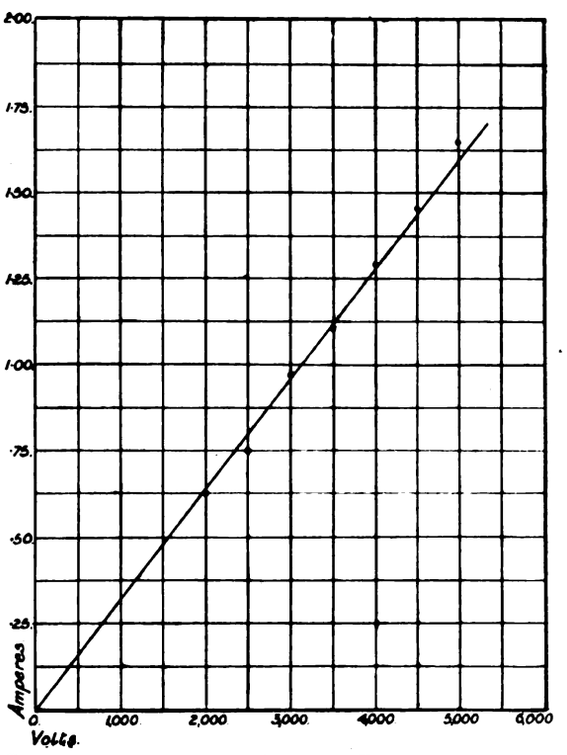

FIG 1.—Capacity Current taken by Cable at Various E.M.F.'s, 90 ⌒.

I may here draw attention to the ease with which capacity measurements of systems of mains may be taken. It is a measurement that is, I think, never taken by station engineers. Knowing the E.M.F. and the periodicity, it is only necessary to take the current. Then

$$\frac{\text{volts} \times \sim \times 2\pi}{\text{amperes} \times 1{,}000{,}000} = \text{microfarads}.$$

If the tests are always taken at one E.M.F. and periodicity, the scale of the ammeter may be marked to read directly in microfarads. This method is, of course, merely according to the "Ohm's law" of the subject, but it does not appear among those given in standard works on the subject. As it can be applied wherever an alternator is available, it should be useful to station engineers and others, especially for taking the capacity after the mains have been laid. The test can be made at the full working pressure, and variations of capacity with age may be easily observed. In order to show what the capacity current may amount to in practice, I have worked out the following table for a length of cable having a capacity of one microfarad. The capacity current is directly proportional to the pressure and to the periodicity. The "apparent watts,"

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or the amperes multiplied by the volts, are proportional to the square of the pressure for any given periodicity. The table gives the current taken at various pressures by a cable of one microfarad at 50 ⁓, also the apparent watts taken and the apparent horse-power. Another column, to be referred to later, gives the true watts.

TABLE I.—Capacity Losses in Cables. Capacity Current, Apparent Energy, and Actual Energy required by a Cable of one microfarad at various E.M.F.'s, 50 ⁓.

Volts.	Amperes.	Apparent watts, V × A	Apparent E.H.P.	True watts, V × A × ·124.
1,000	0·314	314	0·42	39
2,000	0 628	1.256	1·69	156
3,000	0·942	2,826	3·8	350
4,000	1 256	5,024	6·7	623
5,600	1·57	7,850	10·5	973
6,000	1·88	11,300	15	1,400
7,000	2·2	15,400	20	1,910
8,000	2·5	20 100	27	2,490
9,000	2 83	25,430	34	3,150
10,000	3·14	31,400	42	3,890
15,000	4·62	69,300	93	8,590
20,000	6 28	125 600	166	15,570
25,000	7·85	196,000	263	24,300
30,000	9·42	282 600	380	35,040
35,000	11·	385.000	516	47,730
40,000	12 56	502,400	672	62,300

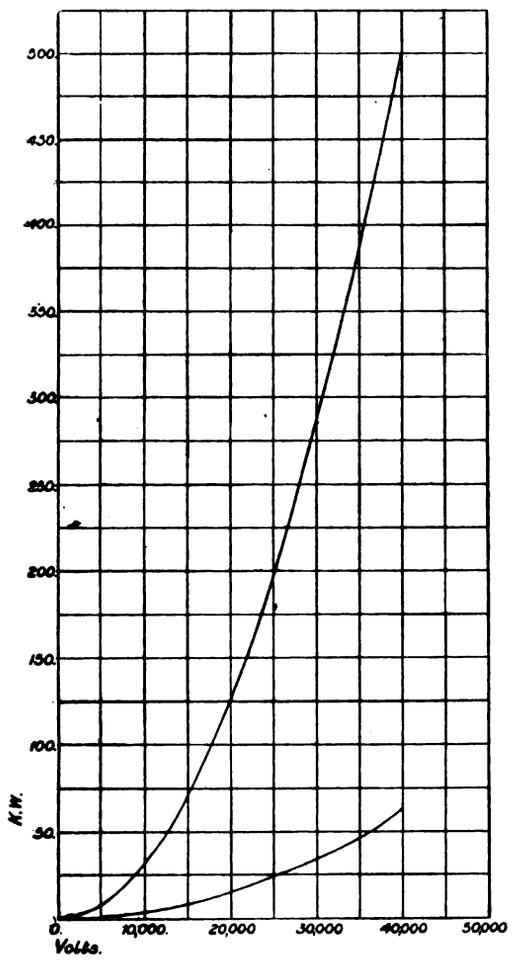

FIG. 2.—Apparent and Real KW. taken by Cable of 1 mfd. at Various E.M.F.'s, 50 ⁓. Upper Curve = Apparent KW., Lower Curve = Real KW.

Fig. 2 is plotted from this table, the upper curve giving the apparent power and the lower curve the true power. Fig. 3 is the lower part of Fig. 2 drawn to a larger scale. At 100 ⁓ the current and watts would be double, and at 25 ⁓ they would be one-half of the values given in the table. When it is remembered that large distribution systems working at 10,000 to 20,000 volts may, and probably often will, have cables the capacity of which may be scores of microfarads, it will be realised that the magnitude of the capacity effect is considerable. Even at low and moderate pressures it is by no means negligible. The term "apparent watts" is rather unsatisfactory. It is generally used to indicate that the whole of some volt-ampere quantity is not true watts, but it is sometimes applied to volt-amperes that are not watts at all. For instance, people will say, "So many true watts and so many apparent watts." The safest plan seems to be to use the term "apparent watts" as including both true and false watts, adding the power factor, when known, to show how many of the apparent watts are true and how many are false.

The next question to consider is, What is the power factor of the cables? This is very important, for whatever we may be able to accomplish in neutralising or compensating the charging current, so far as I know we can do nothing to reduce the true watts absorbed by the dielectric of any given cable at any given pressure and periodicity. These true watts are made up of ordinary copper loss or C^2R due to any charging current flowing in the conductor, to leakage, and to dielectric hysteresis. The C^2R loss due to the passage of the capacity current is usually unimportant, at least in large cables. It is easily calculated.

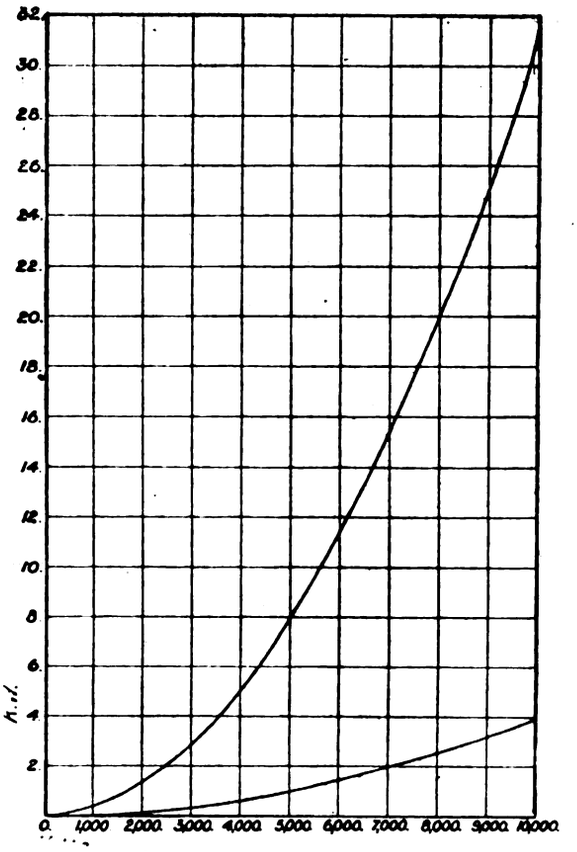

FIG. 3.—(This is the lower part of Fig. 2 drawn to a larger scale. Upper Curve = Apparent KW., Lower Curve = Real KW.

The leakage is also usually unimportant. Thus if a 2,000-volt cable has an insulation resistance of, say, 1,000 megohms per mile, the leakage will be only two millionths of an ampere and four thousandths of a watt per mile. Then there is the loss from dielectric hysteresis—that is, the loss of energy due to the insulating material being subjected to rapidly repeated and violent electric strains. Whether this effect is simply due to mechanical friction caused by rapidly repeated attractions and repulsions between the particles of the insulating material, and between that material and the metal within it and outside of it, or whether it is due to some more obscure molecular or polarisation effect, I do not know. A simple explanation is to be preferred if a satisfactory one can be got. From what we can observe of actual mechanical vibration it seems possible that the first-mentioned cause is sufficient to account for the loss. But how much is this loss? By the kindness of Mr. Sparks and the County Company I have been enabled to make some tests on this and other points. The cable placed at my disposal was 5½ miles of $^{37}/_{15}$'s concentric rubber covered. It was steel sheathed, drawn into 2in. cast-iron pipe—the outer conductor was earthed, and the steel sheathing also earthed every 220 yards by stranded copper cables bolted to the iron pipe. This cable was intended to be used at 6,000 volts 50 ⁓, but my test was made at 2,050 volts 100 ⁓. The makers' test gave the capacity as follows: ·86 microfarad between inner and outer, and 1·06 microfarad between outer and earth. As the outer was earthed I need only consider the inner. The capacity current should be:

$$\frac{2{,}050 \times 100 \times \cdot 86 \times 5{\cdot}5 \times 2\pi}{1\,000{,}000} = 6{\cdot}092 \text{ amperes.}$$

I found the actual current was six amperes—practically confirming the makers' test. It was interesting to find a measurement made at a high E.M.F. and high periodicity gave the same result as a ballistic galvanometer test with a low E.M.F. The cable was run for several hours with a Thomson recording wattmeter in circuit, this instrument having been specially

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tested by the County Company at low power factors. The pressure was nearly steady at an average of 2,040 volts, the current being six amperes. The apparent watts were therefore $6 \times 2{,}040 = 12{,}240$. The true watts by the wattmeter were 1,515, or 275 watts per mile. The power factor $= \frac{1{,}515}{12{,}240}$ $= 0{\cdot}124$—that is to say, the true watts were 12·4 per cent., or about one-eighth of the apparent watts. The $C^2 R$* and the leakage were both negligible, so the whole of this loss was due to dielectric hysteresis. It cannot be said that 2,226 apparent watts and 275 true watts per mile are negligible quantities. This is at 2,000 volts 100 ~. When the cable is worked as intended at 6,000 volts 50 ~ the losses per mile will be $\cdot 86 \times 6{,}283 \times 3 = 1{\cdot}621$ amperes; the apparent watts per mile $1{\cdot}621 \times 6{.}000 = 9{,}726$; and the true watts $9{\cdot}726 \times {\cdot}124 = 1{,}206$ per mile. This, of course, is on the assumption that the power factor is the same at high pressures as at low (as seems probable), and that the loss in this instance was accurately determined.

The dielectric loss is not preventable. It may be lessened by increasing the thickness of the dielectric—that is, by reducing the strain, or by using a dielectric of low specific capacity, and by working at a low periodicity—but for any given case it must be accepted as one of the conditions of working. In some respects it is like the hysteresis loss accompanying the magnetising and demagnetising of iron. But dielectric hysteresis seems to differ from magnetic hysteresis in showing no saturation effect. Possibly at very high pressures the curve may begin to bend down, but I should expect the insulation to break down earlier than the proportional law. I have already said that the actual loss in the dielectric, whatever its amount, is going on always when the mains are energised, whether any power is being transmitted or not. In the case just examined of the 6,000-volt 50 ~ transmission, it amounts to about 0·23 watt per foot of cable. So far as it is a cause of waste of power, this may be, and often is, a much more important loss than the ordinary $C^2 R$ copper loss. This will be seen from the following comparison: The $^{37}/_{15}$'s cable (0·154 square inch) has a resistance of 0·271 ohm per mile, or 0·542 per mile for the two conductors. The constant dielectric loss of 1,206 watts per mile is therefore equivalent to a copper loss due to the constant passage through both conductors of 47·2 amperes, or at the current density of 326 amperes per square inch (or in the single conductor 67 amperes = 460 amperes per square inch); or a current that would give a drop of 25·6 volts per mile, or 0·46 per cent. per mile on a 6,000-volt circuit. If the cable is in continuous use, its dielectric uses up 10,564 Board of Trade units per mile per annum. To further illustrate this loss I have worked out tables for 2,000 volts and 7,500 volts, taking five commercial sizes of concentric cables and giving the dielectric losses, and the copper losses that would be equivalent to those dielectric losses. I have taken the dielectric power factor as 0·124, as before. This factor may, of course, vary with different cables.

TABLE II.—Cables Working at 2 000 Volts, 50 ~. Losses in Dielectric per Mile.

Size of cable		$^{17}/_{20}$	$^{19}/_{20}$	$^{19}/_{16}$	$^{19}/_{14}$	$^{37}/_{16}$
Copper section, square inches		·007	·019	·060	·094	·118
Resistance		6	2 213	·7	·45	·36
Capacity, microfarads		·33	·5	·6	·7	·75
Apparent watts		419	628	754	880	944
True watts		52	78	93	109	117
Current (and current density) in conductor that would give loss equivalent to that in dielectric	Amp	2 95	5 95	11·55	15 6	18
	Amp per sq. in	420	312	192	165	153
B.T. units per mile per year		455	683	815	955	1,025

TABLE III.—Cables Working at 7,500 Volts, 50 ~. Losses in Dielectric per Mile.

Size of cable		$^{17}/_{20}$	$^{19}/_{20}$	$^{19}/_{16}$	$^{19}/_{14}$	$^{37}/_{16}$
Microfarad per mile		·2	·33	·364	·425	·454
Apparent watts		3,300	5 450	6,000	7,000	7 500
True watts		410	670	744	870	930
Current and (current density) in conductor that would give loss equivalent to that in dielectric	Amp.	8·3	17·4	32·6	44	50 7
	Amp. per sq. in.	1,180	913	540	467	430
B.T. units per mile per year		3,590	5,870	6,520	7,630	8 147

Nots.—In Tables II. and III. the equivalent copper loss is taken as that in a single conductor—not in a "lead and return"—for the reason that the dielectric loss is the same (for the same capacity) whether the main is a single one or double.

* The $C^2 R$ in this case = 13·4 watts.

Take a higher pressure illustration: Imagine a system of 40 miles of cable working at 20,000 volts 50 ~, the capacity being 0·5 microfarad per mile. With no load and no apparatus connected to the mains, the generator would have to provide a charging current of 125·6 amperes at 20,000 volts = 2,512,000 apparent watts. If the power factor is ·124, then the actual energy absorbed by the mains will be 311,488 watts, and the number of Board of Trade units consumed per year will be 2,728,633, or an annual output that is exceeded by only a very few electric supply stations in this country. The loss works out at 1·5 watts per foot of the cable. One rather unfortunate property of cables is shown by these tables. I refer to the fact that as different sizes of cables, made systematically to be suitable for safely working at any given pressure, have capacities which do not lessen very much with decrease of size, the dielectric loss of small cables is therefore disproportionately large. For example, in the five sizes given, the section increases in the ratio 1 to 17, but the capacity only as 1 to 2·28.

The carrying power of a cable is limited in most cases by drop of volts rather than by heating or loss of power, otherwise this dielectric loss would very much restrict the load that could be put on cables. Nevertheless, this loss seriously affects the question of raising the pressure for long distances or large powers—at least, where underground or covered conductors have to be used. As the copper loss is inversely in the square of the current, the temptation is to increase the pressure and reduce the current. But the dielectric loss being proportionate to the square of the pressure, and being, moreover, a constant or all-day loss, whereas the copper loss is only fully felt at times of full-load limits to increase of pressure are imposed which may be reached sooner than has been supposed. This opens a field for very careful consideration—and balancing of advantages—of high and low (or lower) pressure. I do not attempt to make any comparisons now. Every case must be examined on its merits, and due weight given to load factor, drop, value of power, plant capacity, and so on. I believe the general opinion has been that the production of capacity current involved practically no expenditure of energy; that it was in reality a wattless current, and that the only waste—a sufficiently considerable one—was in running the alternator under light load. I think nothing contrary to this opinion was put forward before the recent parliamentary committees on Power Bills. Those committees were assured, for instance, that so far as power was concerned, the losses with underground cables were the same as with aerial lines. I fear this is by no means the case. I do not wish to adopt an alarmist tone on this subject, but I think it will be admitted that if the tests referred to above are even only approximately correct, the subject deserves the very serious consideration of electrical engineers. It is probable that those who have had to do with extra high-tension mains, or even with long or extensive mains working at moderate high pressures, will have noticed, as I have, that when switching such mains on the engine has been checked much more than would be consistent with the production of merely wattless current.

We may now pass from the question of the power factor and the true power to the wattless part of our "apparent watts." This we see is about 87·6 per cent., or seven-eighths of the total. It is very desirable we should do anything we can to lessen the production of "wattless current" by the alternator, as the amperes are real even if the watts are not. In producing "wattless current" at full pressure the alternator is taking a good deal of power, and is working very wastefully as to steam consumption. It takes practically as much plant to produce the current as if the energy were real. In fact, it might easily happen from the known wastefulness of engines working at light load and from other causes that the true energy would cost less to produce it than the false or wattless energy. For example, to charge 20 miles of the 6,000-volt cable referred to above (and assuming that no means are used to counteract the capacity) the alternator would have to be run at 6,000 volts, sending out $1{\cdot}621 \times 20 = 32{\cdot}4$ amperes = 194,500 apparent watts, or 260 apparent electrical horse-power. This would require a 200-kw. alternator fully loaded so far as current is concerned, although the true energy would only be $194{\cdot}5 \times {\cdot}124 = 24$ kw. As there are objections to running a large alternator by a small engine, a large combined plant is often run on a low power-factor circuit. Fortunately the difficulty can be avoided very simply, by the application of known principles. To some extent this is done now, but I think it is done accidentally or unconsciously, or at least without system.

(To be continued.)

Sheffield.—The Tramways Committee expect that the system of running cars through from end to end of the city, approved by the City Council last week, will be working on Feb. 1. The benefit which will be derived from the through system is the removal of the block caused at present by the existing termini in the central streets. There will be no increased service, and the fares will be 1d. from the city to each terminus, while the ½d. stages will remain unaltered.

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LIGHT RAILWAYS.

The Light Railway Commissioners have submitted to the Board of Trade for confirmation under the Light Railways Act, 1896, an order for the construction of light railways in the borough of Mansfield, and the urban districts of Mansfield Woodhouse, Sutton-in-Ashfield, and Hucknall-under-Huthwaite.

Major J. Wallace Pringle, R.E., has held an enquiry at Chattenden Barracks, near Chatham, into the proposed Chattenden naval tramway which the Admiralty propose to construct in order to place the new naval ordnance magazines in direct communication with Woolwich Arsenal.

The electric railways between Merthy and Dowlais and Cefn are complete, and will be opened in March.

The Law and Parliamentary Committee in their report on various light railway undertakings in the West Riding, state that the orders for the Barnsley and District Extension No. 2, and the Wales and Laughton light railways have not yet been received. The Commissioners have issued the order authorising the Tickhill light railway. The Riding solicitor and surveyor have been instructed to attend any local enquiry into the scheme of the proposed Rotherham, Tinsley, and Tickhill Light Railway Company. An effort is being made to secure a uniform gauge of 4ft. 8½in. for all light railways constructed in the Riding.

At a recent meeting of the Hanley Town Council the Town Clerk reported on the provisions of the draft order of the Light Railway Commissioners for the construction of light railways in the borough, applied for by the Potteries Electric Traction Company, Limited, and the Council decided to dissent from any of its property being taken for the proposed work. It was also decided to object to the construction of the light railways through and near the Market-square, on the ground that they would so greatly interfere with the wholesale vegetable and fruit markets as to almost destroy their usefulness; and to strongly object to the proposed railway to Far Green unless the applicants undertook to continue it within 12 months to Sneyd Green, and also to the proposed line to Bucknall, unless it was continued to Towns End, Bucknall, within 12 months. The Council further objected entirely to the construction of these light railways unless the applicants agreed to the following conditions amongst others: the insertion in the order of a clause empowering the purchase by the Council of the proposed undertakings at the same date that the Council were empowered to purchase other lines in the borough; that halfpenny stages on the line be arranged. The town clerk was instructed to communicate with the neighbouring towns affected by the application of the electric traction company, with a view of joint action in opposition with regard to any points agreed upon by them or to the fares at present charged at the local enquiry before the Commissioners. The Council are again urging the Potteries Electric Traction Company and the Shelton Iron, Steel, and Coal Company to take steps to minimise the danger arising from the level crossing in Etruria-road.

The Light Railways Committee submitted to the last meeting of the Stoke-on-Trent Town Council a series of objections to the Potteries Light Railways (Extension) Draft Order, and these were discussed at considerable length by the Council. It was decided to object to the construction of a loop at the junction of High-street and Liverpool-road, connecting the proposed new line from Stoke to Newcastle with the existing line from Stoke to Hanley, on the ground that it would be dangerous to the public. The committee suggested that the Council should object entirely to the construction of the proposed line from Newcastle to Trent Vale, connecting the tramway terminus at Newcastle with the line from Stoke to Hanford at the Black Lion Inn. The Council also objected to the proposed line from the terminus of the present tramway to Trent Vale over Hanford Bridge unless the applicants widened the roadway by purchasing land for that purpose. Generally the Council objected to the application unless the following, amongst other, conditions regarding it were accepted by the applicants: that a clause should be inserted in the order of the Commissioners empowering the purchase by the Council of the proposed light railways and equipment on July 28, 1917, the same date that the Council was empowered to purchase the other lines in the borough; that no conduit feeder or return cables should be laid in any street or road without the consent of the Council; and that halfpenny stages on the lines be arranged.

The Cork Council at their last meeting considered an application made on behalf of the Irish Electric Railways Company, Limited, for the approval of the Council of the construction of proposed light railways between Kenmare and Castletownbere, and the latter and Bantry, with a guarantee by the barony of Bere for the term of one year only of the nominal payment of 4 per cent. on the sum of £100. This application was withdrawn on application made by the General Electric Company of Ireland, Limited, for the construction of the proposed line of railway or tramway, and the matter was referred to a committee composed of the Finance Committee and of the members of this Council who are the representatives of the district affected, to report on it to the County Council, with instruction to consider the propriety of fixing a reasonably short time limit for the completion of the line.

It is proposed to apply to the Commissioners for an order to construct a line from the Southam-road Station on the Great Western Railway to Willoughby Station on the Great Central Railway. The proposed line will pass through Harbury, Ladbrook, Southam, Napton, Grandborough, Shuckburgh, Wolfhampcote, to Willoughby. The line will give increased communication with London, Birmingham, Banbury, Leamington, Oxford, and Rugby. The probable cost of the line will be about £5,000 a mile, and the distance to be traversed is about 10 miles.

Mr. James Dillon, Board of Works inspector, has held an enquiry into the merits of the projected electric railway from Midleton to Ballycotton as regards the engineering questions connected therewith.

The Northwich Urban District Council have received notices and plans from the promoters of an intended light railway between Warrington and Northwich, and the subject has been referred to the committee already appointed for the consideration of the matter.

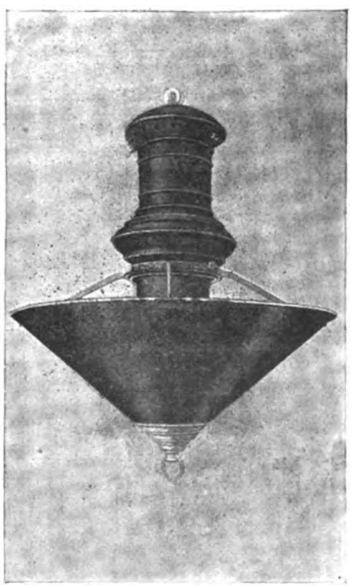
The Oldham Town Council have refused to sanction certain contracts in connection with the electric tramway scheme. It has been declared that the scheme was being "rushed," and that lines were laid long before they were needed.

The order made by the Light Railway Commissioners authorising the construction of tramways in Wakefield will be opposed by the West Riding County Council when it comes before the Board of Trade. The difficulty concerning Kirkgate Bridge, which crosses the river, has not yet been solved.

The Waterloo District Council have granted 200 guineas to Mr. F. S. Yates, 100 guineas to Mr. G. Oliver, the engineer and clerk of the works respectively, and 30 guineas to Mr. John I. Thompson, clerk, in respect of the extra duties discharged by them in connection with the promotion of the construction of the Waterloo-with-Seaforth tramways.

THE "ARK" LAMP.

The type of enclosed arc lamp with the distinctive name "Ark" has now been developed by Messrs. Johnson and Phillips for some years with some success. The latest new type of this lamp to be issued is an inverted arc, which is shown in the illustration herewith. It will be seen from this that all that is done by the makers in converting this lamp into the inverted type is to remove the outer globe and to



suspend beneath the lamp a cone reflector, which directs all the light upwards towards the ceiling. The lamp in consequence has all the features of long burning, simplicity, and durability which is common to the ordinary types of "Ark" lamps. It will burn on any circuit, and is so designed as to be complete in itself, as the resistance or choking coil required is contained in the open case. While there is not quite so much object in using an inverted lamp when the arc is enclosed in an opalescent globe, there are certain conditions in which a good diffused light is required without the source of light being visible. In these positions the enclosed inverted lamp illustrated above should find great favour.

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QUESTIONS AND ANSWERS.

If thou hast knowledge let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

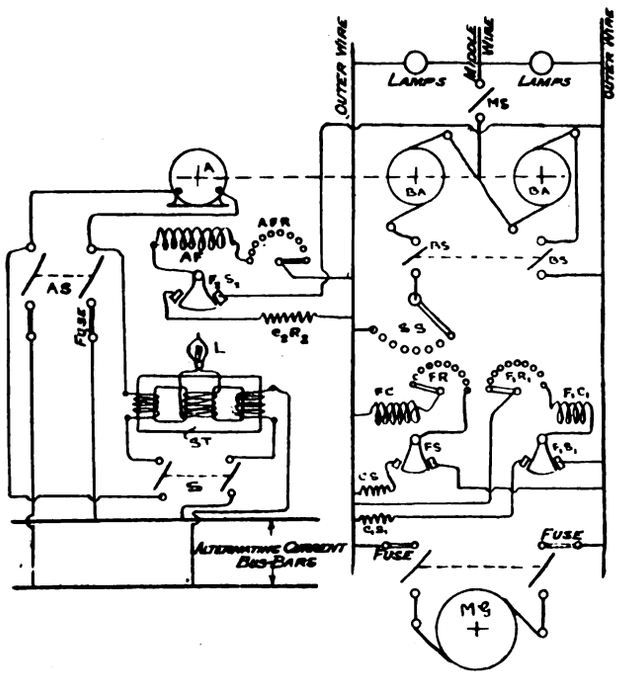
343. In stations supplying energy on the three-wire system at 400 to 500 volts on the outers, the Board of Trade require the neutral wire to be *permanently* earthed at the station. What are the advantages and what the dangers of such a proceeding?—E. M.

344. State whether there is any preference between three-core or triple-concentric cable for underground three-phase distribution. Give reason for reply.—D. P.

ANSWERS.

Question No. 337.—In a combined alternating and three-wire continuous-current station it is intended to couple the two systems by connecting an alternator direct to two continuous-current machines, which will be required to balance the three-wire system, supply the whole of the system on light load, or to drive the alternator and supply the alternating system at times of light load. Note.—The alternator is of the slow-speed type. Give diagram of connections.

Best Answer to No. 337 *(awarded* 10*s.)*.—Owing to the above question not being perfectly conclusive in all details, it is necessary to make one assumption. The questioner says that the two systems are connected together by coupling an alternator to two continuous current machines which are to balance a three-wire system and supply the whole of the system on light load (by this latter part we



assume that the alternator is to run as a synchronous motor driving the continuous-current machines as generators) or to drive the alternator and supply the alternating-current system on light load. Herewith is given a proposed scheme of connections which would enable us to obtain any of the required combinations. Each switch or piece of apparatus is given a reference letter, the signification of the letters being as follows: B A, B A_1 represent the two continuous-current machines, which may act as motors or self-exciting dynamos, consequently the flux density in the magnets must be sufficiently high to allow of this; A, the alternator—the three machines, A, B A, B A_1, are all coupled rigidly together; B S, B S_1, double-pole switch for the balancers, B A, B A_1; S S, motor-starting switch for the balancers; F C, F_1 C_1, the respective shunt coils of the balancers; F R, F_1 R_1, regulating resistances for the balancer shunts; F S, F_1 S_1, field-breaking switches with fan-shaped blades, which put resistances in parallel with the shunts at the instant of breaking—these are for the balancers; C_1 S_1, C S, non-inductive cushioning resistances for breaking the field of the balancer; M G, main continuous-current supply; M S, switch for putting middle wire into circuit; A F, alternator field; A F R, regulating resistance for alternator field; F_2 S_2, alternator field switch; C_2 R_2, non-inductive cushioning resistance for alternator field; S T, synchronising transformer; L, synchronising lamp; S, synchronising switch; A S, alternator main switch.

Description of Operations for any Desired Combination.—1. To balance the three-wire system: The main generating supply having been started up, first close both field switches, F S and F_1 S_1; then close the double-pole switch, B S, B S_1, and cut out the resistance of the starting switch, S S. The two machines will now be running as motors in series on light load. We now close the middle-wire switch, M S; this completes the three-wire system, and as the load comes on, the balancer will motor or generate on either side according to the distribution of the load.

2. Supply system on light load, the alternator running as a synchronous motor and driving the continuous-current machine as generator: We assume here that the main continuous-current supply is still on, and we wish to take up the load by running off the alternating-current system. We proceed as follows: First the alternator is brought up to its correct speed and voltage by means of the balancers which are running. The alternator field is being excited off the outers of the three-wire system. We now close the synchronising switch, S; the lamp, L, is then noted, and when the alternator, A, is in phase with the main alternations on the 'bus bars, the switch, A S, is put in, leaving the alternator running as a motor on the alternating supply, but as yet doing no work. The continuous-current generator, M G, may now be cut out. This is done by first reducing the voltage by means of the shunt resistance and then breaking the circuit with the main generator switch. We are now left with the alternator running as a motor and driving the continuous-current machines as generators, which now feed into the three-wire system. The voltages of the three-wire system may be regulated by means of the resistances in the shunts of the machines.

3. Drive the alternator and supply the alternating-current system: This means that the balancer must be running on the three-wire system; the alternator being coupled to the balancer is, of course, also rotating. The operation consists now of simply paralleling the alternator on the 'bus bars in the usual manner and then removing from the 'bus bars the other machine which may be running?—H. P.

Question No. 338.—What are the requirements for a lightning arrester for overhead cables, and how far are these requirements fulfilled in the present instruments?

Best Answer to No. 338 *(awarded* 10*s.)*.—The function of a lightning arrester is, firstly, to conduct to earth all discharges of atmospheric electricity which may otherwise do some damage to the plant or other apparatus in use, and, secondly, to prevent the line current from following the lightning discharge to earth, and so short-circuiting or badly overloading the plant at the power station. The voltage required to *maintain* an arc across a given air-gap is far less than that required to *start* the arc; hence the line current will *follow* where it cannot *lead*. An alternating potential difference of 10,000 volts will spark about $\frac{1}{2}$in. in air, but will *maintain* an arc of at least 6in. if once started.

There are, generally speaking, three kinds of discharges due to atmospheric electricity: (1) lightning actually striking the line; (2) induced rush or surgings in the line; (3)

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slow accumulation of charge in the line. It is doubtful if the lightning arresters now in use can save a line from some damage if it is struck directly by a powerful lightning discharge. Such occurrences are, however, comparatively rare. Class 2 are most numerous. When a lightning discharge takes place in the neighbourhood of a line, the action induces an E.M.F. in the line, which is generally of a rapid oscillatory character, producing surgings of current backwards and forwards along the line. It is this class of discharge which has most generally to be dealt with. Class 3 appears to be due generally to a charge accumulated from the air surrounding the line. If it is desired to prevent lightning discharges from entering the line at all, a common and successful plan is to employ a guard wire. This is generally an iron wire stretched along the whole distance of the line about 12in. or 18in. above the top wire, and is earthed at about every fifth pole, or, say, 15 times to the mile. This is very effective in districts which are not subject to very violent thunderstorms.

The general principle of lightning arresters is that of a short air-gap, one terminal of which is connected to line and the other to earth, with suitable arrangements for extinguishing the arc started by the lightning discharge. There are, however, several successful types of protector on the market in which the line is permanently earthed through a high resistance, which allows the lightning discharge to pass to earth, but prevents the line current following. One of the best of these is the Wurts non-arcing railway lightning arrester, which consists of two brass terminals mounted on a wood block, the upper one connected to line and the lower to earth. Between the terminals is a space of about $\frac{1}{2}$in., which is made into a high-resistance conductor by nine grooves of charred wood. For a 500-volt circuit the resistance of this arrangement is over 50,000 ohms, so that the leakage current is quite negligible.

In the Thury lightning arrester the discharge passes to earth through two air-gaps at the top and bottom of a metal arm about 2ft. long. This arm is pivoted near the bottom, and the lower gap is shunted by an electromagnet. The line current passes through the coils of the magnet in preference to the lower air-gap, and in so doing pulls the movable arm to one side and breaks the arc at the gaps. The arm then returns to its original position ready for the next discharge.

In the Oerlikon condenser lightning arrester a number of discs of iron are interleaved with mica discs of exactly the same diameter and threaded on to an insulated spindle. The top and bottom discs are connected respectively to line and earth, and the lightning discharge is broken up over the intervening mica edges between each metal disc, while the line current is practically unable to form an arc. About 45 metal discs are required for a 5,000-volt circuit. These arresters can be used for alternating or continuous currents. After long use, however, the edges of the metal plates get welded together, and these have to be renewed.

In the Wurts lightning arrester two solid metal cylinders in series with a carbon-rod resistance are placed within $\frac{1}{32}$in. of each other, and parallel to one another, and by the cooling action of the mass of metal chill the arc and extinguish same. For pressures higher than 1,000 volts a series of cylinders is used.

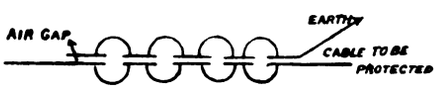
Siemens's arrester consists of two wires or rods bent into Y form. The distance between the vertical portions of the two rods can be varied to suit the line voltage, while the upper parts diverge to perhaps 18in. The arc is broken chiefly by the action of the heated air, which rises and carries the arc upwards into the space between the diverging rods. This arrester is extremely simple, but is rather slow in action.

In the Thomson-Houston lightning arrester, which is very largely used, the discharge is put to earth through two air-gaps, the latter of which is shunted by an electromagnet. The line current, if it passes the first gap, takes its path through the magnet coils owing to their lower resistance, and in doing so blows out the arc in the first gap, which latter is placed where it will be best acted on by the field produced. It will be seen that this arrester differs from the "Thury" in that the arc is extinguished by the *electrical* action of the field produced, not the mechanical action. Its action is exceedingly quick and reliable for continuous currents.

In the Wurts non-arcing metal lightning arrester a series of cylinders of non-arcing metal, such as zinc or antimony, are arranged with air-gaps of $\frac{1}{32}$in. between each, the first being connected to the line and the last to earth. With *alternating* currents a short-circuit is not maintained. A continuous current arc, however, is not broken. This arrester is largely used, the interruption of the arc being extremely rapid.—E. M.

Answer to No. 338 (awarded 5s.).—Almost all the information we possess about lightning arresters will be found in vol. xix. of the *Journal* of the Institution of Electrical Engineers, which contains the paper read before a meeting of that body on April 24, 1890, by Prof. O. J. Lodge, and the discussion which followed the paper. Prof. Lodge stated that "any lightning protector is better than none at all, and the best of those in use are by no means inefficient instruments. They do not afford perfect security, and the occasions when they partially fail are not very numerous." When we consider the vagaries of a thunderstorm, the varying pressures of the electricity, the fact that either the earth or the cloud may be positive, it would be surprising if an arrester were made which the manufacturer or inventor would guarantee to act in every case.

Prof. Lodge showed many experiments during the reading of the paper, the place of the lightning flash being taken by discharges from Leyden jars, and he showed that if the protector consisted in any part of a coil of wire the lightning would jump from layer to layer and pierce the insulation, while if the protector consisted of two knobs near to each other, one having an earth connection and the other being in electrical connection with the line to be protected, part of the lightning flash might, and probably would, run to earth, jumping from knob to knob, but still enough would remain to flow along the line wire in most cases to do serious damage. In fact, Prof. Lodge states: "No conceivable form of single air-gaps, whether between knobs or points, or plates or wires, or between wire and tube, or coil and cylinder, or any other possible device, can possibly afford complete and adequate protection. If these single air-gaps are not perfect protectors, and the current leaps from layer to layer if a coil is used, we are forced to use a combination of forms, and Prof. Lodge proposes a series of knobs or plates so arranged that the surplus of the charge left after passing the first arrester may find a means of escape through the next, and so on. The arrangement is shown in the diagram. It must be remembered that the



only great difficulty which occurs in protecting electric light leads is that the lightning spark is able to start an arc across the air-gaps to earth, which may be maintained by the main current.

Now, then, the requirements for a good protector may be put down in a negative form. (1) It must not consist of a coil through which the current due to the lightning flash has to pass; (2) it must not consist of a single air-gap; (3) it must be so arranged that the arc to earth shall not be maintained by the main current.

With regard to the extent to which these requirements are fulfilled with modern instruments, much depends on the make; some instruments are good, some moderate, some radically bad. Telephones are usually protected by means of two pieces of brass cut into adjacent points; telegraph instruments are protected by means of two plates insulated from each other by means of paraffined paper, while there are numerous instruments for the protection of the electric light leads. Some of these are built upon the model of Prof. Lodge's device. Many others are designed with a single air-gap, the length of which can be adjusted at will, as the air-gap is between a plate and the end of a pivoted lever. In these the other end of the lever is attached to a soft-iron core hanging in a solenoid, along which the main current has to flow if it maintains the arc to earth made by the lightning flash, and the very fact of

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its so flowing energises the coil and opens the length of the air-gap.

Another form consists of two parabolic horns of metal, one on the earth wire and the other on the main lead. The air-gap thus gradually increases in length as you advance up the horns, whilst another form consists of a series of fuses so arranged that if one blows, a second is brought into use.

It will therefore be seen that it is impossible in a general way to state how far the necessary requirements are fulfilled in modern instruments, but that the question has to be left when the requirements are stated.—M.

CATALOGUES.

The Mackey's Electric Lamp Company, Limited, of New Church-street, Bermondsey, S.E., have issued with the beginning of the century a new list of their incandescent lamps. These lamps are now manufactured by the firm in a great variety of sizes and shapes to meet the views of the customers who go in for artistic effects in which the shape of the lamp is to blend with the design of the electrolier. With the ordinary consumer, however, the well-known bulb shape is still most in favour. For lamps up to 110 volts the firm now list four different efficiencies, commencing with 2½ watts per candle and going up to four watts per candle. Naturally, the life is in the inversed ratio of the efficiency. For instance, it is claimed that for lamps from 3½ to 4 watts per candle an average life of 1,000 to 2 000 hours may be expected, whereas with high-efficiency lamps from 2½ to 3 watts per candle the life will be more like from 200 to 300 hours. It will be interesting to note how far the firm have succeeded in securing 2½ watts per candle in their lamps for an extended time. With the higher-voltage lamps, to be used on 200 to 250 volt circuits, 3½ to 4 watts per candle is the best that can be done, but we look to these figures being reduced in the near future.

The Brush Electrical Engineering Company have forwarded to us their price-list which has recently been issued for their dynamos, alternators, motors, and electrical accessories. The great majority of information in these lists is old, and deals with the types of machines which have been standardised by this firm for some years past. We notice that the Brush machines for arc lighting, together with the various accessories, such as regulators, lightning arresters, etc., are still on the market, in spite of the various new systems of arc lighting which have been perfected during the last 15 years. The Mordey-Victoria alternators are also still in the list, but we notice that more prominence is given to the alternators of the inductor type. The medium-speed alternating current single-phase motors now being supplied by the firm are designed on the Kolben system, and from the illustrations we gather that they are most conveniently arranged for application to the machines they have to drive. In one type a fast and loose pulley is provided on the motor shaft, so that the belt can be thrown over by a striking gear from the loose to the fast pulley after the motors have run up to speed. These are illustrated for frequencies of 100, 85, and 50 complete periods per second. A special design of a street transformer box is also shown on one of the pages of the catalogue, which has a number of good features. Above the transformer is placed the switch gear, which can be arranged to be operated from the street through the cover of the box. Switching off in this way renders the transformer dead before the attendant goes to examine the same. We notice that the lists are so arranged that they can be circulated independently.

LEGAL INTELLIGENCE.

CORPORATION OF WOLVERHAMPTON v. THE BRITISH ELECTRIC TRACTION COMPANY.

In the Chancery Division of the High Court of Justice on the 11th inst., before Mr. Justice Farwell, **Mr. Warmington** appeared to move, on behalf of the plaintiffs, for an order against the defendants to enforce Mr. Justice Joyce's judgment given against the defendants in the action tried by him during last sittings. The trial referred to was brought by the plaintiffs to enforce specific performance of a statutory contract under which the defendants were to sell to the plaintiffs the whole of their undertaking. The defendants were, however, still in possession, and what the plaintiffs wanted was to obtain possession of the property, and they had tendered the amount of the purchase money on two occasions—£4,259 was the amount—but the defendants' solicitors, as well as one of the secretarial staff, had declined to take payment. The plaintiffs were still prepared to pay the purchase money, and what they wanted was possession.

Mr. Thompson, who appeared for the defendants, said his clients did not object to the order asked for being made, if necessary. If the purchase money was paid the Corporation could have possession of the undertaking, notwithstanding the fact that the form of conveyance was not executed. There had been a two-fold difficulty—first, as to the payment of interest; and the other as to the form of conveyance.

His Lordship said that was all the plaintiffs wanted. Was an order for possession embraced in Mr. Justice Joyce's judgment?

Mr. Thompson said the order was for payment of the purchase money and the execution of a proper conveyance.

His Lordship said he failed to see why the defendants had not given up possession, but inasmuch as they had now, by their counsel, undertaken to do so on payment of the purchase money, there remained nothing but the question of costs of the motion. The delay having arisen through the action of the defendants, the order of the Court was that the defendants should pay the costs.—*Birmingham Daily Post.*

FARLOW v. DUBLIN UNITED TRAMWAYS COMPANY.

On Monday in Queen's Bench Division No. 1, before the Lord Chief Baron, Mr. Justice Johnson, and Mr. Justice Madden, in the new trial motion of this case, the Right Hon. The MacDermot, Q.C., with whom were Messrs. Gordon, Q.C., and J. F. Murphy (instructed by Messrs. Casey and Clay), who represented the defendants, mentioned that notice of new trial was served because counsel considered the damages awarded—namely, £1,100—in an action for injuries caused through the alleged negligence of the defendants, as excessive. The case had been allowed to stand from last sittings. The report of the Lord Chief Justice, before whom the case was tried, had since come in, and from the character and nature of that report, counsel had advised his clients not to go on with the motion.

The **Solicitor-General**, with whom was Serjeant Dodd (instructed by Mr. Miley), for the plaintiff, asked that the motion be refused with costs.

The Court made an order to that effect.—*Dublin Evening Mail.*

THE BRITISH THOMSON-HOUSTON ELECTRICAL COMPANY, LIMITED, v. THE BRISTOL TRAMWAYS COMPANY.

Leave to appeal from an order of Mr. Justice Day, in Chambers, confirming an order made by the Master appointing a barrister to act as umpire in an arbitration between the parties, has been refused.

COMPANIES' MEETINGS AND REPORTS.

NERNST ELECTRIC LIGHT.

The adjourned annual meeting of this Company is to be held to-day (Friday), the 18th, when a long statement by Mr. B. M. Drake, managing director, will be brought before the shareholders. It will be remembered that at the meeting held on Dec. 19 certain charges were brought by another director (Mr. B. Zusman) against Mr. Drake's policy as managing director, and also against Mr. Drake personally. In answer to these charges a circular has been prepared by the managing director, a copy of which is now in our hands. It is much too long to reproduce in full, and there are also in it answers to a number of personal charges, which we do not propose to take up. With respect to Mr. Zusman's charge, that Mr. Drake had unduly favoured the Electric Resistance and Heating Company at the expense of the Nernst Company, Mr. Drake states that there was no contract nor understanding with the first-named company that they were to supply heaters to the Nernst Company at cost price. The proposal that these heaters should be supplied at 15 per cent. under the price charged to other customers is, in Mr. Drake's opinion, an exceedingly fair one. It would place the Nernst Company on much more favourable terms than other manufacturers of Nernst lamps. Mr. Drake then explains the exact terms on which he transferred 250 shares in the Nernst Company for 250 shares in the Resistance Company. As regards the undue favour said to be shown by him to the British Electric Works Company, he explains that he has absolutely no connection with that company, nor has he ever held a single share in it. The extract which Mr. Zusman read from one of Mr. Drake's letters to the chairman of the above company loses the meaning placed upon it by Mr. Zusman when the context is known. Mr. Drake also explains that, whereas they had to pay rather more per holder to the British Electric Works Company than they could have obtained them from elsewhere, orders were placed with that firm because they undertook to give more prompt delivery. On the question of the neglect of Mr. Drake to decide upon a trading policy, he explains that while he differed from Mr. Zusman as to the best way in which to carry on a supply of Nernst lamps, he had a definite policy which was approved of by the directors of the Company. They could not, however, do much in this direction until the lamps were ready to be placed on the market in quantity. The rest of the statements on this question involve such personal matters that we do not feel called upon to go into them. There is also the question as to whether Mr. Drake had given the time to the Company's business which it required, and here again it is a question for the shareholders as to whether or not Mr. Drake has given all the time which is necessary up to the present stage. He points out in his statement that whereas he has received £290 as managing director, he would, if he had devoted his whole time to the undertaking, as once proposed by Mr. Zusman, have received a salary of £2,000 per annum. Mr. Drake adds that he could not have usefully devoted any more time to the Company's business than he has done. Accompanying this circular is a letter, dated Dec. 12, from the staff, which contradicts the charges of want of organisation brought by Mr. Zusman.

In reply to this statement, Mr. Zusman has issued a rejoinder,

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which, we presume, will also come before the meeting to-day. The most technical point in the same is a charge that, although the repeat order for holders was said to be given to the British Electric Works Company because they could get more prompt delivery, there was no penalty clause inserted in the contract, and that the holders had not been delivered to time. The rest of the rejoinder deals mostly with personal matters, and the charges first brought by Mr. Zusman are repeated. It remains to be seen what course the Company will take at the meeting to-day. The situation is considerably complicated by the fact that a number of the shareholders invested in the undertaking without reading thoroughly the prospectus. They were therefore under a misapprehension as to the ownership by the Company of the English patent rights. It must be remembered in this connection that the promoters of the Company did not place in a prominent position in the prospectus a statement that the English patent rights had not been secured. It would be unfair that any soreness in this respect among the shareholders should be visited against the managing director.

GENERAL ELECTRIC.

The first statutory general meeting of this Company was held on Wednesday at the Cannon-street Hotel, Mr. Hugo Hirst presiding.

The **Secretary** having read the notice convening the meeting, the **Chairman**, after expressing his regret that Mr. Gustav Byng (the chairman of the Company) could not be there to preside, said the whole of the share capital, as well as debenture stock, had been subscribed, issued, and alloted. All the calls for the whole of the debenture issue had been paid up, and though the last call on the preference shares was only due on April 1, out of 18,000, 13,342 had paid up fully £10, while 3,901 had paid up in accordance with the requirements of the prospectus the sum of £7. 10s. each. The debentures were held by 153 subscribers, the biggest holding by one person or party being £15,000. The preference shares were held by 422 subscribers, the biggest holding being 651 shares. The whole of the properties purchased by the new company, with the exception of a few leaseholds held on rack rent, have been duly transferred to them by the vendors. The debentures of the old company had been paid off, and the mortgage of the new debenture stock had been executed and the deeds handed over to the trustees. An application had been made to the Stock Exchange for a quotation of the preference shares and debenture stock, and the requisite declaration had been made, and they were expecting shortly to have a day fixed for a settlement and quotation on the London Stock Exchange. Application would be made at Manchester and Glasgow in due course. It was a most pleasing fact that a very large proportion of the preference capital had been allotted to numerous customers of the firm. A fact no less gratifying was that the staff of the General Electric Company and their friends had invested quite a considerable amount in their business, which showed the great confidence they had in their firm. Of the money thus received, after paying off old debentures and other obligations of the Company, practically all had been pledged to certain undertakings which were suggested in the prospectus. Electricity still afforded great fields for the enterprising, and with that conviction they had had no hesitation in acquiring 60 acres of additional land adjoining the property mentioned in the prospectus. They had placed the contract for their very large engineering works, a central power-house, for a large quantity of most up-to-date machinery, and within a very short period they hoped to have supplemented their present overcrowded works at Manchester and Birmingham with such new additional works which would enable them to undertake at a profit any and every kind of electrical engineering work that had ever been attempted in this country. It might interest debenture holders to know that the money they were spending on these factories was all going on the first property mentioned in the prospectus, and would considerably exceed the minimum sum of £60,000 which they promised to expend thereon. They were about to build roads and goods sidings so as to be able to enjoy the advantages of cheap freights and raw materials, and they were on the point of closing contracts for the manufacture of a number of articles that they had been in the habit of buying, to disclose the nature of which at this juncture would be unwise. A considerable portion of the unissued part of the ordinary shares had been put aside for gradual allotment to the principal members of the staff. Mr. Warburton, their adviser, had assisted them in developing a scheme which they expected would shortly come into operation. It was very simple, and they hoped would work beneficially both for the staff and for the Company. With regard to their business, he was pleased to state that there had been a considerable increase in sales for every month during the nine months that they had been in existence as a new company compared with the respective months of the previous year. One of their oldest departments in which they considered themselves leading manufacturers in this country—the telephone department—was receiving a most satisfactory impetus through the competition that was now springing up between the Government, telephone companies, and municipal authorities. As regarded their incandescent lamp business, he believed the Robertson lamp was made in better quality and larger quantities than any other lamp in this country. He wished to state here that the Incandescent Electric Lamp Works making the Robertson lamp were identified as closely with them as ever, but as in that enterprise they had some colleagues outside their own firm, the works were carried on as a separate company, and appeared in the list of investments in the prospectus.

In reply to Mr. Frederick Walker, the **Chairman** said that no doubt if ever they issued ordinary shares to the public those investors who had supported them up to the present would, as a matter of course, be considered first, though in what shape it would naturally be premature to say that day. That, he thought, was only a sound business policy to adopt. As regarded issuing further ordinary shares, there were many reasons why this was not possible at the present time. He would give only one of these, and he had no doubt Mr. Walker would understand it. They had been up till recently a private business, and they were all at once absorbing or taking up a lot of capital from the public which necessarily must for a few years be unremunerative. Until that capital became productive, they could not possibly increase their profits very much over what they had shown in the prospectus; but this new capital was an additional charge on their present profits, and they thought it was only fair that until it was in working order, and they knew to what basis it had brought them, the holders of the present ordinary shares should take all risks.

The proceedings then terminated.

BRUSH ELECTRICAL ENGINEERING.

An extraordinary meeting of this Company was held at Winchester House on Monday for the purpose of considering an agreement with the British Electric Traction Company.

Mr. J. B. Braithwaite (chairman) presided, and in the course of his remarks expressed the opinion that the agreement submitted for the approval of the shareholders that day was decidedly in the interest of the Brush Electrical Company. The Brush Company had been engaged in the last two or three years in making large extensions to the works at Loughborough, and in developing every branch of traction plant, and they were now in a position to supply everything necessary in connection with electric tramway traction. The British Electric Traction Company, on the other hand, was without doubt the leading British company engaged in the business of electric traction. The result of the agreement would be that the Brush Company would secure a large share of orders for electric plant throughout the country by their connection with the Traction Company. Of course, the other company asked for something as a *quid pro quo*, and that would take the form of a 5 per cent. rebate on all orders. The confidence which the Traction Company felt in the Brush Company, and in their ability to provide such profitable work, was shown by the clauses in the agreement which provided that they should be represented on the Board of the Brush Company by three gentlemen; and further, with the idea of securing some portion of the manufacturing profits for themselves, the Traction Company were willing to take as many ordinary shares in the Brush Company as the shareholders wished to let them have at a fair exchange—viz., the market price. In other words, the Traction Company offered one of their shares, carrying dividend from April 1 last, in exchange for every 7½ Brush shares, carrying dividend from Jan. 1, 1900. He wished to impress upon the shareholders that this exchange was purely optional so far as they were concerned, but the Traction Company bound themselves to take any number of these shares offered to them on the terms mentioned. The agreement could be terminated at the end of one year by either party if the arrangement proved to be unsatisfactory. It was an agreement for alliance for mutual benefit, the success of which would depend upon the good will which the two parties put into it. Those directors who now tendered their resignations to make way for the three representatives of the Traction Company would be compensated by that company to the extent of £2,500 in all. The Chairman then moved the adoption of the agreement.

Mr. J. S. Raworth, in seconding the motion, said he had furthered the completion of this agreement in the full belief that it would be entirely in the interest of the shareholders of the Brush Company as well as the Company itself.

In reply to Mr. Lamont, the **Chairman** said that only the ordinary shares were affected by the agreement. The preference shares remained exactly as they were.

Mr. Lamont asked whether there was any recognised standard of fair commercial value for the work the Brush Company expected to get?

The **Chairman** referred him to Clause 6 in the schedule to the agreement, which provided for a reference to a committee in the event of a difference arising.

A **Shareholder** wanted to know what undertaking there was that the Traction Company would not squeeze the shareholders of the Brush Company out of existence?

The **Chairman** replied that it would not be in the interest of the Traction Company to attempt such a thing; but if they did, at the end of one year the Brush Company could cancel the agreement. The shareholders were fully protected.

A **Shareholder** remarked that in the event of the Traction Company acquiring the large majority of the Brush ordinary shares, they could do exactly as they liked by vote.

The **Chairman** explained that the preference shareholders would rank with the ordinary shareholders in the matter of voting; and he having told a shareholder that it was impossible to conclude the contract without consulting the shareholders on the subject, the motion was put and carried, with three dissentients.

On the motion of the **Chairman**, seconded by **Mr. C. E. Hedgkin**, the resignations of Mr. A. Ayres, Mr. A. H. Sanderson, Colonel F. G. Stewart, and Mr. E. Woods as directors were accepted.

Lord Vaux of Harrowden and Mr. C. S. B. Hilton, the nominees of the Traction Company, and Mr. R. Percy Sellon, general

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manager of the Brush Company, were then elected to fill the vacancies on the Board.

A vote of thanks to the chairman closed the proceedings.

LONDON AND GLOBE FINANCE.

At the adjourned extraordinary general meeting of this Corporation, held at Cannon-street Hotel on Monday, the Marquis of Dufferin in the chair, **Mr. Whitaker Wright** stated the result of the negotiations with the creditors since the last meeting. All the creditors except one had signed an agreement whereby they would release the Company from all obligation on payment of the sum of £485,000. The creditor who had not yet consented was not antagonistic if the arrangement was going to be completed on businesslike lines. The two things wanted were £500,000 wherewith to pay the Company's debts, and a further sum of several hundred thousand pounds wherewith to carry on their operations and so regain that prosperity which they formerly enjoyed. To raise the former sum the directors had decided to dispose of the Company's interest in the Baker-street and Waterloo Railway, and the sale was on the point of consummation. Then it was proposed that the Company should be reconstructed, the new shares being issued with a liability of 5s. each, and it might be possible to substitute a debenture bond for a liability of 5s.

A resolution was passed for the voluntary winding up of the Company.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN

Brighton—The Council invite tenders for cables. Tenders by Feb. 14. Full details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for 42 electric cars. Tenders by March 2. Details in our advertisement columns.

Colne.—The Electrical Committee invite tenders for various plant. Tenders by Jan. 19. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for engine and dynamo. Tenders by Feb. 9. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for four electric motor cars for the pier electrical tramway. Tenders by Feb. 6. Details in our advertisement columns.

Aberdeen.—The Tramway Committee invite tenders for the electrical equipment of their bathing station route. Tenders by Feb. 13. Details in our advertisement columns.

Oldham—The Electricity Committee invite tenders for supply, delivery, and erection of engines and dynamos. Tenders by Jan 29. Details in our advertisement columns.

Great Yarmouth.—The Town Council invite tenders for the supply of 800 tons, or thereabouts, of steel girder tramway rails of from 80.b. to 90lb. per yard. Tenders by Feb. 6.

Plymouth—The Corporation invite tenders for about 300 tons rails, fishplates, etc. Specification, etc., may be obtained from Mr. James Paton, borough engineer. Tenders by Jan. 21.

Brighton.—The Council invite tenders for the overhead trolley construction and equipment on the whole of the tramway routes. Tenders by Feb. 14. Details in our advertisement columns.

Wigan.—The Electric Light and Tramways Committee invite tenders for dynamos, Korting condensers, switchboards, etc. Tenders by Feb 2. Full details in our advertisement columns.

Bradford.—The Tramways Committee of the Corporation invite tenders for the complete electrical overhead equipment of over five miles of tramway. Tenders by Feb. 2. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Canterbury.—The Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 30. Details in our advertisement columns.

Brighton—The Corporation invite tenders for the supply and erection at the Corporation electricity works, North-road, Brighton, for various tramway plant. Tenders by Jan. 28. Details in our advertisement columns.

Tynemouth.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Tynemouth, of one 450-kw. steam dynamo. Tenders by Jan. 31. Details in our advertisement columns.

Hull.—The Works Committee of the Corporation invite tenders for the supply of one multipolar generator, to be coupled direct to a Belliss high-speed engine. Tenders by Feb. 8. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of boilers, with mountings, gangway, feed and drain pipes, etc., complete. Tenders by Feb. 15. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for the supply and installation of the complete motor and electrical plant of the central station of the town electrical works. Tenders by April 1. Details in our advertisement columns.

Copenhagen.—Tenders are invited for accumulator batteries and other electric works by the Copenhagen Electricity Company, 30, Gothersgade. Tenders by Jan. 21.

Aberdeen.—The Electric Lighting Committee invite tenders for surface condensers, air and circulating pumps. Tenders by Feb. 8. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Sheffield.—The Tramways Committee invite tenders for a slow-speed vertical engine for driving a 1,000-kw. tramway generator. Specification, etc., may be obtained from Mr. A. L. C. Fell, M.I.E.E., general manager, Town Hall. Tenders by Jan. 21.

Eastbourne.—The Electric Light Committee invite tenders for the erection and completion of a proposed electric lighting station, with administration block. Plans, etc., may be seen at the Borough Engineer's Office, Town Hall, Eastbourne. Tenders by Feb. 4.

Batley.—The Corporation invite tenders for the supply, delivery, and erection at the proposed electricity works of three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Feb. 9. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for work to be done in connection with the electric lighting of the town hall and public offices, High-street, Ilford. Specifications, etc., may be obtained on application to Mr. John W. Benton, clerk, Council Offices, Ilford. Tenders by Jan. 21.

Islington.—The Electric Lighting Committee invite tenders for the erection of a water-tower, tanks, and sundry additions to the central electric lighting station, Eden-grove, Holloway, N. Plans, etc., may be seen at the office of Mr. A. Hessell Tiltman, F.R.I.B.A., 51, Russell-square, W.C. Tenders by Feb. 12.

Wimbledon.—The Urban District Council invite tenders for the supply and erection of steam and exhaust pipes, etc., and the moving of two boilers, feed pumps, feed-water heater, and storage tank, an independent surface-condensing plant, and two water-tube boilers. Tenders by Feb. 18. Details in our advertisement columns.

Great Yarmouth.—The Corporation invite tenders for the supply, delivery, and erection of two water-tube boilers, and two 200-kw. high-speed continuous-current steam dynamos, for electric traction purposes. Specifications, etc., may be obtained at the office of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W., or Mr. J. Wm. Cockrill, M.I.C.E., borough surveyor, Town Hall, Great Yarmouth. Tenders by Feb. 5.

RESULTS OF TENDERS.

Cheltenham.—An order for a second 500-kw. turbo-alternator has been placed with C. A. Parsons and Co.

Derby.—The Town Council have accepted the tender of Messrs. Ferranti, Limited, for a new engine and alternator at £6,000.

Bedford.—The Urban Sanitary Authority have accepted the tender of Heuley and Co. for a rubber mat for use at the electricity works at £15.

London, S.W.—The tender of R. Dawson and Co., Limited, Stalybridge, has been accepted for wiring the electric light installation at the Tooting Bec Asylum at £4,416.

Bermondsey.—The tender of Crompton and Co., of Chelmsford, at £2,595, for the supply, delivery, and erection of cast-iron arc lamp columns, arc and incandescent lamps, etc., has been accepted.

Halifax.—The Corporation have accepted a tender for 15 miles of electric cable of high voltage. It is stated that the order went to a Cologne firm, whose tender was £490 per mile, or £54 per mile below the lowest British tender.

Middleton (Lancs.).—The Corporation have accepted the tender of W. B. Haigh and Co., Limited, Oldham, for the supply, delivery, and fixing at their electricity works of superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and accessories.

Glossop.—The Town Council have accepted the following tenders: Drake and Gorham, electric installation, £603. 10s., and electric motors, £50. 10s.; C. Fielding and Sons, pipes, fittings, etc., £215. 10s., gallery and screen, £37. 10s., and dynamo chamber, £32; Jackson and Co., chemicals and apparatus, £51. 13s. 8d.

Hammersmith.—Five tenders, ranging from £129 to £235, have been received for constructing a concrete roof over the economiser. Mr. Polden's tender of £129. 10s. has been recommended for acceptance; and also the following tenders, being the lowest in each case: Silvertown Ironworks Company, cast-iron pipes, £79. 13s. 6d.; T. Piggott and Co., steel pipes £76. 5s., and 20in. valves £50.

Hackney.—The following sub-contractors have been agreed to: Contract of W. T. Allen and Co., for arc lamp pillars—J. Maude and Co., Mansfield, Notts, castings. Contract of Aiton and Co., for pipework and valves—Clay Cross Company, Clay Cross, and McFarlane, Strang, and Co., Glasgow, cast-iron pipes; Stewart and Menzies, Glasgow, and J. Russell and Sons, Wednesbury, wrought-steel pipes; T. Piggott and Co., Birmingham, cast-iron tank.

Tunbridge Wells.—The following tenders for the supply of square pitch-pine poles have been received: Baltic Steam Sawmills Company, 40ft. poles £5. 8s., 45ft. £6. 7s. 1d., 50ft. £7. 19s.; Wells and Co., Limited, 40ft. poles £5. 7s. 6d., 45ft.

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£6. 12s. 6d., 50ft. £7. 19s. The tenders of the Baltic Sawmills Company for the supply of 20 45ft. poles, and of Wells and Co., Limited, for 10 40ft. and six 50ft. poles, have been accepted.

Birkenhead.—The Corporation have accepted the tender of Crompton and Co., Limited, Mansion House-buildings, London, E.C., for the supply, delivery, and erection of (Contract Q) switchboard and instruments for Craven-street generating station; also the tender of Aiton and Co., 25, Laurence Pountney-lane, London, E.C., for supply, delivery, and erection of (Contract B) steam, exhaust, feed-water, and drain pipework for Craven-street generating station.

Fulham.—The Guardians have received the following tenders for wiring, etc., the Parish Receiving School:

In Simplex tubing.

Tyler and Duncan, New Bridge-street	£333	17	3
T. L. Hellyar, Hammersmith	332	8	0
Wells and Co., Paddington-street, W.	326	0	0
National Electric Wiring Company, Newington-butts	289	0	0
H. F. Joel and Co., Finsbury	270	0	0
Alwyn and Craven, Cowcross-street	240	3	6
Barlow Bros. and Co., Shaftesbury-avenue	235	0	0
W. C. Scott, Hammersmith	231	4	2
F. J. Colsby, Thayer-street, W.	220	15	0
Pinching and Walton, Crutchedfriars	212	5	0
J. W. Manley and Co., Limited, Victoria-street, S.W.	199	12	5
W. J. Fryer and Co., Sloane-square	199	0	0
C. Cooper and Co., Fulham-road, S.W. (accepted)	185	7	6

In wood casing.

Tyler and Duncan	309	8	4
T. L. Hellyar	302	12	5
Wells and Co.	297	19	6
National Electric Wiring Company	212	5	0
H. F. Joel and Co.	252	0	0
Alwyn and Craven	239	6	0
Barlow Bros. and Co.	187	0	0
W. C. Scott	207	14	5
F. J. Colsby	205	5	0
Pinching and Walton	180	7	0
J. W. Manley and Co., Limited	186	1	8
W. J. Fryer and Co.	175	0	0
C. Cooper and Co.	179	5	0

BUSINESS NOTES.

TRACTION.

Folkestone.—The Town Council have approved the draft of the tramways provisional order.

Sheffield.—The Owlerton tram route will probably be open for public use by the end of the month.

Scarborough.—The Corporation have declined to consent to the Scarborough Tramways Company's Bill.

Twickenham.—The Town Council have decided to oppose the London United Tramways Extension Bill.

Pemberton.—The District Council have resolved that Mr. Davidson be at once appointed to value the tramways.

Hanley.—The Town Council have adopted certain objections to proposed new lines of the Potteries Electric Traction Company.

Birstall.—The District Council have decided to ask the consent of the Board of Trade to its purchasing the tramway line from Birstall to Gomersal.

Willesden.—The proposal of electric trams for Willesden was rejected last week, after a poll of the residents, by 1,734 votes, 2,868 being recorded for and 4,602 against.

Huddersfield.—We understand that the date named for the completion of the electric tramways is to-day, and that the whole route will be opened to the public within a week or so.

Wakefield.—In connection with the electric tramway scheme, Kirkgate Bridge is to be altered, and the cost borne jointly by the County Council, the Corporation, and the syndicate.

Litherland.—The Urban District Council are making enquiries as to whether there is still time to apply for an electric lighting provisional order for the district in the next session of Parliament.

York.—The City Council have resolved to press the Board of Trade to give their consent to the compulsory purchase of so much of the Fulford section of the tramways as lies within the city boundary.

Leeds.—It is reported that at the next meeting of the City Council the Tramways Committee will recommend that the salary of Mr. John Burbridge, the chief electrical engineer, be increased to £600 per annum.

Newton-in-Makerfield.—The South Lancashire Tramways Company have agreed to insert a clause in their Bill before Parliament empowering them to widen the roads along which the proposed extensions will run.

Cork.—The Council have sealed the deed between the Cork Electric Tramway and Lighting Company, Limited, and the County Council in connection with the tramway extension from Ballintemple to Blackrock.

Gosport.—The Urban District Council has formally sealed its memorial in regard to the tramways company's Bill for the purpose of securing a *locus standi*, and the necessary steps to deposit the same in Parliament are being taken.

Leamington.—The Tramways Committee, in their last report to the Town Council, recommended the Council not to consent to the tramway provisional order unless satisfactory terms could be arranged between the Council and the company.

Chester.—At a special meeting of the Town Council on Wednesday, various details of the tramways scheme were discussed, and formal resolutions were passed determining upon an application to Parliament for a Bill for the purposes mentioned.

Hampstead and Charing Cross Railway.—A meeting, under the auspices of the Hampstead Tradesmen's Association, has passed a resolution in favour of the proposed extensions of the railway under Hampstead Heath to Golder's Hill.

Wigan.—The Parliamentary and Electric Light and Tramways Committees have entered into an agreement with the Standish Urban District Council with regard to the proposed tramway from the boundary of the borough to High-street, Standish.

Plymouth.—At a special meeting of the Tramways Committee it was resolved that the tramways be constructed to the eastern boundary of the estate belonging to the Corporation and equipped for overhead electric traction at an estimated cost of £10,532.

Hindley.—The District Council have confirmed their resolution that notice in writing be given requiring the owners or promoters of the tramways in Hindley to sell to the Council so much of their tramway undertaking as is within the urban district of Hindley.

Sunderland.—The Town Council have adopted the proposal of the Tramways Committee to extend the tramways from Roker terminus to Seaside-lane, Christ Church to Grangetown, and St. Barnabas's Church to Ryhope-road at an estimated cost of £27,794.

Ince-in-Makerfield.—The Urban District Council have notified the present owners of the tramways undertaking of their intention to apply to the Board of Trade for their approval to the Council purchasing the tramways, authorised by the Wigan Tramways Order, 1879.

Kingston.—The Town Council have sealed a memorial to the examiners in Parliament complaining of the alleged non-compliance by the London United Tramways Company with the standing orders in relation to the requisite consents of local and road authorities.

Greenwich.—The Borough Council have decided to inform the Board of Trade that they object to the proposal as to the reconstruction and electrical equipment on the Schuckert surface-contact system of the South-Eastern Metropolitan Tramway Company's system.

Paisley.—A conference took place last Friday between representatives of Paisley, Renfrew, and Johnstone Corporations regarding the proposals of Mr. Murphy for the running of the local tramways. Considerable discussion took place, after which the conference was adjourned.

Dublin.—Application will shortly be made by the General Electric Company of Ireland to the Lord-Lieutenant in Council for authority to construct a series of light railways or tramways from the city boundary to outlying portions of Dublin and Wicklow at an estimated cost of £220,000.

Dunston.—In connection with the proposed tram service the plans have been drawn out, and these will be submitted to the Whickham Urban District Council, and after approval by them, and the Durham County Council and the Board of Trade, the work will be immediately commenced.

Birkenhead.—The Town Council have approved the recommendation of the Tramways Committee that the fares to be charged on the New Ferry route should be 1d. between New Ferry and Green-lane, 1d. between Bedford-road and Woodside Ferry, and 2d. for any greater distance.

Stepney.—In order that the Council may have a *locus standi* in relation to the Bills of the proposed City and North-East London Electric Railway and the London County Council General Powers Bill (which deals with the proposed Rotherhithe and Ratcliff tunnel), the Council have given notice that they dissent therefrom.

Ashton.—The Town Council, on the recommendation of the Tramways Committee, have resolved to request the Electric Tramway Company to run a sufficient number of cheap workmen's cars to meet the requirements, and to draw their attention to the frequent changes in the time and irregularity in the running of the cars generally.

Leith.—At the Town Council's meeting last week a letter was read from the Edinburgh Street Tramways Company stating that in view of the relaying of the Leith-walk section the directors desired to bring under the notice of the Council the propriety of introducing the overhead electric system. The matter was remitted to the General Committee.

Liverpool.—The Chamber of Commerce has decided to support the Bill about to be reintroduced before Parliament for powers to construct an electric express railway between Manchester and Liverpool. The outer circular route of tramways was brought into public use this week. Twenty four cars are on the route, and a six-minute service is given.

Wandsworth.—The Borough Council have decided to oppose the London County Council's scheme for the construction of a tramway, commencing in the Lower Richmond-road, Putney, passing across Putney Bridge, etc., on the ground that Putney Bridge is too narrow, and that the curve to the west into Lower Richmond-road would constitute a public danger.

Aberdeen.—The Town Council have agreed to the recommendations of the Tramways Committee that a double line of tramway

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shall be constructed in Great Western-road, from Forbesfield-road to Mannofield, cable ducts to be laid and the rails bonded for electric traction, and that in order to provide a passing place the line shall be doubled in Rosemount-place for a distance of 100 yards westward from South Mount-street.

Wallsend.—At last Tuesday's meeting of the Urban District Council the chairman was empowered to give his formal consent to the Bill for electric tramways, the company in the meantime to give a written undertaking that the county bridge would be widened to 40ft., and to pay compensation in the event of injury to property. A resolution was adopted to the effect that the Council do not approve of the County Council becoming owners of the tramways.

Newcastle.—At the meeting of the Tramways Committee last week it was reported that arrangements had been made with Benwell Local Board as to the continuation of the tramlines from Elswick-road to the church, and from Westgate-road to Chorley Pit-lane. The Walker Local Board have intimated that on certain conditions they are willing to concede the right to the Corporation to run trams to Walker. Jesmond-road is to be widened in connection with the scheme.

Barrow.—The tramways were purchased some months ago by the British Electric Traction Company for £22,000, and they have been desirous of substituting electricity for steam. Nothing has yet been done in the way of locomotive renewal. So far they have been unable to come to terms with the Corporation, and the result is that great complaints are made about the running of the present trams. The Corporation is blamed for not purchasing the tramways when they had the option.

London Electric Railways.—An influential meeting of owners of property in the western end of Fleet-street was held on Tuesday to consider the Bills now being promoted in Parliament by the Victoria, City, and Southern, and the Piccadilly and City Railway Companies for powers to construct electric railways under Fleet-street. It was resolved that a committee be appointed to watch the progress of the Bills, and to protect the interests of the owners of property in Fleet-street affected by the proposed works.

Airdrie.—At a meeting of the electors of the Fifth Ward last week it was decided to send a memorial to the Board of Trade in connection with the tramway scheme, protesting on the ground that the ratepayers considered their rights had been sold, and asking the Board of Trade to make an agreement and compel the tramway company to provide a tramway for that part of the burgh, because the Fifth Ward, or eastern portion of the burgh of Airdrie, was being deprived of the advantage of the Act got last year.

Dukinfield.—At a special meeting of the Town Council last week, it was decided to promote a Bill in the next session of Parliament, along with the Town Councils of Stalybridge, Hyde, and Mossley, for power to construct and work tramways and supply electric energy in the boroughs named, and for other purposes. The estimated cost of the joint scheme is £400,000. The four Corporations of Stalybridge, Dukinfield, Hyde, and Mossley will have to find £100,000 each. There will be four stations, one in each borough, but only one generating station.

City and South London Railway.—The accounts for the half-year ended 31st ult. show a balance, after providing for the debenture stock interest and the full dividends on the 5 per cent. preference stocks (1891 and 1896), sufficient to allow a dividend on the consolidated ordinary stock at the rate of 1¼ per cent. per annum, carrying forward £1,249. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, the balance carried forward being £1,267. The receipts from all sources for past half-year were £46,740.

Cardiff.—In connection with the electric tramways scheme, the borough engineer has been requested to estimate the cost of construction per yard per single and double track, and present the same to the Tramways Committee. At the meeting of the committee last week, the borough engineer presented a report on the progress of the work for the electrical trams, showing that fair progress had been made. As to the power station, the clay from the foundations was now being burnt on the side for concrete operations, and its use had proved a great success. A cubic yard of this material could be produced for 1s. 6d., whereas the cost of broken stone was 5s.

Southwark.—At the Council meeting last week, the Law and Parliamentary Committee presented a report with reference to the Bill which is being promoted by the Victoria, City, and Southern Electric Railway Company, under which they seek power to construct two tunnels for separate up and down traffic from Victoria to the City, and from the City to Peckham, to be worked by electricity. The committee thought it was desirable that workmen should be able to return to their homes at an earlier hour than six in the evening, and that the ticket issued should entitle the holder to return by any train during the day, or to any intermediate station. They therefore recommended that the solicitor to the company be approached with a view to the insertion in the Bill of a clause to this effect. The recommendation was adopted.

Halifax.—At the next meeting of the Town Council, the question of the electric tramways extensions will be discussed. How to extend the tramways to some of the adjacent populous districts, having regard to the inclines, is a matter that has for some time engaged the serious attention of the Tramways Committee. What is now suggested is that the Corporation shall try the experiment of a lift. The route on which the trial will be made, if the proposal of the committee be accepted by the Town Council, will be on the intended extension to Elland. By Elland-road there is a steep hill, and it is here that it is proposed to place the lift, which would be somewhat after the style of the cliff tramways at Scarborough. The tramcars would be run over the level from Halifax direct on to the lift, which would deliver the cars on to connecting lines on the Elland-road, whence they would proceed to Elland. Should the experiment prove a success, a similar system will, it is believed, be carried out for Southowram, which is situate beyond Beacon Hill.

LIGHTING AND GENERAL.

Motherwell.—The electric street lamps will be lighted on Feb. 1 for the first time.

London Gazette.—An adjudication order has been made out *r* A. Hudson, 67, Thurnscoe-road, Bradford.

Portsmouth.—The Admiralty have approved a scheme for lighting the dockyard by electricity instead of gas.

Ossett.—The Council have decided to unite with other local authorities in opposing the Yorkshire Electric Power Bill.

Consett.—The agreement between the Council and the Northern Counties Electrical Supply Company has been approved of.

Globe Telegraph and Trust Co.—The directors have declared an interim dividend of 1s. 9d. per share on the ordinary shares.

Burton.—A report similar to that noted under "Taunton," *re* Rucker *v.* London Electric Supply Corporation, has been adopted.

Bath.—The Urban Sanitary Authority have purchased the premises in Dorchester-street, adjoining the electric light station, for £4,000.

Bristol.—The Electric Committee have been requested to report as to the cost of lighting Lawrence-hill Bridge by electricity.

Spain.—We have recently seen a statement to the effect that there are now 400 electrical works in Spain, with an output equal to 70,000 h.p.

Morecambe.—The proprietors of the new Alhambra buildings now being erected by Messrs. Gardner and Scott have decided to put in an electric plant.

Merthyr.—The Electric Lighting and Traction Company have practically completed their works, and are ready to make connections for light and power.

Brighton.—The Guardians have asked Messrs. Drake and Gorham, Westminster, to prepare and submit a scheme for the lighting of the workhouse.

Bradford.—The enquiry into the Corporation's application for power to borrow £140,000 for extension of the electricity works, etc., is announced for to-day.

Heywood.—The Electric Lighting Committee are making progress with the works, but they are kept back on account of the plant, which is not ready.

Hackney.—The following scale of charges is recommended: for private lighting, 4d per Board of Trade unit; for motive power, 2d. per Board of Trade unit.

Wharfedale.—It is proposed to call shortly a joint meeting of local authorities for the purpose of discussing the proposals of the Yorkshire Electric Power Syndicate.

Dumfries.—The Electric Lighting Committee are about to frame conditions for the appointment of an electrical engineer to prepare a scheme for the supply of the town.

Pudsey.—A sub-committee has been formed to confer with two of the Yorkshire electric supply companies respecting the provision of electric power for the town.

Edmundsons' Electricity Corporation.—The directors have declared a dividend of 5 per cent. per annum on the ordinary shares for the half-year ended Sept. 30.

Jedburgh.—The draft provisional order to empower Messrs. Crompton and Co. to introduce electric lighting into Jedburgh has been approved by the Town Council.

Norfolk.—Very extensive alterations to the asylum have been agreed to by the County Council. It is proposed to erect electric lighting plant estimated to cost £20,000.

Guildford.—The Guildford Electricity Supply Company have notified their intention to lay certain mains up Tuns-gate and Southhill-road towards the Warwick's Bench.

Tettenhall.—Under the provisional order proposed to be applied for by the Midland Electric Corporation, it is stipulated to charge 6d. per unit for the first 100 and 3d. per unit afterwards.

Aylesbury.—The Board of Trade have refused to grant an extension of time for the carrying out of the provisional order for electric lighting or to consent to the transfer of the powers.

Goole.—All the papers in reference to the application for an electric lighting order have been deposited. Up to the present the Council have not been served with any notices of opposition.

Supper and Dance.—The National Telephone Company's employés at Aberdeen held their annual supper and dance in the Bon-Accord Hotel, Market street, last week. About 50 couples were present.

Wireless Telegraphy.—The Mediterranean Squadron now at Toulon will shortly put to sea with the object of making an exhaustive series of experiments with wireless telegraphy with the Marconi system.

Ashton.—Mr. Appelbee has commenced his duties, and Mr. Hammond's report on the electricity works and the question of the development of motorcars in the borough is shortly to be fully considered.

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Manchester.—Mr. Leicester R. Lee, formerly assistant mains engineer under Mr. F. E. Procter, has been appointed chief mains engineer to the Corporation electricity department at a salary of £300 per annum.

Southend-on-Sea.—Mr. W. A. Dyer, A.M.I.E.E., has been appointed as chief assistant to Mr. D. F. Adamson, M.I.E.E., the electrical engineer to the Corporation. Twenty-seven applications were received.

Lowestoft.—A cable is to be laid to Messrs. Morton's works at a cost of £283. Messrs. Bush and Dryburgh have been asked to fix some samples of fittings in various parts of the town hall for the inspection of the committee.

Dukinfield.—A conditional agreement with Messrs. Storrs and Co. for the purchase of a plot of ground called "The Flatt" for the erection thereon of a generating station has been referred to the General Purposes Committee.

Greenwich.—The exchange telephone of the National Telephone Company, Limited, is to be installed at the town hall, Greenwich-road, and the Council's depôts at Banning-street and Church-lane, at a total cost of £32 per annum.

Banbury.—The Town Council have consented to the transfer by the Electrical Power Distribution Company, Limited, to the Banbury and District Electric Supply Company, Limited, of the Banbury Electric Lighting Order, 1900.

Johnstone.—The Commissioners have decided to oppose the application of the Clyde Vale and Caledonian Electric Power and Lighting Company for a provisional order for the supply of motive power and for electric lighting in the district.

Warwick.—After an interview with the representative of the promoters of the electric light undertaking for Warwick, the resolution of the Council, passed on Nov. 9 last, has been rescinded, and the application will therefore be assented to.

Hove.—The Legal and Parliamentary Committee have not acceded to the request of the Brighton Council, who wanted to alter the route through Hove by which the electricity mains are to be carried into the town from the new works at Portslade.

Orrell.—The Lancashire Electric Power Company have asked the Council to afford their representative an opportunity of meeting their committee, but the Council have deferred consideration of the matter, thinking that the letter was rather premature.

Pemberton.—The committee's minutes, which were approved last week, contained a report from the engineer on the tenders submitted to him for the electric lighting of Pemberton, and recorded a resolution that 10 firms be communicated with as to reduction in price.

Warrington.—It is stated that the Electric Lighting Committee will probably be able to complete the new electric lighting station for about £2,000 less than was estimated. The Council-chamber and the corridors of the town hall were lighted for the first time by electricity last week.

Handsworth (Staffs).—The formal resolution approving of the promotion of the Bill which has been deposited in Parliament for conferring further powers upon the Council with respect to tramways and electric lighting, and for other purposes, was passed at the last meeting of the Council.

Hindley.—The draft provisional order for the supply of electricity has been approved, also a report from Mr. Charles Hopkinson as to the electric lighting scheme, and application is to be made to the Board of Trade for a reduction of the compulsory area, as recommended in the report.

Wolverhampton.—Application is to be made for sanction to the borrowing of a further £3,000 for the purpose of the electric lighting undertaking, including the cost of providing and fitting up another transformer sub station, with the necessary cables and new services, meters, and indicators.

Leith.—The Electric Lighting Committee have resolved to recommend the Council to borrow money from time to time for electric lighting purposes, up to the limit already authorised by the Secretary for Scotland. There has already been borrowed £44,000, leaving £21,000 still available.

Harrogate.—Colonel A. G. Durnford, R.E., held an enquiry on Wednesday into the application to borrow £10,000 for electric light purposes, required principally for generating plant. At the works there is a plant equal to supplying 26,000 8 c.p. lamps, while there are altogether 30,395 lamps in the town.

Dumbarton.—The County Council will oppose, so as to procure a *locus standi*, the following applications for provisional orders: Caledonian Electric Power Company, Clyde Valley Electrical Power, Kilbowie and Duntocher Railway, Clydebank Tramways, Clydebank Electric Lighting, and North British Railway.

Hammersmith.—At Wednesday's meeting the Electricity and Lighting Committee reported that since their last meeting eight additional consumers had been connected, representing a maximum of 279 8-c.p. lamps. These, added to the number previously reported, show a total of 781 consumers taking current from the mains.

Telephone Poles.—While in the United Kingdom the various local authorities are either for or against poles without any attempt at uniformity, we find that in Buenos Ayres a very simple rule has been laid down, and that is that in streets less than 20 yards wide the wires are carried over the roofs, while poles are allowed in the wider streets.

Elland.—Mr. W. Emmott (Halifax), the Council's consulting engineer, has presented his report with reference to a recent visit of members to Fleetwood, where a dust destructor scheme is in operation which will suit the requirements of this Council, who desire to combine the same with the proposed electric lighting scheme. Estimates have been ordered.

"Willing's Press Guide."—This remarkable shilling's worth has just made its appearance for 1901, and this, the twenty-eighth annual issue, is in every regard similar to, and is as serviceable as, its highly valuable predecessors. It contains almost all the references to English and Continental newspapers and periodicals required in a compact space, easily get-at-able, and clearly printed.

Appointments Vacant.—The Electricity Committee of Doncaster invite applications for the post of assistant electrical engineer, at a salary of £104 per annum.—The Corporation of Devonport are prepared to appoint a chief assistant engineer to the borough electrical engineer, at a salary of £130 per annum. Full particulars of these and other vacancies appear in our advertisement columns.

Musselburgh.—The promoters of the burgh electric lighting scheme have asked for an extension of the period in which they must pay the deposit of £500 as security for their proceeding with the scheme. It is explained that owing to the bad state of the financial market they had had a difficulty in financing the scheme, which was wedded to that of the electric tramway. The matter was referred to the Provost and Law Committee.

Limerick.—A committee meeting of the whole house of the Corporation was held on Thursday last week for the purpose of discussing the Shannon Electric Power Bill as affecting the interests of the Corporation, and to hear a deputation from the promoting company on the subject. After discussion it was decided to refer the matter to be dealt with by a joint committee consisting of all the members of the Harbour Board and the Corporation.

Edinburgh.—It is reported that 3,217 applications have been received for lighting connections and 1,090 for motor connections, making a total of 4,307. The Electric Lighting Committee have agreed to recommend the appointment of a deputation to visit several English towns in connection with the provision of condensing plant for the M'Donald-road station. This recommendation came before the Council on the 15th and was recommitted.

Dissolution of Partnership.—We are informed that the partnership hitherto existing between Mr. J. E. Spagnoletti and Mr. Joseph Crookes, trading as J. E. Spagnoletti and Crookes, Goldhawk Works, Goldhawk-road, W., has been dissolved by mutual consent. Mr. J. E. Spagnoletti will continue the business, in conjunction with Mr. H. M. Bayly, who for many years has acted as manager, as J. E. Spagnoletti and Co., at the same address.

Stoke Newington.—The Council have received an application from the County of London and Brush Provincial Electric Lighting Company, Limited, asking to be afforded an opportunity of submitting terms, etc., for taking over the order at present held by this Council. A draft of the proposed Stoke Newington electric lighting order, as deposited at the Board of Trade by the North Metropolitan Electric Power Distribution Company, Limited, has also been submitted.

Bolton.—At the last meeting of the Electricity Committee tenders were considered for the supply of electric motors for cold stores, and the matter was referred to the engineer to interview the Markets Committee upon the matter. The electrical engineer was requested to prepare and submit plans showing the extensions proposed at the electricity works. The committee approved of specifications for the supply of cables, and tenders were ordered to be obtained from certain firms.

Abercarn.—Representatives of Abercarn and Risca District Councils met on Tuesday evening, Councillor E. Harris, Abercarn, presiding, and upon the motion of Mr. Bowyer, Risca, seconded by Mr. G. H. Nurse, J.P., Abercarn, it was resolved to engage Messrs. Meadows and Lloyd, Westminster, London, at a fee of 40 guineas, to report upon a joint scheme for the electric lighting of the two districts, the other authorities in the Valley having withdrawn from the proposed joint undertaking.

Dysart.—At the last meeting of the Town Council a report was submitted in connection with the proposed lighting of the burgh by electricity, which showed that the company had to supply five times the amount of light at twice the amount being paid at present. The members expressed themselves in favour of the introduction of electricity, but decided to obtain further information as to the cost, and also what success had attended the introduction of electric light into burghs of similar size.

Walsall.—The town clerk has been authorised to raise a sum not exceeding £20,048 in respect of loans which have been sanctioned by the Local Government Board for the purposes of the electric lighting undertaking. Application is to be made for sanction to the borrowing of a further sum of £3,000 for the purposes of the electric lighting undertaking, including the cost of providing and fitting-up another transformer sub-station, with the necessary cables and new service meters and indicators.

Irvine.—At the last meeting of the Town Council it was resolved that the Commissioners shall have full power to receive the report of Mr. Bryson, electrical engineer, and, if found satisfactory, on the strength of it an order shall be applied for to lay down electric plant suitable for the town and acceptable to the Commissioners. It was also agreed to petition against the provisional order of the Caledonian Electric Lighting Company, who propose to set up a station in the Halfway to supply the district with electricity.

Penge.—At the last Urban District Council's meeting attention was called to the bad lighting of the district, and it was suggested that it would be as well, seeing that several of their neighbours had adopted the electric light, to come to some arrangement for a supply. The Chairman thought it would not be wise for the Council to apply to any other body. It would be better for them

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to be approached, as they could then get more favourable terms. The subject was referred to the Works Committee, the surveyor to report.

Morley.—The engineer has been instructed to take any steps which he may consider necessary to improve the arc lamps in Queen-street. The Council are in favour of the Board of Trade's proposed alteration of the proviso to Clause 6, Section B, of the Board of Trade regulations of March 4, 1896, whereby the local authority may, if they consider desirable at any time, change the pressure on the cables. Incandescent lamps fixed at the side of the arc lamps will in future be replaced by 32-c.p. lamps instead of 16-c.p. lamps as at present.

Specialities for Furnace Linings – Messrs. Geo. G. Blackwell Sons, and Co., Limited, have just issued a second edition of their list of specialities for furnace linings, such as magnesite, bauxite, and chrome bricks, calcined magnesite, and magnesite and bauxite cement, etc. It is claimed that these bricks will stand an exceedingly high temperature, and they should therefore be advantageous for use in the linings of open-hearth and reheating furnaces for steel, and also for the smelting works where lead, copper, silver, spelter, zinc, and other metals are treated.

Private Bills.—The period allowed for the deposit of memorials alleging non compliance with the Standing Orders of Parliament in respect to the private Bills to be proceeded with next session expired on the 18th inst. It is announced that memorials have been lodged in relation to six schemes—viz., the Brompton and Piccadilly circus Railway Extensions, the Charing Cross Hammersmith, and District Electric Railway, the Metropolitan District Railway, the Scarborough Electric Tramways, the Harrogate Corporation, and the South Yorkshire Electric Power Bills

Colwyn Bay.—The total expenditure on the electricity works, in connection with the first scheme now completed, and including the promenade lighting, is £7,349. Arc lighting has been installed in the principal streets, and these streets have been wired for private supply, while mains have been laid to the new pier pavilion and the Pwllycrochan Hotel, both being remunerative. The new cable to the Pwllycrochan Hotel belongs to the second instalment of the scheme, which the Council have already decided to proceed with, because the machinery first put down was already fully loaded.

King's Lynn.—From the last minutes of the Electric Lighting Committee we note that the total applications received represent 7,639 lamps of 8 c.p., an increase of 105 during the month, and that street lamps have been fixed in various new places. Messrs. Yates and Thom's new boiler has been placed and tested; it successfully withstood 260lb. pressure. Messrs. Lewis, Bayliss, and Co. have completed their switchboard. Messrs. Laurence, Scott, and Co. have sent the first dynamo to Belliss and Morcom to be mounted and tested with the engine. A list of the courts and alleys of the borough proposed to be lighted is being prepared.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 30 as a special settling day for Kensington and Knightsbridge Electric Lighting Company Limited, and the Notting Hill Electric Lighting Company, Limited, £73 008 4 per cent debenture stock, and have also ordered the said securities to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Brisbane Electric Tramways Investment Company Limited, 75 000 ordinary shares of £5 each, 75 000 5 per cent. cumulative preference shares of £5 each, and £400,000 4½ per cent. first debenture stock.

Perth.—We understand that the Council have submitted to Mr. Hawtayne a list of 14 candidates for the appointment of a resident electrical engineer for his opinion, and asking him to select any five of the applicants he might consider fit for the post. The list includes Messrs. William Briggs, Govan; G. H. Carter, St. Helens, Lancashire; A. H. Clark, Preston; E. Cross, Aberdeen; H. Hastings, Sidcup, Kent; Thomas Hunter, London; J. Lambert, Dundee; Robert H. Paterson, Edinburgh; E. A. Prussman, Doncaster; J. T. Kilpatrick, Windsor; J. I. Robertson Dumfries; J. O Whitaker, Chiswick; R. M. Wilson, Cambuslang; E. W. Rees, Liverpool.

Ayr.—The Corporation have offered to supply electric current to the G. and S.W. Railway Company on the following terms: from 1,000 to 100,000 units at 2½d. per unit; if over 100,000 units are taken the charge to be 2d. per unit from the first unit up to 200,000, and if over 200,000 units the charge to be 1½d. per unit from the first unit up to 300 000. The only difference between this offer and that proposed by the railway company is in the suggested charge of 1¾d. per unit instead of 1½d. per unit, should the consumption exceed 200,000. A sub-committee has been appointed to complete the arrangement with the railway company on the best terms they can.

Whitehaven.—At a recent meeting of the Town Council reference was again made to the breakdown of the electric lighting system. A sample of the lead-covered cable, which had given out, had been sent to the makers, Messrs. Siemens Bros., who replied that in their opinion the defects were due to moisture percolating through the joints of the brick conduits in which the cables were laid, and the destruction of the insulation by some chemical compound contained in the soil. Messrs. Hopkinson and Talbot, electrical experts, also wrote with regard to the breakdown of the armatures, stating that they were of opinion that this had occurred owing to the age and construction of the machines.

Aberdeen.—At last week's meeting of the T.C. the Gas and Electric Lighting Committee recommended that the report and plans of the new electricity station at Dee village be laid before the Council for their information with a recommendation that if the plans were approved of, the committee should be authorised to proceed with the work estimated for in the report; and in the event of the Council deciding that no accommodation was to be provided for an electric car repairing shed, the committee should be instructed to have the place remodelled with the view of utilising the site to the best advantage for an electricity station. The cost of the work estimated for is £25,410. The matter was further adjourned in order to be discussed at a joint meeting of the various committees interested.

Yarmouth.—The income from the electric light last quarter was £2 286. 7s., and after meeting all working expenses and providing for capital repayments and interest charges, a profit of £265. 3s. 7d. is shown. In the two previous quarters there was a deficiency of £405, which is thus reduced to £410. As the price of the light has been reduced to an extent amounting to £618 in the past nine months, and coal has been so much dearer, the result must be very satisfactory. Sanction has been obtained to a loan of £27,000 for extensions of buildings, plant, and mains. Two additional boilers will be procured, and extensions of the buildings and switchboards carried out, at a cost of about £5,000. Tenders for two sets of continuous current dynamos for additional arc lighting and tramway traction are also to be invited.

Personal.—We learn that Mr. Andrew Stewart, who has for the last few years superintended some important installations for Messrs. Harland and Dixon's works in Glasgow, has been appointed engineer in charge of the Durham Electric Power Distribution Company's first station at Gateshead, and will commence his duties there early in February. We feel assured that the hearty good wishes of all who know him are accompanying him to his larger field of action.—We hear that Mr. Morton Beales, who has for some time past been connected with Messrs. Ferranti, Limited, Hollinwood, Lancashire, has resigned his position with that company in order to join the staff of Messrs J. G White and Co., Limited engineers and contractors 22A, College hill, Cannon-street, with whom he started his duties on Jan. 1, 1901.

Fall in Iron and Coal Prices.—The quarterly meeting of the Midland iron trade was characterised by severe depression and a further slump in prices. Ordinary Staffordshire bars were offered at £7. 10s., a reduction of £2 15s. from the maximum reached in April and galvanised sheets were quoted £12 at Liverpool, a fall of £3. Pig iron was 25s. per ton lower than 12 months ago. Chilled rolled were reduced 10s. on the 10th inst. The coal trade in Staffordshire and Warwickshire is at length experiencing the effect of the decline in the iron trade. Abatements have been continuously made during the past month, and it was recently announced that some descriptions of manufacturing fuel have fallen 2s. 6d. per ton since the year opened, forge coal being quoted 11s. 6d. to 14s. at the pits, and slack 4s. to 6s., according to quality. Further reductions are expected.

Cleveland and Durham County Electric Power Co.—This Company propose to produce and supply electrical energy or power in bulk to authorised distributors for lighting purposes, and to persons for power purposes only. The area within which the Company may carry on business comprises the whole or portions of the unions of Easington, Sedgefield, Hartlepool, Stockton, Darlington, Teesdale, Auckland, Weardale, Lanchester, Durham, and the following unions or parts of unions in the North Riding of Yorkshire: Middlesbrough, Guisborough, and Stokesley. The generating or power stations are proposed to be erected on certain lands in the parishes of Witton-le-Wear, Lanchester, Consett, Hutton Henry, Woodham, Brotton, and Billingham. The capital of the Company is to be fixed at £1,000 000, with borrowing powers to the extent of £333,000.

Liverpool.—The minutes of the General Trade Committee presented at the last meeting of the Chamber of Commerce, showed that the Board of Trade had been communicated with with regard to the question of establishing electrical communication with the Fastnet and the mainland. The Board of Trade stated that they had not been able to arrive at any decision in the matter, and that negotiations with the Irish Lights Commissioners had presented serious difficulties. The committee resolved to recommend the council to place a resolution on the programme of the spring meeting of the Association of Chambers of Commerce, urging the necessity of communication for signalling purposes being established between the mainland and the Fastnet, the Smalls, and any other similar station of importance to British shipping. The council have placed the resolution required on the programme.

Maidenhead.—The adjourned meeting of Maidenhead ratepayers to consider the electric light question was held on Monday evening in the town hall, and ended in a most unsatisfactory manner, as both motion and amendment were declared lost. Local feeling runs high, and a number of letters on the subject appear in the *Maidenhead Advertiser*, including one from the Mayor, stating that, whether the amendment was lost or carried, the voting must have been very nearly equal, and that it is somewhat astonishing that out of so large a meeting so few hands were held up when the amendment was put. It was at this juncture that so much impatience had been displayed that for the moment it did not occur to him to have the votes counted, and he at once put the resolution, upon which the voting had been unmistakable, there being a very large majority against it, and which was a sure indication that the Council are requested to go on with the undertaking.

Cheltenham.—The Mayor, in introducing at the last Council meeting the minutes of the Lighting Committee with reference to a considerable extension of street-lighting, etc., which were passed, said they were gradually extending the area of arc lighting, and nothing which they had done could not be justified by motives of

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trade convenience or public welfare. They had touched every ward in the town, and the arc lamps were now in existence along the route of the proposed tramway through the town. The decrease in the price of coal and other circumstances was reducing the cost of public arc lighting, and he looked forward to the time when they would be able to pay for public lighting out of the profits of private lighting. The gross profit on the electric light was equal to a dividend of 3¼ per cent., but it must be remembered that they had had to put aside £6,000 towards the repayment of the capital. There had been no call on the rates for the expenses of the electric light station, and the superiority of the present light over the old was undoubted. Application is to be made to borrow £25 000.

Taunton.—The Electric Lighting Committee reported to the last meeting of the Council that the proceedings in the action of Rucker *v.* London Electric Supply Corporation were now at an end, the plaintiff having entered into arrangements with the committee representing the associated corporations (of which the Taunton Corporation is one) and companies which raised a fund to defend the proceedings. The plaintiff had not only withdrawn his appeal, but had also entered into a deed of covenant under which he had covenanted not to sue any of the associated corporations or companies, and also to indemnify them should any other person or persons bring any proceedings whatsoever in respect of the letters patent upon which the plaintiff's action was brought. The committee added that the economiser and condensing machines were working satisfactorily, and were effecting a considerable saving in fuel. The connections to the mains during the past quarter were equivalent to 486 8 c.p. for lighting, 120 8-c.p. for radiators, 1,200 8-c.p. for motors—total, 1,806 8 c.p. lamps.

Electric Lighting Boards.—In further reference to the Electric Lighting Boards' system of electric lighting, the new company which has lately been formed to exploit the work under the title of Electric Lighting Boards (British Manufacturing Company), Limited, has made an effective start by supplying the large quantities of patent strip used in the great Palace of Glass scene in the Drury-lane pantomime, and in the marvellous ballroom scene at the Hippodrome. These two very comprehensive applications, under particularly difficult circumstances and at very short notice, again show the great use of the system where time and economy are of importance, quite irrespective of any question regarding the possibility of a rapid variation in the position of the lights. Although the company's system has only been before the public for a few short weeks, the manner in which it has been received has already led the company to extend its factory accommodation to some large premises at King's Cross, whilst retaining its showrooms and West-end workshops at 18, Dean-street, Soho, W.

Commercial Intelligence Bureau.—The offices in Queen Victoria-street having proved altogether inadequate for the business of the Commercial Intelligence Bureau, larger premises (occupying 4 000 square feet on the ground floor) have been secured at 49 and 51, Eastcheap, London, E C. Business men wishing to increase their trade are cordially invited to call and inspect this organisation. Nothing of the kind has ever been seen in England. The "Cabinet of Trade Digest" for each separate trade and names and addresses of foreign buyers, it is claimed, is the most complete and up-to date system in the world. Each cabinet contains 5,000 to 10,000 entries, constantly supplemented by post to each subscriber. The price of complete service is £6 per annum. Traders and manufacturers are invited to write for full particulars to Eastcheap, as above. Buyers and merchants visiting London are especially invited to visit the bureau, where they may obtain, free of any charges, information respecting the various lines of goods manufactured in Great Britain. They will also find in the library of the bureau the principal trade journals of the world.

Bermondsey.—The Borough Council have decided that the salary of the borough surveyor shall be £500, rising to £600. At the last meeting the Council instructed the town clerk to approach the Board of Trade with reference to the insertion in the Bill they propose to introduce next session of provisions to extend the power of the Bermondsey electric order over the whole area of the borough. The Town Clerk stated that he had just received a reply from the Board of Trade, who expressed the opinion that the clause desired would be beyond the scope of the Bill, and that any proposal for the extension of the area of supply, except so far as was necessary to effect small adjustments of boundaries, was a matter which should be dealt with by provisional order under the Electric Lighting Acts. The Council decided to inform the Board of Trade that they did not see their way to take over any portion of the works of the County of London and Brush Provincial Electric Lighting Company on account of the system of supply differing materially from that which the Council were installing. They were further of opinion that in any case where the Council had mains on one side of the street, power to supply current on both sides of the street should be given them.

Epsom.—At last week's Council meeting the Clerk reported on the correspondence with the County of Surrey Electrical Distribution Company with reference to the suggestion made with a view of ascertaining on what terms the company would be prepared to take over the powers of the Council for carrying out the electric light undertaking. He had had an interview with Mr. George Offor, who pointed out that the company was at the outset compromised with a particular system, which might not meet with their approval, or adapt itself to the methods of distribution usually selected by them. For instance, the generating station would not very likely be required, as the town could economically be supplied from a trunk main running from a central station to supply Carshalton, Wallington, Sutton, Epsom, etc. The company had power to supply private consumers at 3d. per unit, and public lighting at 2d. per unit. Eight hundred and twenty circulars were issued recently, and 370 answers were received; 113 persons voted in favour of the Council carrying out the undertaking, and 102 against, giving a majority of 11. It was decided to ask the representatives of the company to attend a meeting of the Electric Light Committee to discuss the question.

Cults.—At the last meeting of the Aberdeen District Committee the Clerk read a memorial with regard to the lighting of Cults, in which it was explained that when Messrs. P. and C. Middleton got liberty to introduce an electric lighting system into the village it was arranged that, in the event of their selling, the District Committee should have the first chance of buying. The liquidators of Messrs. P. and C. Middleton had indicated their willingness to sell the system for £5,000. The sub-committee accepted this meantime, but without prejudice to their pre emption, although they do not wish to buy at present. The liquidators complain that this hampers them, and that they could not sell to any other party. The sub-committee reply that they would not put anything in the way of the liquidators selling, but they could not relinquish their right of pre-emption. A more serious matter had arisen, however, in connection with the lighting of Cults. An interdict had been granted by the sheriff against the electrical station being used in consequence of the noise, and the matter was now under appeal in the Court of Session. The liquidators stated that they were afraid they would be unable to carry on the system should the appeal go against them and the sub committee replied that they would look to the liquidators to carry out their obligations.

Carnarvon.—At a recent meeting of Gwyrfai District Council correspondence was produced with reference to the projects of a syndicate formed for constructing waterworks for the supply of villages in several parishes, electric light works in the town of Carnarvon, and a light railway from the latter place along the shore to Dinas Dinlle. The *Liverpool Courier* states that with regard to the water supply, Mr. Peterson wrote to the effect that as the water rights of Cwmdwythwch, which had been intended as the source of supply, had been granted to the Snowdon company, the scheme would have to be postponed for a year. As soon as his application for the electric powers was sufficiently advanced he intended to apply in the usual way to the Light Railway Commissioners with regard to the Dinas Dinlle railway. He, however, had to contend with great difficulties, as the Carnarvon Town Council had taken a most extraordinary attitude, but he did not believe that the Board of Trade would listen to any objection by parties who were the first to induce him to spend money, but who as soon as the money was spent endeavoured to make the application abortive. He also understood that the Gwyrfai Council might oppose under the same circumstances, but should such an opposition be offered it would be his duty to reconsider the whole matter. As to the proposed Ebenezer light railway, no progress had been made since the time he was informed that the principal landlord and the representatives of the district concerned had not decided upon the route. After discussion, it was resolved to intimate to Mr. Peterson that his application with regard to the various projects would not be opposed on the distinct understanding that a clause be inserted in the order making the powers obtained by it inoperative unless the work were commenced within three years after the date of the order.

John Gibb and Son's Electric Fans.—The following is a report (dated Jan. 4, 1901) on tests made on the above fans by Dr. Hele-Shaw, F.R.S., M.I.C.E., professor of engineering, and Mr. Alfred Hay, B.Sc., M.I.E.E., lecturer on electro-technics, both of the Liverpool University College: "We have carried out a careful series of tests with two of Messrs. John Gibbs and Son's electric fans, one of which was a 24in. fan, while the other, driven by a watertight completely enclosed motor, was a 15in. fan. The 24in. fan (No. 205) when supplied at a potential difference of 100 volts was found to take a current of 3·05 amperes and to run at a speed of 655 revolutions per minute, delivering 5,100 cubic feet of air per minute The temperature rise after 3¼ hours' run was found to amount to only 23deg. F. The same fan, when fitted with a conical discharge pipe tapered from 24in. to 12in., was found to take 3·2 amperes at a potential difference of 105 volts, discharging 1,360 cubic feet per minute. The pressure in the discharge pipe was found to exceed that of the atmosphere by an amount corresponding to a column of water ¼in. high. The smaller fan (No. 247) was 15in. in diameter, and was driven by a totally enclosed and completely waterproof electric motor. When supplied at a potential difference of 110 volts the fan was found to run at a speed of 695 revolutions per minute, taking a current of one ampere and giving a discharge of 1,160 cubic feet per minute. The temperature rise after three hours' run was found to be 50deg. F., which is well within the limits of safety. The running of the 15in. fan was remarkably smooth and silent. We consider the above results to be highly satisfactory. The mechanical construction of the fans is substantial, and the workmanship good." The facts in the report as to the effect of a conical discharge pipe shows how easily a good fan can be spoilt in practice if it is placed in positions which restrict the inlet and outlet of air.

Calendars.—Among the many wall calendars received by us we notice particularly a very serviceable one by Messrs Johnson, Riddle, Couchman, and Co., which is extremely well printed, and shows the dates clearly defined in large figures. A lithograph representing the very extensive premises at 22, Southwark Bridge-road, E.C., where the firm carry on their business of designers, chromo-lithographers, letterpress printers, engravers, and general stationers, appears at the top of each page.—The calendar issued

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by Messrs. Wm. Firth, Limited, iron and steel merchants, of Leeds, has a weird Burne-Jones-looking frontispiece, and shows some illustrations of rail and girder sections.—We have also received similar calendars from Messrs. George Anderson and Co., engineers and ironfounders, who are makers of polishing machines, derrick cranes, steam frame saws, aerial ropeways, etc.; from the Campbell Gas-Engine Company, of Halifax; and another from Messrs. W. H. Willcox, Limited, who call it a "date remembrancer," and they draw special attention to their brand of dynamo oil.—The Hunslet Engine Company, of Leeds, have come forward with a very artistic production showing photographs of locomotives built by them both for contractors' work and for railway purposes generally.—Messrs. Nalder Bros. and Thompson Limited, have also taken this means of drawing attention to their ammeters and voltmeters; and a specimen of the tank locomotive constructed by the Atlas Locomotive Works is shown on an almanac presented by Messrs. Peckett and Son, of Bristol. In the same category we must place blotting pads supplied by various companies, of which that of the Patent Victoria Stone Company, Limited, is probably familiar to most of our readers, as it is a yearly production by this well known company. It is a combination which includes a blotting pad, note block, diary, and a beautifully illustrated catalogue. The photographs of the company's works at Stratford, Groby, and elsewhere, and the reproduction of beautiful mouldings and buildings which have been erected lately with Victoria stone are especially interesting, as showing the wide scope of the company's work.—The Anti Friction Alloys Company are also distributing blotters with a peculiar map, meant to represent the fact that their metal is practically used in every part of the civilised world.—Messrs. Robert Boyle and Son, Limited, also publish a very elegant pocket calendar printed in gold on celluloid, a component which lends itself admirably to such productions, and the scale upon the reverse side makes it a serviceable pocket companion for those who have frequently occasion to measure material.—Messrs. C. A. G. Browne have also forwarded us a most useful diary issued by Messrs. Mordaunt Lawson and Co., Limited, iron and steel merchants, Fisher-street, Carlisle, and elsewhere. It has three days upon an opening (folio), and is interleaved with blotting paper, upon which hearty good wishes are intermingled with offers to buy or sell or make to order any plant, rails, pipes, machinery, castings, etc., in any quantity required.

NEW COMPANIES.

St. Helen's Electric Lighting Company, Limited.—Capital, £10,000. Object: to carry on the business of electrical engineers, electricians, practical engineers, contractors, mechanical and chemical engineers, etc.

Crowther and Co.'s Electrical Industries, Limited.—Capital, £10,000. Object: to acquire the business of Crowther and Co., electrical engineers and contractors, and to carry on the business of an electric supply company in all its branches.

Promotion Syndicate, Limited—Capital, £100. Object: to promote and register a company entitled the Electrical Patents Developments Company.

Middlesex Motor Carriage Company, Limited.—Capital, £3,000. Object: to acquire the business carried on by W. J. Colville at Station-parade, Willesden Green, N.W., and to carry on the business of cycle and motorcar manufacturers, etc.

Auto-Steam Generator Syndicate, Limited.—Capital, £5,000. Object: to carry on the business of cycle, velocipede, vehicle, ship and launch builders and merchants, electricians, etc.

Electrical Transport and Power Company, Limited.—Capital, £10,000. Object: to apply for any provisional or other order or other Act of Parliament to enable the syndicate to construct tramways or light railways, and a bridge and works, appurtenances thereto, in the Island of South Hayling, or elsewhere, and to carry on the business of tramway, light railway, ferry and bridge promoters, constructors, and proprietors, electrical engineers, electricians, suppliers of electricity, etc.

Williamson and Joseph, Limited.—Capital, £4,000. Object: to acquire the business referred to in an agreement with the Consolidated Telephone Construction and Manufacturing Company, Limited, and to carry on the business of electricians, electrical and general engineers, suppliers of electricity, etc.

T. C. R. King, Limited.—Capital, £16,000. Object: to acquire the business carried on by T. C. R. King at Norwich, and to carry on the business of sanitary engineers, plumbers, gasfitters, hot-water engineers, electric and mechanical bell fitters, decorators, contractors, etc.

Milnertown (Cape Town) Estate and Railway Company, Limited.—Capital, £330,000. Object: to acquire the business of the Milnertown Estates Limited, of Cape Town, and to acquire, own, maintain, and work any railways, tramways, bridges, ferries, canals, roads, telegraphs, telephones, and other works and undertakings.

Blackburn Engineering Company, Limited.—Capital, £1,000. Object: to acquire the business of the Blackburn Engineering Company, and to carry on the business of ironfounders, mechanical and electrical engineers.

Hire-Purchase Electric Wiring Company, Limited.—Capital, £10,000. Object: to supply any apparatus for and connected with the transmission, distribution, and user of electric current for light, power, etc.

Ewart and Son, Limited.—Capital, £36,000. Object: to carry on the business of sanitary and electrical engineers, etc.

Standard Electric Company, Limited.—Capital, £10,000. Object: to acquire the business carried on at 190, 191, and 192, Upper Thames-street, and 17, Garlick-hill, E.C., as the Standard Electric Company, and to carry on the business of art metal manufacturers, machinists, electricians, electrical and mechanical engineers, etc.

Chinese Engineering and Mining Company, Limited.—Capital, £1,000,000. Object: to carry on in China and elsewhere the business of mine and colliery owners mechanical engineers, electrical and water-supply engineers, etc.

South-Western Motorcar Company, Limited.—Capital, £10,000. Object: to carry on the business of jobmasters, omnibus and vehicle proprietors, electrical, steam, gas, and other motorcar manufacturers, etc.

Celey Electric Works, Limited.—Capital, £2,000. Object: to carry on at Richmond, Surrey, or elsewhere, the business of electricians, mechanical and electrical engineers, etc.

Park Bros., Limited.—Capital, £1,000. Object: to acquire the business of an electrical engineer and cycle manufacturer carried on by F. W. V. Park, J. M. Park, E. G. Park, and T. Park, as Frederick William Vivian Park, at Leamington Park, etc.

Railway and General Construction and Maintenance Company, Limited.—Capital, £1 000 Object: to acquire and turn to account any powers for the construction, equipment, and working of light or other railways and tramways and to carry on the business of engineers, contractors, electricians, etc.

Boardman Electrical Patents Company, Limited.—Capital, £2,000. Object: to adopt an agreement with F. R. Boardman and W. C. Edwards, to develop and carry on the business therein described, and to carry on the business of electrical manufacturing engineers, electricians, etc.

Strachan and Henshaw, Limited.—Capital, £25,000. Object: to acquire the business of engineers, machinists, millwrights, boilermakers, iron and brass makers, electrical engineers, etc., carried on at Lewins Mead and elsewhere in Bristol as Strachan and Henshaw.

Southerns, Limited.—Capital, £5,000. Object: to carry on the business of house furnishers and outfitters, painters, plumbers, suppliers and fitters of electric apparatus and fittings, electricians, etc.

Dursley Pedersen Cycle Company, Limited.—Capital, £20,000. Object: to acquire the business carried on at Dursley by M. Pedersen, R. A. Lister, and C. A. Lister as the Dursley Pedersen Cycle Company, and to carry on the business of cycle manufacturers, manufacturers of electrical and other carriages, etc.

Riker Motor Vehicle Company, Limited.—Capital, £1,000. Object: to manufacture, sell, let on hire, and deal in electric motors, cycles, etc.

Northwood Electric Light Company.—Capital, £15,000. Object: to supply electricity for public and private lighting, and for motive power throughout the whole of the parish of Ruislip.

"Beyrel" Motorcar Company, Limited.—Capital, £120,000. Object: to acquire and amalgamate into one concern the following motorcar manufactories and businesses and extending and continuing the same—viz., the business, goodwill, machinery, plant, cars, stock-in trade, works, and assets of the Société des Automobiles, Hermes, Système Beyrol, Paris; and of the Yorkshire Motor Vehicle Company, Vaughan Motor Works, Bradford; the North of England Motor Company, Aire-street, Leeds; and the Manchester Motorcar Corporation Works, Victoria Bridge, Manchester.

PROVISIONAL PATENTS, 1901.

JANUARY 3.

180. **Improvements in telephone index boards.** Albert Davidson, Bank-buildings, George-street, Sheffield.

187. **Improvements in electrically-propelled vehicles.** Reginald Empson Middleton, 17, Victoria-street, London.

202. **Improvements in or relating to fittings for incandescent electric lamps for illuminating shop windows, or for other analogous purposes.** Alfred William Beuttell, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

217. **Improvements in or relating to electrolytic current interrupters for X-ray work.** Harry William Charles Cox, 10, Cursitor-street, Chancery-lane, London.

234. **Improvements in suspensory devices for carrying incandescence electric lamps by flexible conductors.** Hugo Hirst and George Henry Ide, 165, Queen Victoria-street, London.

JANUARY 4.

257. **Electrically-played banjo or like stringed instrument.** James Henderson Gordon and William Ross, jun., 62, St. Vincent-street, Glasgow.

266. **Improvements in brushes for dynames and the like.** Joseph Matthews and William Davies, 77, Colmore-row, Birmingham.

275. **Improvements in electric switches.** Charles William Scott Crawley and William Leonard Madgen, 24, Southampton-buildings, Chancery-lane, London.

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294. Improvements relating to galvanic cells or batteries. Michael Martin Bair, 45, Southampton - buildings, Chancery-lane, London.

JANUARY 5.

310. Improvements in electrical switches. Arthur Edward Richardson, 119, Trevelyan-buildings, Corporation-street, Manchester.

333. Improvements relating to electric motors. Pierre Marie Le Hégarat, 60, Queen Victoria-street, London.

340. Improvements in electromagnetic apparatus for winding clocks or timepieces. Léon Kusnick, 47, Lincoln's-inn-fields, London.

JANUARY 7.

365. An improved electric car trolley head. Thomas Jones Littler, 81A, Greig-street, Park-road, Liverpool.

367. Improvements in multiple wall connections for electric lighting, heating, and the like. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London. (Complete specification.)

393. Improvements in electrolysis and apparatus therefor. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (The National Electrolytic Company, United States.) (Complete specification.)

409. Improvements in apparatus for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

410. Improvements in apparatus for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

411. Improvements in apparatus for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

JANUARY 8.

459. Improvements relating to electrical organs. Egerton Goolden Pulford, 10, St. George's-crescent, Liverpool.

467. Improvements in attachments for telephones. David Laing and George M. Ferry, 111, Hatton-garden, London. (Complete specification.)

469. Improvements in or connected with electrical storage batteries or accumulators. Oscar Bèhrend, 47, Lincoln's-inn-fields, London.

471. Improvements in electric motors. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward D. Priest, United States.) (Complete specification.)

484. Improvements relating to secondary electric batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Globe Electric Company, United States.) (Complete specification.)

486. Improvements relating to electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Globe Manufacturing Company, United States.) (Complete specification.)

492. Improvements relating to apparatus for measuring the power and the phase difference in three-phase electric systems. Riccardo Arno, 45 Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 8, 1900, being date of application in Italy.)

500. Improvements in or connected with joint fittings for electric cables. Thomas Henwood and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

501. Improvements in or connected with electrometers. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

503. Improvements in electric driving mechanism. Angel de Castro and Henry Wilhelm Schlomann, 322, High Holborn, London. (Complete specification.)

507. Improvements in electric switches. William Ely, 6, Lord-street, Liverpool. (Complete specification.)

JANUARY 9.

543. Current collectors and safety devices applicable to electric railways and tramways. Joseph Parsons and Paul Fred Otto, 22, County-road, Walton, Liverpool.

560. A device for drawing the trolley arm of an electric locomotive or other vehicle propelled by electricity to a safe position should the trolley become disconnected with the supply wire or bar. Harold Sisson Jacques, The Station Hotel, Northfield, near Birmingham.

569. Improvements in electrical regulating, measuring, and indicating apparatus. Albert Campbell, 15, Rothwell-street, Primrose Hill, London.

585. Improvements in and relating to electric switches and the like. Frederick Hagger Headley, 322, High Holborn, London.

594. Improvements in and connected with means and apparatus for the production of light by electricity. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, Stamford Hill, London.

595. Improvements in and connected with means and apparatus for the production of light and certain other rays by electricity. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, Stamford Hill, London.

596. Improvements in and connected with means and apparatus for the production of light by electricity. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, Stamford Hill, London.

JANUARY. 10.

612. Improvements in the manufacture of sulphate of ammonia from furnace gases and the like by electrolysis. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

624. Improvements in or relating to electric storage batteries. Malcolm Sutherland and Elias Marcuson, 61, Chandos-street, Strand, London.

681 Improvements in electric mono-rail railways and vehicles therefor, applicable also for other traction. James Mitchell Hewitt, William Gould Rhodes, and John Morris Newton, 6, Bank-street, Manchester.

688 Improvements in the construction of telephone cables. Francis Tremain, 70, Palace-chambers, Westminster, London. (Complete specification.)

690 Improvements in electric controllers. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Electric Controller and Supply Company, United States.)

691 Improvements in resistance coils. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Electric Controller and Supply Company, United States.)

692. Improvements in arc-rupturing devices for brush-holders and the like. James Yates Johnson, 47, Lincoln's-inn-fields, London. (The Electric Controller and Supply Company, United States.)

700. Improvements in the manufacture of wire strips and the like by electro-deposition, and in apparatus therefor. Richard David Sanders, 4, South-street, Finsbury, London.

702 Improved system of electric traction. Claude Marie Joseph (*dit* Claudius) Limb, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 5, 1900, being date of application in France.)

706. An automatic indicator and recorder of and signal aboard approaching or passing cars or trains and of the routes taken likewise, a herald thereof to passengers' waiting points as all such independent of fog, etc, also applicable to electric bell annunciators for minimising wires, movements, etc., and to other purposes. Edgar Lionel Benjamin, 48, Sutherland-avenue, Maida Vale, London.

JANUARY 11.

724. Improvements in or relating to telephone instruments with magneto generator. Bertil Johann Brander, Pitman Hotel, Birmingham.

740. Improvements in and connected with call lines in telephone exchanges. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

750. Improvements relating to filaments for incandescent electric lamps. Eberhard Sander, 45, Southampton-buildings, Chancery lane, London.

776. Improvements in or relating to electrically-operated ploughs. Conrad Meissner, 18, Buckingham - street, Strand, London. (Complete specification.)

JANUARY 12.

831. Improvements in laying street underground electric conductors. William Burnard Isworth, 37, Cursitor-street, Chancery-lane, London.

833. Improvements in current collectors for electric railways. Frederick Taylor, Westinghouse Building, Norfolk-street, Strand, London.

840. Improvements in electric safety fuses. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actiengesellschaft, Germany. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Jan. 26.

1900.

13975. Systems for controlling electric meters. British Thomson-Houston Company, Limited. (Barry.)

16051. Means for starting alternating-current motors. British Thomson-Houston Company, Limited. (Steinmetz.)

17049. Coin-operated electric meters. Kraemer and Weber.

19754. Key sockets for incandescent electric lamps. Lucas, Marsh, and Vandam.

20362. Renewing the filaments of electric incandescent lamps. Howard.

20471. Connectors for electric wires and the like. Rymer-Jones.

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20488. Safety devices for electric motor-control systems. British Thomson-Houston Company, Limited. (Day.)

20995. Poles for electric railways, electric lights, and telephone and telegraph lines. Serrell.

21294. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

21662. Means of holding the inner glass and lower carbon of an electric arc lamp. Green.

21904. Arrangement of electrical resistance especially adapted for electric arc lamps. Green.

21991. Connections for electrical conductors Cleveland.

22010. Method of connecting electrical conductors. Cleveland.

To be published on Feb. 2.

1900.

396. Electricity meters. Behrendt.

655. Electrically-actuated mechanism applicable for various purposes, such as the steering of ships, the working of engine-room or like telegraphs, or the training of guns. Vaughan. (Vaughan.)

1022. Electric arc lamps. Marks. (Continentale Jandus Elektricitäts A. G. (Soc. Anon.)

1148. Troughs for electric cables. Siemens Bros. and Co., Limited, Foster, and Nott.

2384. Alternate-current distribution. Mordey.

3933. Method of and apparatus for reversing the trolley in electric tramcars and other like vehicles. Oldfield.

4555. Electric distribution. Lorrain. (Bedell.)

4885. Electrical instruments for measuring current pressure and power in electric circuits. Parr.

8227. Windings for dynamo-electric generaters, motors, and convertors. Fynn.

9260. Electric light carbons. Browne. (Sanders.)

11099. Electric targets. Paterson.

13378. Electric switches. Whittingham.

13971. Rectifiers for alternating electric currents. British Thomson-Houston Company, Limited. (Thomson.)

14550 Insulation of electric conductors. Lake. (Tesla.)

16148. Electrically-propelled motor road vehicles. Ryan.

16798. Underground conduits for electric conductors. Zappe.

16966. Electromotor. Sauer.

17184. Electric switches. Hewitt and Rhodes.

17846. Telephonic apparatus. Shore and Heap.

18946. Receiving apparatus for photophones and phonographs. Poliakoff.

19506. Electric arc lamps. Green.

19824. Printing telegraphs. Burry.

20960. Reversible galvanic cells or so-called storage batteries. Edison.

21762. Operating dynamo-electric machines. British Thomson-Houston Company, Limited. (Emmet.)

21861. Controlling electric boosters. British Thomson-Houston Company, Limited. (Hewlett.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Jan. 12	565	531	+ 24	—	—
Birmingham Trams.	,, 12	3 769	3,932	- 136	6,863	—
Blackburn Corp'rat'n	,, 13	1 191	—	—	2,724	—
Blackpool Corporatn.	,, 10	153	123	+ 30	—	—
Blackpool-Fleetwood	,, 12	122	142	- 20	264	283
Bolton Corporation..	—	—	—	—	—	—
Bradford City Trams	,, 13	754	354	+ 400	1,473	692
Bristol Tramways Co.	,, 11	3,386	2 680	+ 706	—	—
Carlisle Tr'mw'ys Co	,, 12	—	—	—	221	—
Central London Ry.	,, 12	5,676	—	—	128,003 *a*	—
City & South London	,, 13	2,041	1,124	+ 917	4,059	2,268
Cork E. T. and L. Co.	—	—	—	—	—	—
Dover Tramways ...	,, 12	153	146	+ 7	301	305
Dublin & Lucan E.R	—	—	—	—	—	—
Dublin U.T., elec. cars	,, 11	3,222	2,753	+ 469	—	—
Dublin S.D. Electric	,, 11	651	578	+ 73	—	—
Dundee Tram Co. ...	—	—	—	—	—	—
Glasgow Corporation	,, 12	8,525	8,227	+ 297	—	—
Halifax Corporation	—	—	—	—	—	—
Hull Corporat'n E.S.	,, 12	1,522	664	+ 858	55,503 *b*	—
Liverpool Corporat'n	,, 5	8,477	6,775	+1,702	—	—
Liverpool Overhead	,, 13	1,512	1,529	- 17	3,055	2,984
Portsmouth Corpn...	,, 12	529	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 13	2,574	—	—	—	—
Southampton Trams	,, 10	557	302	+ 255	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—

a From July 30, 1900. *b* Since April 1, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Arca Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-126,000	1	..	11/16-12/16
British Insulated Wire, Ord., 1-40,000	5	..	10½-11½
—— 40,001-70,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	..	100-106
British Electric Works, Ordinary, 50,001-86,000	1	..	1-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	1-1
—— 4½ per cent. First Mortgage Debentures	108	..	96-97
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4½-5
Brush Electrical Engineering, Ordinary	2	..	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	..	2-2½
—— 4½ per cent. Debenture Stock	100	..	105-111
—— 4½ per cent. 2nd Debenture Stock	100	..	101-103
Callender's Cable, Debentures.	100	..	109 113
—— Ordinary	5	..	13-14
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	3	..	3½ 4
—— 5 per cent. Debentures	—	..	99-103
Edison and Swan United, Ordinary	3	..	13-2½
—— 5 per cent. Debentures	5	..	2½-4½
—— 4 per cent. Deb. Stock, Red.	100	..	88-90
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	..	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1½-2½
—— 7 per cent. Cumulative Pref.	2	..	2½-3
—— 5 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5½-6
—— 6½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	20½-21½
—— 6 per cent. Debentures	100	..	101-104
Telegraph Construction and Maintenance	13	..	88-93
—— 5 per cent. Bonds	100	..	100 103
Telegraph Manufacturing, Ordinary	5	..	10-11
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	6½-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	5-6
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6½-6¾
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	..	5½-6½
Chelsea Electricity Supply	5	..	6½-7
—— 4½ per cent. Debentures	100	..	109-112
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (60 p.c. pd.) Red.	—	..	61-63
County of London and Brush Provincial, Ordinary	10	..	8½-9½
—— 6 per cent. Cum. Pref.	10	..	11½ 12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	105-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7½-8½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10½
London Electric, Ordinary	3	..	1½-2
—— 6 per cent. Pref.	5	..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-101
Metropolitan, Ordinary	10	..	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	..	110-113
—— 5½ per cent. Mortgage Debenture, Red	100	..	96-99
Notting Hill Electric Lighting	10	..	14½-15½
Oriental, 1879	1	..	1½-1¾
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	5½-6
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	..	70-80
Royal Electrical Company of Montreal	$100	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 6 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	..	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-18
—— 7 per cent. Pref.	5	..	8½-9½
—— 2½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	..	12-13
—— 20,001-109,437	5	..	1 1-16-1 3-16
Electric Railways.—			
Central London, Ordinary	10	..	8½-8¾
—— Pref. Half-Shares	5	..	4½-5
—— ,, ,, deferred	5	..	3½-3¾
City and South London, Consolidated Ordinary	100	..	52-56
—— Ordinary	10	..	4½-5½
—— 4 per cent. Debenture Stock	100	..	115-120
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-13¾
Waterloo and City, Ordinary	100	..	94-97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	..	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9½-10½
British Electric Traction, Ordinary	10	..	12½-12¾
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	11½-12½
—— 5 per cent. Perpetual Debenture Stock	100	..	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4½-4¾
—— 5 per cent. Deb. Stock, Red.	100	..	104-107
—— Prov. Cert., all paid	—	..	95-98
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10½
New General Traction, Ordinary	5	..	5½-6
—— 6 per cent. Cum. Pref.	5	..	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-17
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	10½-11½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
—— 4½ per cent. Debenture Stock	100	..	102-105
Telephones.—			
National Telephone, Ordinary	5	..	4½-4¾
—— 6 per cent. Cum. First Pref.	10	..	13-14
—— 6 per cent. Cum. Second Pref.	10	..	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	4½-5½
—— 4 per cent. Deb. Stock, Red.	100	..	97-100
—— 5½ per cent. Deb. Stock, Red.	100	..	94-97
Oriental Telephone and Electric Company	1	..	¾-1½

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NOTES.

Michael Faraday. — We are informed that Mr. Thwaite, as vice-president of the Society of Yorkshiremen in London, has promised to address the society in March on Michael Faraday, who was of racial descent on both sides a Yorkshireman.

Electric Light and the Eyes.—For some considerable time the medical faculty of Heidelberg have been considering the effect of the incandescent electric light on the eyes. They have arrived at the satisfactory conclusion that it can in no way be described as harmful to the eyes, and as a proof of this they recommend it for lighting halls and places of entertainment.

The Rontgen Society.—The president of the Rontgen Society, we hear, has placed at the disposal of the council a gold medal to be awarded to the maker of the best practical X-ray tube for both photographic and screen work. The competition is open to makers in any country. Tubes intended for competition must be sent in addressed to the Rontgen Society, 20, Hanover-square, London, W.

Institution of Junior Engineers.—On Saturday, Jan. 12, a large party of members of this institution visited the works of Messrs. W. T. Henley's Telegraph Works Company at North Woolwich. They were received with every attention, the various processes in connection with the manufacture carried on being seen in operation and fully explained by the members of the staff, under whose guidance the inspection was made.

Institution of Engineers and Shipbuilders.—We have received the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, issued in January this year. The volume contains a paper on "The Engineering Crisis in the Navy," by Mr. D. B. Morison; the discussion on Mr. J. D. M'Arthur's paper on "Marine Engines Shafting;" and Mr. J. Grant McGregor's paper on "Temporary Work on the Canadian Pacific Railway."

New Book.—Part III. of Deschanel's "Natural Philosophy" has just been issued by Messrs. Blackie and Son. It is entitled "Electricity: An Expansion of Everett's Deschanel, Part III., on the Lines of Modern Electrical Theory," by J. D. Everett, M.A., D.C.L., F.R.S., Emeritus Professor of Natural Philosophy in the Queen's College, Belfast. The contents are divided into electrostatics, magnetism, and current electricity. A colour-plate showing the effect of electric discharges in Geissler tubes enclosing rarefied gases figures as frontispiece, and a large number of illustrations of appliances, etc., are interspersed throughout the text.

Committee on Telegraphic Communication.—An Inter-Departmental Committee has been appointed to enquire into the present system of telegraphic communication between different parts of the Empire, to investigate the relations between private cable companies and the Imperial and Colonial Governments, and the policy which should be pursued by them in future, especially when new concessions are sought; also to examine and report as to rates. The committee is composed as follows: Lord Balfour (chairman), the Marquis of Londonderry, Mr. Hanbury, Lord Hardwicke, Lord Onslow, Major-General Sir J. C. Ardagh (Director of Military Intelligence), and Rear-Admiral Custance (Director of Naval Intelligence).

An American National Standardising Bureau.—We understand that a proposal is about to be brought before the Congress of the United States in favour of establishing a national standardising bureau for electrical and other instruments. The New York Electrical Society has accordingly passed a resolution strongly in favour of legislation in furtherance of this object, and has also resolved to take joint action with any other society in the matter. The importance of uniform standards cannot be overestimated, and we should think that the United States Government will be quite prepared to spend the necessary money in order to establish on a firm basis a national standardising institution on the same lines as the Berlin Reichstanstalt.

Royal Meteorological Society.—At the annual general meeting of this society on Wednesday last week, the president, Dr. C. Theodore Williams, in the chair, the secretary read the report of the council, which showed the society to be in a satisfactory condition, there being an increase of 55 in the number of Fellows over those of the previous year. Reference was made to the celebration of the society's jubilee on April 3-4 last, and also to the death of Mr. G. J. Symons, F.R.S., who had, amongst other things, bequeathed to the society about 2,200 volumes and 4,000 pamphlets from his valuable library. The election of officers and council for the ensuing year took place, Mr. W. H. Dines, B.A., being appointed president, and Dr. C. Theodore Williams treasurer.

Electric Haulage on Canals.—In reply to a deputation from the Association of Chambers of Commerce recently, asking for the appointment of a Royal Commission to enquire into the canal system of this country, Mr. Gerald Balfour suggested that the association should rather appoint a committee to draw up a scheme for its improvement. The President of the Board of Trade drew attention to the steps which had already been taken by Parliament to improve the position of the water traffic in the British Isles, and to prevent the railway companies from throttling the industry of the country. The reforms most urgently needed are the enlargement of the locks, uniformity of gauge and electric haulage, and we have little hesitation in saying that a few years will see electric traction universally adopted on canals in this country.

Suggested Electrical Communication with the Fastnet.—The necessity for establishing electrical communication for signalling purposes between the mainland and the Fastnet, the Smalls, and other similar stations of importance to British shipping, has been taken up by the Liverpool Chamber of Commerce. The Board of Trade have been unable to arrive at any decision in the matter, serious difficulties, it is said, having been presented by the Irish Lights Commissioners. The council of the Liverpool Chamber, however, has decided to bring forward a resolution at the spring meeting of the Association of Chambers of Commerce, urging the necessity for such communication, and suggesting that either cables or wireless telegraphy might be employed with advantage. A further suggestion is that the Government shall arrange for day and night signal stations at important positions on our coasts.

Voting by Electricity.—An electrical machine to expedite roll calls in the American Congress is the latest novelty in the States. The invention is said to be the result of considerable labour on the part of a Mr. Otey, of Virginia. The idea, however, is a simple one. The electrical apparatus would be connected with each member's desk by wiring in such a manner as would enable him to touch a button and display his vote—aye or no—by means of incandescent lights placed opposite to his name on a board directly at the rear of the Speaker's desk, and in front of the main entrance. The American *Electrical Review* states that the present system of voting occupies about three-quarters of an hour. If this be the case, we are sure the

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Congressmen will welcome anything in the shape of a time economiser, and Mr. Otey's invention, we should think, stands a good chance of being adopted when it is submitted to the House.

Phosphorescence of Inorganic Substances.—The Chemical Society in its *Journal* publishes an abstract of a paper by Mr. Eugen Goldstein on this subject. The author states that phosphorescence can be very advantageously detected by means of a form of apparatus in which the powdered substance falls from end to end of an exhausted tube, and is illuminated by cathode rays at one part of it; phosphorescent substances show a streak of coloured light, whilst other substances are only luminous in the path of the rays. The irregular results which have been usually obtained are due to impurities; salts of Li, Na, K, Rb, Cs, Ca, Sr, Ba, Al, Zr, Mg, Be, Zn, and Cd, which for the most part form colourless oxides, all show a blue to violet fluorescence, but minute traces of Cu, Cr, Mn, U, Ni, Co, Pb, Ce, La, Y, Er, Pr, or Nd suffice to produce a strong fluorescence which often entirely masks the blue fluorescence of the pure substance.

Carbide of Calcium in India.—Although this metal at present is not produced in India, it is now being retailed in that country at the rate of four annas the pound, which at the present rate of exchange equals 4d. in English money. According to our contemporary, *Indian Engineering*, this is considerably lower than the wholesale price. It is thought that by retailing carbide at such an exceedingly low figure, acetylene lighting in India will be largely adopted. Our contemporary does not credit the English company with any connection in this direction, but it suggests that as the field in India for acetylene lighting is such an immense one, it may possibly have occurred to some German producers of the chemical to attempt its cultivation, and to spread acetylene lighting by delivering quantities of carbide upon the market at a price that would offer, what are naturally a very conservative class of buyers, some inducement to experiment with it.

Earth Telegraphy.—A Mr. Guarini is the latest inventor to receive the attention of the daily Press. He claims to have discovered a means, which our daily contemporaries naturally assume to be quite new, of transmitting signals through the earth. From the description which is given of his experiments it is clear that he uses two earth-plates at the sending end, and other two earth connections at the receiving end. The distance apart of the two earth-plates at both the transmitting and receiving ends has to be considerable, and when this is granted one will see that there is nothing in connection with the invention which has not been tried experimentally before. In fact, the arrangements are practically those used by the late Mr. Lindsay, of Dundee, in transmitting signals without connecting wires. The subject, however, is sufficiently interesting to the daily Press to warrant long notices, in which exceedingly little information of any kind is given.

Belt Accident.—On Tuesday week a fatal accident happened to a machine minder named Peter Reid, aged 18, of 2, Coombe-villas, Westcombe Park, who was in the employ of the D.P. Battery, Victoria Works, Charlton. At the inquest on Friday it was stated that the deceased mounted the platform above the flywheel of a dynamo machine to push the belting off the shafting on to a pulley. In doing so he slipped, and fell between the main driving belt and the flywheel, and was crushed to death. He had been warned not to go on the platform. Mr. William Worthington, the manager of the works, said that the flywheel of the dynamo machine made from 90 to 100 revolutions per minute. The flywheel was properly fenced by two guards, but there was no railing around the platform. It was not a dangerous work, but it was not advisable for a lad to do it. The company had now resolved to have the platform railed in, in addition to the guards. The enquiry occupied some time, and in the end the jury returned a verdict that the deceased died from injuries sustained whilst removing the belting from a shafting in motion, the platform being unprotected at the time.

Electrical Balloon Signalling.—Mr. Eric Stuart Bruce recently delivered a lecture before the London Institution on "Modern Aeronautics." At this lecture he showed the electric balloon signalling apparatus which he has devised, and which he states has now been adopted in England, Belgium, and Italy. With this system, incandescent lamps placed below the balloon enable signals to be flashed to a great distance. The main subject, however, before the institution at the lecture was the question of navigating balloons, and the lecturer stated that up to the present no very great success had been obtained in this direction. He illustrated the various attempts which have been made—by M. Giffard in 1852 with steam, by M. Tissandier with electricity, by Captains Krebs and Renard with electricity, by Count Zeppelin by the use of aluminium, with petroleum motors, and by M. Santos Dumont with a gasolene motor. So far no one has gained the £4,000 prize offered in France to any who should succeed in navigating a balloon from St.-Cloud round the Eiffel Tower and back. No balloon has yet been navigable, however short the distance, against a breeze stronger than 3m. the second.

The South Staffordshire Mond Gas Bill.—This Bill, which is to come before the House of Commons this year, has for its object the distribution of Mond producer gas for power and heating apparatus over a large area in South Staffordshire. The various town councils in whose districts the company seek the right to supply power, are considering whether they should not unite in joint opposition of the Bill. We are pleased to see, however, that the West Bromwich Town Council, which recently had the matter under discussion, were not in favour of the opposition being carried to any great length. The opinion was expressed by one speaker that the proposed new system would not affect the electric lighting undertaking in West Bromwich, and that it was unlikely to affect their gas undertaking to any large extent. If the opposition be conducted throughout on these broad-minded lines, there will be every chance for the company to make a genuine trial of the possibilities of this system. While we believe that the Mond gas has wonderful advantages in the cheap production of power, we are not upholders of its being used for distribution, as this can be done more advantageously by means of electricity.

Hiring of Electric Fittings.—The St. Pancras Borough Council have received a report from the Electricity Committee to the effect that they have not at present the right to supply consumers with electrical fittings and accessories on the hire system. The committee report that in 1893 the late vestry obtained the opinion of Mr. Fletcher Moulton, Q.C., on the question, who held that they had not any powers in their possession to go beyond the terminals in the consumer's house. The St. Pancras Borough Council have accordingly resolved to call a conference of local authorities who are the owners of electricity supply undertakings, with a view of promoting legislation in favour of powers being acquired to supply apparatus on the hire-purchase system. In any case, however, we believe that each council would have to make application for these powers individually, and the most easy course is to include these powers in a general Bill the

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next time one is to be promoted for objects connected with the Council. A number of the provincial towns have already secured such powers, and have done much to extend the scope of their electrical undertakings by supplying motors and electrical heating apparatus on the hire-purchase system.

A New Coal Calorimeter.—Mr. Samuel W. Parr, in a recent paper, describes this apparatus, which, he claims, differs from those usually employed in that no gaseous oxygen is required, the coal being burnt by means of sodium dioxide. The carbon dioxide and water produced are absorbed by the sodium oxide formed. From an abstract of Mr. Parr's paper, contained in the Chemical Society's *Journal*, it seems that 1 grm. of the sample, dried at 105deg., is mixed with 17 grm. of sodium dioxide; the mixture is put into a cartridge which is placed into an insulated vessel containing a certain volume of water of known temperature. The charge is fired by means of a red-hot copper wire, the increase in temperature is noticed, and the usual calculation made. For exact particulars of the construction of the apparatus and the cartridge, the illustrations of the original paper should be consulted. An allowance of 27 per cent. of the total indicated heat must be made on account of the heat developed in the combination of the carbon dioxide and the water with the chemical employed. An allowance must also be made for the use of the hot copper wire; the average of many determinations on various lengths up to 2in. established a fairly uniform factor of 0·012deg. per ½in. of No. 12 copper wire.

Electricity from Peat.—From the Continent comes the statement that it is proposed to utilise the great peat beds of North Germany for the generation of electricity on a large scale. The matter has been fully considered by Dr. Franks, and he estimates that a hectare of turf 3m. thick gives 2,500 tons of dry turf, equivalent to 1,200 tons of coke, or, in English measure, an acre of turf 10ft. thick gives 1,000 tons of dry turf, equivalent to 480 tons of coke. The mosses of the Evus Valley, which cover an area of 1,000 square miles, might furnish the equivalent of 300,000,000 tons of pit coal—that is to say, more than the total production of Germany for three years. The turf would be burnt at central stations of 10,000 h.p. capacity, consuming annually 200,000 tons of turf, the product of 200 acres of the beds. One application of the power produced would be to the service of the canal connecting Dortmund to the Evus, which will soon be finished, but the author thinks the most interesting will be the manufacture of acetylene, the materials for which can be obtained easily and cheaply in the neighbourhood. With 10,000 h.p. a quantity of acetylene can be produced daily equivalent for lighting purposes to 150,000 gallons of petroleum, or annually in value to 20,000 tons of foreign imported petroleum.

Electrochemistry.—Messrs. W. Lash. Miller and Frank B. Kenrick are the authors of a paper in the *Journal of Physical Chemistry* on the question of quantitative lecture experiments on electrochemistry, and an abstract is given in the *Journal* of the Chemical Society as follows: "The authors describe a very ingenious instrument for use on a lecture table which is capable of marking the necessary changes of resistance in a Wheatstone bridge and of indicating to a class the resistance required. The principle of the method is the following: The needle of a dead-beat galvanometer of the D'Arsonval pattern, when displaced from its zero position, completes a relay circuit, and by means of suitable mechanism causes a rheostat to turn and alter the resistance, the direction being dependent on the side to which the needle moves. This rheostat is provided with a dial and pointer, which indicate the resistance. When the equilibrium is reached and the needle returns to zero, contact is broken and the motion of the rheostat ceases. The authors describe how, by means of this instrument, various electrolytic experiments may be shown to a class, as, for example, the proof of Ostwald's law, preparation of isohydric solutions, measurements of E.M.F.'s, and of polarisation, etc."

Air-Spaces in Armature Cores.—Mr. H. Geisenhoner, of Schenectady, has recently patented in the States a cheap arrangement of making air-spaces up through the laminated cores of dynamo armatures. We understand that the patent in question has been assigned to the General Electric Company. The inventor's plan consists in pressing out of certain of the cored plates a number of projections which can be bent round over a circular rod of metal, much in the same way that hinges are often formed on tin boxes. Two of these projections are always constructed on radial lines, so that the one bar of metal can be passed through the two. The ends of these bars are then turned so as to secure them in place. The armature plates having these projections formed on them are then placed face to face, so that a considerable air-space is secured up through the rims of the core. The frequency of this air-space is, of course, a matter of detail which can be left to the constructor. We notice, however, that in the illustration accompanying the patent the upper loop punched out of the cored plate is shown placed on the teeth of the same. We presume that it is required there in order that there may not be any vibrations between the last core plates at either side of the air-gap. It would, however, in certain armatures be quite impossible to construct the embracing loop out of the small amount of material available in the teeth.

Production and Use of Electricity.—Considerable interest centered round the inaugural address of Dr. A. P. Laurie, M.A., F.R.S.E., last week, on the occasion of his appointment as principal of the Heriot-Watt College, Edinburgh, in succession to Principal F. Grant Ogilvie, now curator of the Museum of Science and Arts. Lord Provost Steel presided, and the crowded audience assembled in the Synod Hall extended a hearty welcome to the new principal. The subject of the address was "The Electric Current: Its Production and Use," and Dr. Laurie showed in particularly clear language how the current was produced and applied to purposes of lighting and power. Interesting experiments and limelight views accompanied the lecture, which embraced the subject of the sources of power available for the generation of electricity. Of course, in this country the coalfields would be the main source of power in supplying the electric current for a long time to come but there were other sources—wind power and water power, for instance. The most important of these was water power, and, therefore, the great waterfalls were likely in the immediate future to become the important centres of industry, but whatever the source of the power which might be adopted for the production of the electric current in the future, one might safely prophesy that if the nineteenth century had been the century of steam, the twentieth century would be the century of electricity.

Cable-Laying.—It will be remembered that the laying of the Alaskan cable, which was undertaken by certain American firms, was not a success, in spite of the energy displayed by the firms in overcoming a number of disastrous incidents, including the wreck of the steamer which was laying the cable. Mr. H. L. Webb has written to various papers in the United States on this question in reply to editorial comments on the subject. The concluding para-

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graph of his letter runs as follows: "You will see, Mr. Editor, I draw from the tale of the Alaskan cable a slightly different moral from that which you draw in your enthusiastic editorial. I thoroughly admire Mr. Brixey's enterprise in building a cable many times longer than any he had ever built before, in shipping it on reels across the continent, in stowing it in a ship not equipped for cable-laying, and in guaranteeing to lay it in good condition; and I also admire Mr. Porter's courage in taking charge of a job in which he had no previous experience, and the pluck and energy with which he pulled himself out of the difficult position in which the 'Orizaba' placed him—and herself. What I do not admire, in these days when submarine cable-laying has become an almost exact science, is the disregard of that science in the organisation of the expedition, and the exaggerated importance you give in your editorial to this shallow-water cable work as compared with the work of English cable concerns that have been occupied during the past 50 years in lacing the globe with cables in all depths of water and under all manner of conditions. If real deep-sea cable-laying is to become an American industry, surely it is better to face the real facts and conditions than to encourage the too common idea that 'enterprise,' 'boldness,' and rule-of-thumb methods are better than experience, caution, and skill."

Switchboard Protection.—A case which may ultimately be of far-reaching importance is being tried at the Greenwich Police Court. It was commenced on Friday last, and after an extended hearing was adjourned for a fortnight. The inspector of factories for the Greenwich district has brought the action against the Blackheath and Greenwich District Electric Lighting Company on the ground that they have neglected to securely fence in certain machinery—*i.e.*, their switchboards—and also because they had failed to register an accident within one week after it had occurred. It will be remembered that two deaths have occurred at the switchboard in question, the last taking place on Oct. 22, 1900. The inspector of factories claims that the cause of the accident is covered by Section 5, Sub-Section 3, of the Factory Act of 1878, and Section 6, Sub-Section 2, of the Factory Act of 1891. From what we can gather from the evidence already given, it was a question how far these sections are intended to protect the workman actually using a dangerous machine if skilled knowledge is required in the process. It is obvious that, however well the high-tension switchboard of the type used in the above company's works is fenced in, the operator is liable to obtain a dangerous shock if he neglects the instructions given to him for working the switch gear. This is equally true of any switch or electrical gear having high-tension parts exposed, and we do not think that any fencing can adequately protect the skilled operator against faults in design. The question also arises as to how far it is better for the skilled man to know that there is danger in connection with his work, in order that he may be always the more careful in guarding against an accidental shock. A brief *résumé* of the case will be found elsewhere in this issue.

Steam Engineering Progress.—Mr. A. F. Nagle publishes in the *American Electrician* for this month an interesting article on "A Century of Progress in Steam Engineering." The author shows that at the beginning of the nineteenth century the steam-engine was working under 10lb. to 15lb. steam pressure, and making from 10 to 30 revolutions per minute. It expanded steam from three to four times, and was aided by both jet and surface condensers. It required the consumption of from 9lb. to 10lb. of coal an hour to develop 1 h.p. To-day we can use steam of any desired pressure. Reciprocating engines are running at from 100 to 300 revolutions per minute, making from 600ft. to 900ft. piston speed a minute. They can be made to expand steam to any extent desired, which may be 40 times, and the economy has been brought to almost 1 h.p. per pound of coal per hour. In the beginning of the nineteenth century the designer of engines had practically no scientific knowledge to guide him, and the inventors, such as Watt, made their improvements from practical deductions from experimental observations arrived at in daily practice. In spite of this want of the knowledge of the laws governing the economic production and use of steam at that time, the progress of the century in the design of boilers has not been so great as might be expected. Thus the author considers that in 1800 boilers were constructed which had an efficiency of from 40 to 45 per cent., whereas to-day the best results vary from 80 to 90 per cent. The general average of boiler efficiency even now might not be more than from 60 to 70 per cent. It is in the steam-engine that the greatest advance has been made, and there does not remain much prospect of increased economy with the ordinary reciprocal engine. The last part of the article is devoted to the development of rotary engines, which in their earlier stages were so unsuccessful. These engines have now given place to the steam-turbine as developed by Mr. C. A Parsons, and the author predicts that this type of engine will in the near future become a standard article for driving electrical machinery.

Electrical Transmission from Coal Mines.—Actual experience has yet to be gained of the economies of power distribution from a coal mine, as the question will always arise as to the comparative cost of the carriage of coal, and of the transmission of electrical energy, with its consequent losses in transformation at the receiving end of the line. The other item entering into this comparison is the capital charge on the electrical cables used for conveying the electrical energy. Actual experience will soon be obtained in this direction in England, as the power schemes passed in the last session of Parliament are being commenced commercially. In America the largest transmission works have been up to the present in connection with water-power schemes, but in Colorado some actual work has been done in the transmission of electrical energy in order to save the cost of transportation of coal. For instance, at the Canon City plant power is transmitted 24 miles at 20,000 volts to various mines in the Cripple Creek district. The actual cost of conveying coal over the distance was about 14s. 6d. per ton, exclusive of the cost of getting the coal from the railway station up to the mines. There was also trouble at the mines in getting a water supply for the boilers. The actual figures of the cost of supply have been given in previous issues, which clearly proved the advantage of the electrical transmission scheme both to the owners of the power plant and to the mine owners. We understand from the *Electrical World* that a similar scheme is now being organised for the supply of power throughout the Colorado Springs district. In this case the coal mines are comparatively near the town, being only 3½ to 4 miles away, and there is not the disadvantage of the want of water in the town. In spite of this, it is considered locally to be advantageous to have the power-house outside the town, and we consider that the company having the work in hand are doing the right thing in laying down their present plant. The old station of the company in the town itself is to be converted into a heat distribution plant, the electrical machinery being removed and the boilers used for steam heating. The voltage of transmission between the power station at the coal mines

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and the various parts of the district will be 6,600, and three-phase currents will be employed.

Underground Cables.—The last meeting of the directors of the Glasgow Chamber of Commerce was principally devoted to a discussion on this subject, which resulted in the determination to ask the co-operation of the other chambers of commerce and the various stock exchanges in the United Kingdom in petitioning the Post Office to establish a complete system of underground telegraph wires. In a speech which indicated deep research, Mr. Paul Rottenburg pointed out that in 1895, in reply to a petition from the chamber, the Post Office authorities stated that a system of underground wires was too expensive, and that the Government felt sure that they could put up poles which would withstand any storm. Since that time the authorities must have spent an enormous amount of money on the repair and upkeep of their overhead wires, while they had also learned that the elements were stronger than the poles that any Post Office could erect. An entire collapse of telegraph connections, such as was often experienced with overhead wires during severe weather, was entirely excluded in Germany. The underground system, which was being worked with the same apparatus as the overhead system in that country, had quite answered all purposes since it was introduced in 1877. It was 3,540 miles in extent, with about 23,750 miles of wires, and it had proved quite adequate under all circumstances for the transmission of news from the centre of the empire in all directions. Although, perhaps, the cost of the underground system was great as compared with that of the overhead wires, it must be remembered that the cost of the German system had only been £2,000 for the period 1882-87, or an average of £400 annually. With regard to maintenance, the cost for an overhead wire was 21 times greater than for an underground wire. France had also gone in for a complete system of underground wires. In this country, it was true, an underground cable had been started between London and Birmingham, but no headway was being made in the way of establishing a complete system. Other speakers expressed the same views, and it is to be hoped the matter will be seriously taken up by the Post Office authorities without loss of time.

Electrical Dangers.—The number of deaths which have occurred on high-tension systems of electric light have frequently been commented on in these columns, and we have pointed out that a number of these fatal accidents could have been averted if only the engineers responsible for the designs had taken due precautions in the first instance. In too many cases, old and dangerous types of switch gear, especially in sub-stations, are allowed to remain, because to replace them by others would involve considerable capital expenditure. In the long run, however, it will do more to the credit of engineers in charge of such stations to report promptly on what is absolutely required to make their system reasonably safe than to wait until, by reason of fatal accidents, they are compelled to put their stations in order. Mr. A. Ellis, the electrical engineer at Cardiff, has recently reported most strongly on this matter to his committee. The report was called for because of several breakdowns, in consequence of which he made a thorough examination of the distributing system. He reports that the transformer sub-stations are in many instances in anything but a satisfactory condition, and he could only describe certain of them as veritable death-traps. He goes on to state that in many cases there were switches and fuses entirely unprotected with a potential of 2,000 volts across the terminals. In one sub-station particularly was this the case, and in this same sub-station there was a pair of high-pressure cables slung across the sub-station and tied up to the metal ladder, by which access to the sub-station is gained. The whole of the sub-stations on the systems would be thoroughly examined, with a view to putting them into a state of efficiency and absolute safety. In a tank at St. Mary-street the various branches to the different points of distribution were coupled to the mains, but instead of being properly jointed they were simply twisted together at the ends and protected only by a sheet of rubber, which was tied around them. In their present state the cables had no protection whatever against moisture, nor was it safe for a man to work on them. The whole of the system of mains and transformer sub-stations were receiving immediate attention, but it would take some considerable time to get them into a state of efficiency. A great deal of the defects are evidently due to the want of organisation in the outdoor staff, which resulted in careless work. We are exceedingly glad to find this matter reported, and trust that the rearrangement of the dangerous sub-stations may take place without fatal accidents occurring.

Institution of Mechanical Engineers. — The report of the council, presented to the annual general meeting of this institution last Friday, shows the progress made during the past year. The pleasing announcement is formally made that the honour of a baronetcy has been conferred upon Mr. Thomas Wrightson, M.P. At the end of the year the number in all classes on the roll of the institution was 3,165, as compared with 2,922 at the end of the previous year, showing a net gain of 243. Among the 33 members deceased during 1900 the name of Lord Armstrong is particularly noticeable. The late Lord Armstrong had been a member since 1858, and the prominent part he took in the earlier years of the institution is shown by his having been a vice-president in 1859 and 1860, and president in 1861, 1862, and 1869. An interesting item is that the award of the Willans premium has been for the first time in the gift of the council, and from the papers read before the institution since the foundation of the fund in January, 1895, they have selected that read in April, 1895, by Captain H. Riall Sankey on 'Governing of Steam-Engines by Throttling and by Variable Expansion," as the most suitable for the award. Sir William C. Roberts-Austen is still at work upon the sixth report to the Alloys Research Committee, dealing mainly with the effect of annealing and tempering on the properties of steel. This report is expected to be ready during the coming year. Prof. F. W. Burstall hopes to complete his second report to the Gas-Engine Research Committee in the course of a few weeks. Considerable progress has been made in the experiments on the value of the steam jacket by Prof. T. Hudson Beare, while Prof. David S. Capper has made a first series of tests on the compound steam-jacketed engine at King's College with different steam pressures and speeds, working single-cylinder, non-condensing. The results have been worked out, and are expected to be ready shortly. With a view to the formation of a historical museum relating to mechanical engineering progress, several gifts of value have been promised. Members are invited to help with suitable contributions of drawings and models. At the request of the executive of the Glasgow International Engineering Congress, the council have consented to take charge of the mechanical section of the congress, the meetings of which will be held during the first week of September, 1901. They have also decided that these arrangements shall not interfere with the ordinary summer meeting of the institution, which will be held during the last week in July at Barrow-in-Furness.

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PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 79.)

It now remains to record a few of the methods used for the localisation of faults. There are two classes of fault which occur in the ordinary routine of electric supply: one is the discontinuity fault; the other is the short-circuit, which latter class contains the short between one conductor and another, and the short between one conductor and earth. The discontinuity fault is of much rarer occurrence than the short, but does occur, so that it must be dealt with. In cables laid underground, this class of fault will nearly always be found in a joint, and is usually caused by the cable being pulled too taut, when laid, and then being contracted, after jointing, by severe frost. Cables laid during very hot weather are more subject to this strain than those laid during cold weather. Another cause is the slipping of ground in which the cable is laid; where there are old cellars which have only been partially filled in, this may easily happen if the cable is laid over the top of them. It is then an easy matter to open joint-boxes in search of such a fault, of course starting at or near the centre of the cable and testing each way with a common detector, the farther ends of the conductor being earthed, or, in the case of a concentric cable, short-circuited with the other conductor. If the fault cannot be found in a joint-box, it must be localised by a capacity test. The cable will be charged from one end up to the break; this charge can then be compared with the charge into a condenser of known capacity, and since the capacity per mile of the cable is known, the length of the cable under test to the break can easily be ascertained.

In view of sometimes having to take these tests, it might be as well that the capacities of all important cables, such as feeders, should be taken after the cables are jointed up and ready for working, the capacities being carefully recorded for future use. In the case of a distributor having such a fault, it is, of course, only necessary to feed the cable at one end, then to visit each consumer supplied from this cable, the break being found between the last one who has the light and the first one who has not.

For the localisation of a fault to earth, or of a fault between one conductor and another, the best method to adopt is the loop test known as Murray's. Suppose that one of two single-conductor cables has developed a fault to earth, it is very easy to make a loop of these two cables at the far end from that chosen as the testing point. Care must, however, be taken to ensure that there is no resistance in the connection of one cable to the other; the best method of connection is to sweat both ends into a sleeve, which is put half on to each cable. At the testing end will be required a galvanometer sensitive to small variations of potential, a Wheatstone's bridge, and a battery. These should be connected as shown in Fig. 7. A B represents one of the proportional arms of the bridge, the other being plugged up; A E represents the variable resistance arm, and B E the cable loop. Let y = the resistance of the cable from B to the fault F, and x = the resistance from the fault back to the bridge at E; then L = the total resistance of the loop, or $L = x + y$. After obtaining a balance, the following formula holds good:

$$x \times AB = y \times EA;$$

then as $L = x + y$, $\quad x = L - y$.

Substituting $L - y$ for x, we get

$$(L - y)\,AB = y \times EA;$$

and $$AB\,L - AB\,y + AB\,y = EA\,y + AB\,y;$$

or $$AB\,L = EA\,y + AB\,y = (EA + AB)\,y.$$

Dividing each side by $EA + AB$

$$\frac{AB\,L}{EA + AB} = \left(\frac{EA + AB}{EA + AB}\right) y; \text{ then } y = \left(\frac{AB}{EA + AB}\right) L$$

Then from the known resistance per mile of the faulty cable, we get the length equal to the resistance y. L would be obtained by the ordinary bridge test for resistance. It will be observed, however, for this test to bring accurate results, the fault resistance must be low, so low that current easily passes through the fault to earth. If it is not of sufficiently low resistance, the fault should be broken down by passing current through it at a fairly high potential; failing this, it would probably be best to connect the galvanometer between A and earth, and the battery between B and E—the galvanometer circuit would then contain the fault resistance.

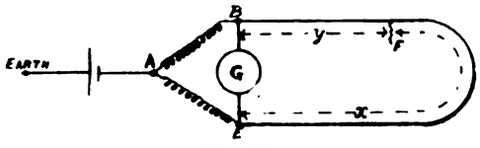

FIG. 7.

Supposing, again, that a short-circuit fault had taken place between the inner and outer of a concentric cable, which might or might not be also an earth fault. A modification of the Murray's loop test could be made as Fig. 8, thus giving a direct copper galvanometer circuit. Let A B represent the outer of a concentric cable and C D the inner of the same cable; also D E the cable used to form the loop, and C H and H E the bridge arms (as in Fig. 7). Then let x = the distance in yards to the fault, and R_1 and R_2 the resistances unplugged in the bridge arms, R_3 the resistance of the good cable forming the loop, and R_4 the known resistance of the cable under test, $R_4 + R_3$ being the resistance of whole loop. Then

$$x = \frac{\frac{R_1}{R_2}\left(1 + \frac{R_3}{R_3 + R_4}\right)}{1 + \frac{R_1}{R_2}} L,$$

L being the length of the cable under test.

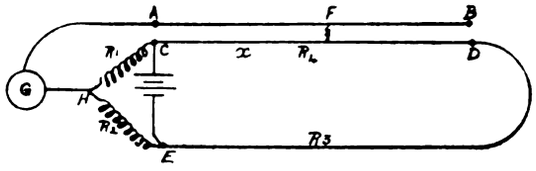

FIG. 8.

The test described as Fig. 7 will be found on p. 225 of Mr. Kempe's handbook, together with the best conditions for making such tests, and should be carefully studied Fault currents would have to be taken into account with the galvanometer between A and earth.

In making the loop tests as above, care must be taken to well insulate any pieces of the testing set not included in the earth circuit, as any leakage will completely upset the test The best insulators to use for this purpose are thick blocks of rubber, as there is no creeping of moisture over the surface presented by such blocks. If a convenient cable does not exist in the ground suitable for forming the loop with the faulty cable, a single-conductor cable of suitable size can be laid along the ground. This would probably make it necessary to do the test at night if any side streets come within the length under test.

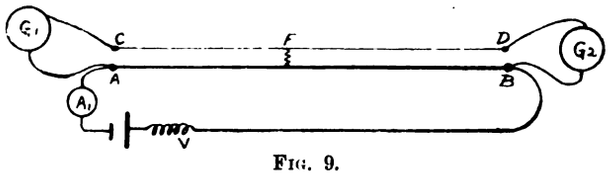

FIG. 9.

Another method of locating a fault, whether it be an earth fault from a single conductor cable or a short between inner and outer of a concentric cable, is known as the fall of potential method, the connections being shown in Fig. 9. Let A B be the faulty conductor, C D be the lead sheathing, or earth, or perhaps the iron pipe containing the cable, or the outer in case of a concentric cable. A is an ammeter with an open scale; V is a variable resistance. Current is now passed round the loop, being kept constant in the ammeter, A, by the variable resistance, V. It will follow that the galvanometer reading taken at G_1 represents the fall of potential along the cable between A and F. The galvanometer is now taken to the other end of the cable, and a reading, G_2, is taken, representing the fall of potential

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between B and F. The two readings so obtained are directly proportional to the length of cable each side of the fault, F. The same galvanometer should be used for each reading, and as the fault resistance is the same in each case it will not affect the deflections obtained. This test does not usually give such good results as the loop tests with the bridge, but is, at any rate, worth trying.

To get anything like good results from these tests it is necessary that the insulation of the faulty cable should be good, except at the fault, so that in any case where the cable is at all worn out, it would be better not to waste time on such a test, but simply to localise by cutting and inspection down to a suitable length, and then relay; or if the cable is in a conduit, to fasten on a good piece of cable to one end and draw this in while pulling out the old one.

A method sometimes tried, but without much success, is the telephone method. This consists in the carrying over the line of the faulty cable a large coil of wire, usually wound on a triangle, to the ends of which is attached a telephone receiver, which, on being held to the ear of the operator, gives a distinct hum. The hum should cease as soon as the fault is passed. If, however, the faulty cable is a sheathed or armoured cable, the sheathing or armouring of which does not make good earth along its whole length, current is carried by such sheathing to the nearest good earth, which may be many yards beyond the actual fault; thus the test is of no use, as while current is passing the hum will remain. Another objection to the telephone is that it cannot be used by day in places where there is much traffic, as the noise from the traffic drowns the hum from the telephone.

(*To be continued.*)

MODERN ELECTRIC LIGHTING PLANT.

BY R. D. SUMMERFIELD.

(Concluded from page 89.)

Engines.—There are four principal types of engines in use for electric lighting at the present day—viz., steam-turbines, running at enormous speeds compared with all other engines; high-speed vertical enclosed engines, either single or double acting; moderate speed vertical cross compound engines; slow-speed horizontal compound or triple-expansion engines.

The steam-turbine has undoubtedly a great future before it for electrical work. Owing to its high speed, the size and weight per horse-power developed is very much less than in reciprocating engines, and this applies equally to the generator, which is coupled direct to the turbine shaft. Steam-turbines, having no reciprocating parts, run with very slight vibration, and require only light foundations, while as regards steam consumption, they are now built to give as good results as the majority of electric light engines in use. The Parsons turbine is the most widely known, followed by the De Laval. Parsons turbines of 1,000 h.p. have been running for some time in Germany and America, and they are now being built up to 3,000 h.p. or more, which shows how confidence in this type of engine is growing.

The high-speed vertical enclosed engine may be called the typical English electric light engine at the present day. Both single and double acting engines of this type are used, there being several different makes of the latter on the market, but very few single-acting engines, and of these the well-known Willans engine easily takes the first place in point of numbers. These engines have not been made in very large powers until quite recently, but at the Paris Exhibition Messrs. Willans and Robinson had on view an engine of 2,400 h.p, the tests of which have been so satisfactory that the makers are now prepared to build engines of this type up to almost any power. In these large engines Messrs. Willans and Robinson employ vertical governors of the same type as their usual shaft governors, but driven by screw gearing from the crankshaft instead of being mounted directly upon it. The engine shown at the exhibition was a triple-expansion one, with three cranks and nine cylinders, the speed being 200 revolutions per minute. Single-acting engines run very silently, they require only slight attention, are self-lubricating, and possess great facilities for getting rid of water in the cylinders. Their principal disadvantage is that they require twice as much cylinder volume as would be required by a double-acting engine to develop the same power at the same speed. The Belliss engine may be taken as the type from which the modern high-speed double-acting vertical engine sprang, but many good makers have turned their attention to this class of engine during the last few years, with the result that there are now several equally excellent engines of this type on the market. These engines are nearly always lubricated with oil under pressure, and this is their weakest point, as they depend upon the forced lubrication to act as a cushion and take up the play in the brasses without causing a knock at each end of the stroke. If the oil-pump goes wrong, or the pipes burst, or the oil becomes too thick to run properly, considerable trouble may be caused, but in actual practice these accidents seldom happen, and engines of this kind are in great favour with very many electric light engineers. Except in the small sizes, they usually have either four or six cylinders, the high-pressure cylinders placed over the low-pressure, and two or three cranks. The speeds vary between about 200 and 500 revolutions, according to size.

Another type of electric light engine used to a considerable extent at the present day is the two-cylinder compound vertical engine of moderate speed, with overhung cranks and only two shaft bearings. The cylinders are mounted on hollow cast-iron columns, which form cross-head guides, and enclose the cranks and connecting rods, preventing oil from splashing about. A heavy flywheel of large diameter is mounted on the shaft between the cylinders, and on this flywheel the moving parts of the generator are built, especially in the case of alternators. The armatures of continuous-current dynamos are usually mounted on the shaft close to the flywheel; in American practice almost invariably, but the retention of the flywheel in these cases seems hardly necessary. The speeds of these engines generally lie between 80 and 150 revolutions per minute, and they are built up to 3,000 h.p. They possess advantages over horizontal engines, in that they take up less floor space, and the wear of the cylinders and pistons is more equal, but they are liable to set up undue vibration unless erected on very massive foundations.

The type of engine which is most used on the Continent for large powers is the slow-speed horizontal engine, which has been carefully studied by Continental makers and brought to a high state of efficiency, as proved by the many magnificent engines of this class shown at the Paris Exhibition. The speeds of these engines vary from 60 to about 130 revolutions per minute. Large and heavy flywheels are the rule and Corliss valve gear, which latter is often of a very delicate, and, in the opinion of many English engineers, needlessly complicated construction. The very economical results obtained, however, seem to justify its use. These engines are usually made either compound or triple-expansion, with two or four cylinders, placed tandem. The cranks are overhung, and only two main bearings used.

Horizontal engines are used largely in America, the quick-speed, single-crank, simple or compound tandem types being great favourites. It must be remembered, however, that American and Continental engineers do not possess vertical engines which can be compared with those made by Willans or Belliss in this country, and they have, therefore, been obliged to make the most of the horizontal engine. It is a question, though, whether horizontal engines will not be found more suitable for the very large powers, 4,000 h.p. and more, now being used, as vertical engines of this power take up a great deal of headroom, as there must be space above them for a heavy crane; they are less accessible than horizontal engines, and more liable to set up vibration.

Direct coupling to generators is the rule in England and generally on the Continent at the present day, belt or rope driving, except for quite small plants, being almost unknown. The Americans have not yet got rid of their complicated and clumsy-looking belt drives, but they are rapidly coming round to English practice in this respect. The aim of the majority of English engine builders is to

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produce a strong, smooth-running, and efficient machine as simply as possible. This tendency on the part of British engineers is very apparent in the design of their locomotives. Contrast, for instance, an English main-line express engine, with its beautiful proportions and almost utter absence of external pipes or rods, with the travelling machine shops which go by the name of locomotives in other countries.

Gas-engines are now used to a great and increasing extent for electric lighting work, principally for private installations in hotels, warehouses, institutions, country houses, etc., but there are also several public lighting stations of small size driven by gas-engines in the United Kingdom—for instance, at Leyton, Belfast, King's Lynn, etc.—and also many in America and the Continent. Gas-engines have increased largely in power during the last few years, two-cylinder engines of 200 h.p. to 300 h.p. being not uncommon. For electric lighting work extra heavy flywheels are used; mushroom lift valves have taken the place of sliding valves, and electric ignition is nearly always fitted. The most noticeable departure from the usual form has been made by the Westinghouse Company of America, who are making large vertical gas-engines which closely resemble steam-engines in arrangement and for which a very high efficiency is claimed. Except for the small sizes, producer gas is used in the majority of engines now put down, as this is a good deal cheaper than lighting gas, although about four times the quantity is required to give the same power. There is great scope for gas-engines in the utilisation of waste furnace gases, and this subject is receiving a good deal of attention just now in France and Germany.

Electric Generators.—Perhaps the three most noticeable points in connection with modern dynamos are the uniformity of design between different makers, the very large outputs for which single machines are now built, and the practical disappearance of single-phase alternate-current plant. The first point may be best illustrated by the design of continuous-current dynamos for medium and large outputs. Such machines are now almost universally of the multipolar type, having usually either four or six poles, except in the larger sizes. The field-magnet ring or yoke is circular, made of soft cast steel, the bottom half being cast solid with the bed-plate and pedestals for the bearings, while the top half is cast separately and bolted to the bottom along a horizontal centre line, so that by removing this upper half and the bearing caps the armature can be lifted straight out. The cores of the field coils are generally of cast steel also. They are usually rectangular with rounded ends, and are secured to the magnet ring by two or more bolts, the coils themselves, which are separately wound on formers, having previously been slipped over them. The armatures are of the drum type, the cores being built up of a great number of soft-iron discs clamped tightly together. Longitudinal slots are cut in the periphery of the core to receive the armature conductors, these being insulated with mica before being put in place. As the slots are wider at the bottom than the top the conductors cannot work out, even if the wooden wedges which keep them tight were removed, so that an armature of this description needs no binding wires. The commutator segments are made of hard-drawn copper, insulated from one another by mica, and the commutators are of large diameter, usually from one-half to three-quarters the diameter of the armature. The brushes are nearly always of carbon, and are moved by means of a worm and wheel. The bearings of these machines are spherical, and rest on spherical seatings in the pedestals, so that a slight movement is possible in all directions, and the shaft is able to set itself truly. The lubrication is carried out by rings revolving loosely on the shaft, their lower parts dipping into oil.

The design of alternate-current generators is also becoming much more uniform, although there is more diversity in these machines than in direct-current plant. Single-phase alternators are rarely or never put down now in new stations where there is any likelihood of a motor load, as single-phase motors have been found to be not at all satisfactory. When the power station is situated some distance from the supply area, or when a considerable motor load is expected, polyphase plant is generally put down, the majority of engineers preferring three-phase current, although some make use of two-phase. A great number of three-phase alternators were shown by Continental makers at the Paris Exhibition, the favourite construction being the flywheel type. In these machines the horizontal cylinders are arranged on each side of a massive flywheel of large diameter, two overhung disc cranks being used, and the speed being from 60 to 80 revolutions per minute. The field-magnet coils are built up on the rim of the flywheel and revolve with it, the armature being stationary. These machines generate current at pressures up to 10,000 volts, and in some cases the field coils and armature are both fixed, the pole-pieces only being attached to the flywheel. These machines are known as inductor alternators.

The size and capacity of dynamos increases steadily year by year, and it would be rash to say what will be the limit in output for any type of machine. The largest dynamos at present are those used for railway and power work, the 5,000-h.p. generators at Niagara being the most powerful in the world, although it is not likely that they will long remain so. The largest machines for lighting purposes running in England at the present time have an output of about 1,500 kw. There are already several of these large machines at work, the majority in London, and it is probable that machines of larger size still will become quite common in a few years' time, now that electric light has come to be considered an absolute necessity for shops, hotels, and business premises generally.

The alternators built by the great Continental firms are almost without exception of the iron-cored type, but in England alternators with no iron in the armature are advocated and built by such high authorities as Messrs. Mordey and Ferranti, the latter having recently supplied the City of London Electric Lighting Company with two single-phase alternators of this description, each of 1,500-kw. capacity. The author is of opinion that the Continental makers are on the right side in this matter, as although non-inductive machines may have certain advantages, the iron-cored generators are mechanically stronger, they are easier to parallel, and they run better in parallel than alternators with no iron in their armatures, as the author has proved from practical experience.

The use of boosters and motor-generators has largely increased of late years, and such machines may now be found in most electric lighting stations. They are useful in a number of ways: they may be used to balance the two sides of a three-wire system, to raise the pressure on any particular feeder, to act as exciters, charge accumulators, change alternate to continuous current, or *vice versâ*—in fact, they may be made to effect almost any transformation, so that it is not surprising that they find such favour with central-station engineers. Sometimes they are made in the form of one machine, with two windings on the armature and two commutators, but more generally they consist of two separate machines on one shaft.

Dynamos generally are now made very much stronger mechanically and electrically than they used to be, every detail being designed with a view to long running and hard wear, while at the same time the use of cast steel in place of cast iron in their construction has effected a considerable saving in weight, thereby lessening the cost of carriage. As the author mentioned before, the use of slotted drum armatures, self-oiling and self-aligning bearings, carbon brushes, and multipolar fields is general. In small stations, where the load can be taken by one engine of no great power, it is a common practice to couple two equal generators direct to the shaft, these generators being joined in series and supplying a three-wire system.

Switch Gear.—Switches are now made of strong and substantial construction and as simple as possible. They are generally made on the quick-break principle, and for voltages of over 100 it is usual to cause the final break to take place between blocks or rollers of carbon, or metal springs which are easily renewable, in order that the switch itself may not be injured by the arcing which takes place. For the high voltages used in alternate-current work the Ferranti oil-break switch is largely used. These switches are of the single-pole type, and are so constructed that, after the main contacts have fairly broken, the circuit is finally

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opened by a small contact-piece working in a porcelain pot filled with heavy oil, which puts out the arc or prevents it forming. It is possible to open these switches when they are carrying their full current at a high voltage without damaging them in any way. Modern switchboards are nearly always arranged on the panel system—that is, the switches, instruments, and fuses belonging to one particular machine or feeder circuit are all mounted on one panel of slate or marble, this being numbered to correspond with the dynamo or circuit connected with it. A greater or less number of these panels are attached to an iron framework, and form the switchboard. For high voltages, projecting slabs of slate or marble are placed between each panel to prevent arcing, and such slabs are often placed between different parts of the switches for the same purpose. Switchboards are generally placed on platforms raised some feet above the engine-room floor; if possible, in a position where the attendant can easily see every machine. In the best practice plenty of room is left at the back of the board for men to work.

With regard to instruments, the well-known "gravity" forms of volt and ammeters are in general use for ordinary currents and voltages, also "hot-wire" instruments, and for high voltages Kelvin electrostatic instruments are largely used. Lately, the Weston type of instruments have found great favour also. Recording voltmeters are to be found in every central station, and often recording ammeters and wattmeters also. Circuit breakers, which are universal in tramway and power stations, have not come into very general use for lighting work, most engineers preferring fuses.

Accumulators.—These are now used very extensively in private installations and small central stations. In the latter they are often utilised to balance the sides of a three-wire system, besides assisting the dynamos over the top load. Great improvements have been made in the lead plates, and modern accumulators last a long time and give little trouble if properly attended to and not discharged at too high a rate. Glass boxes are used for the small-size cells, while the large ones are generally put up in lead-lined wooden boxes.

General Arrangement of Lighting Stations.—The selection of a suitable site for a power station becomes more difficult year by year, owing to the increased cost of land in or near most towns, high price of fuel, local by-laws which must be observed, etc. The ideal station would be one situated in the centre of the supply area, built on the banks of a canal or river, with a good road entrance and railway siding accommodation. These advantages are seldom to be obtained together, except at a prohibitive cost for land, and designers of stations are, therefore, obliged to weigh carefully the advantages and disadvantages of several possible sites before deciding. The best site undoubtedly is on the banks of a canal or navigable river, as plenty of water is then available for condensing, and possibly for feeding the boilers, and coal can be brought to the works much cheaper in barges than by railway. These points are considered more important than distance from the supply area, as the cost of cables can be kept down by generating at high pressure and transforming in sub-stations.

Power and lighting stations are now always designed with a view to future extension, as engineers have learnt by experience how rapidly the demand for electric current grows when once started. The usual way is to build a temporary wall across one end of the station, or even to board it up, and to provide sufficient space outside to lengthen the building to double its original size, the machinery, flues, pipes, switchboard, etc., all being arranged for easy extension. The usual practice is to arrange all the boilers in a row in one building and all the engines in a row in another parallel building, a wall separating the two. This arrangement gives the shortest length of steam-pipe, and has several other advantages, but for very large stations it would make the buildings too long, and in these cases the engines and boilers are generally arranged in double rows.

The great aim of central-station engineers is to produce current as cheaply as possible, and, therefore, all kinds of appliances are made use of to effect economy. Besides those mentioned before, such as coal and ash-handling machinery and mechanical stokers, there may be noticed oil-filters, by means of which the oil may be used again several times, combined feed-water heaters and purifiers, which are often used now in place of economisers, and last, but by no means least, condensers. It is the usual practice now to make the condensing plant separate from the main engines, the exhaust pipes being arranged so that the engines can be made to exhaust into the atmosphere or condenser at will, and changed from one to the other while running on load. Except for large plants, the air and circulating pumps are generally mounted on or attached to the condenser, forming a compact plant. Many engineers prefer a high-speed air-pump such as the Edward's, as with the small quantity of water dealt with at each stroke there is little danger of flooding. In some stations all the engines and steam-pumps are connected to the condenser, in other the exhaust steam from the auxiliary plant is utilised in feed-water heaters, etc. Where space is available, cooling towers are often put down in connection with condensing plant.

In conclusion, the author is aware that there are many interesting and important points in connection with modern electric lighting plant which he has omitted to mention, but in the foregoing article he has only attempted to give a rough, general outline of actual modern practice, and the direction in which this practice appears to him to trend. To sum up in a few words, he is of opinion that the steam-engines now in use will be almost entirely superseded in a few years' time by steam-turbines and by large gas-engines worked with producer gas, the electric generators of that period being probably of a much larger output than those now in use, and producing high-pressure continuous or three-phase alternating currents, which will be transformed in sub-stations situated in the area of supply.

THE CONTROL OF TRAMWAY MOTORS.

In an article contributed to the *Elektrotechnische Zeitschrift*, Mr. K. Sieber deals with the question of the control of tramway motors as follows: The motors principally used for traction work may be divided into two classes: (1) where the armature current has always the same value as the exciting current; (2) where this is not the case.

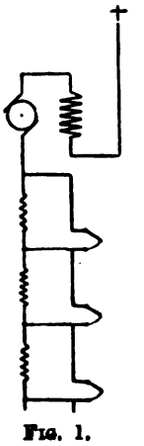

Fig. 1.

To the first class belong (1) the series-wound motor with simple auxiliary resistance (Fig. 1); (2) series-wound motor with provision for running in series-parallel (Fig. 2); (3) with Sprague connections for cars equipped with single motors. To the second class belong (4) the shunt-wound motor (Fig. 3); (5) motors excited by means of current from an independent source—accumulators—(Fig. 4); (6) motors with Sprague connections for two-motor cars (Fig. 5); (7) motors with compensating windings between armature and exciting coils for cars equipped with two or more motors (Fig. 6); (8) motors with a variable shunt to the exciting coils (Fig. 7).

With the exception of (8) the motors belonging to the second class have the following common disadvantage: Should the speed or field of one motor of a two-motor car vary ever so slightly relative to the second motor, the

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loads on the respective armatures will be put considerably out of balance thereby.

This is a very important point, and may be illustrated by an example. Let the field of one motor through some cause or other be weakened 2 per cent. relatively to that of the second motor. Further, let the difference of potential measured between the terminals of the motors be 500 volts, the armature resistance ½ ohm, and the load on the one motor 30 amperes. The counter E.M.F. acting in this armature is therefore

$$500 - \frac{30}{2} = 485 \text{ volts.}$$

The second motor is forced to run at the same speed as the first by virtue of the contact of the wheels with the

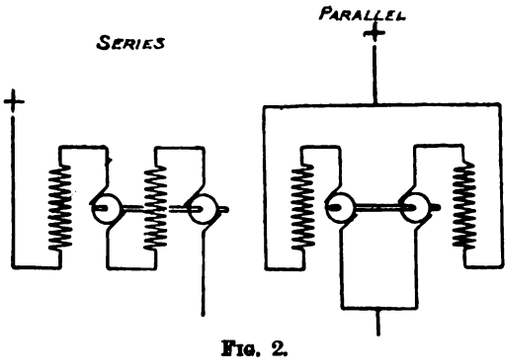

FIG. 2.

rails, but since its field is 2 per cent. weaker, the counter E.M.F. will be correspondingly 2 per cent. less—that is to say, it will be

$$0{\cdot}98 \times 485 = 475{\cdot}3 \text{ volts,}$$

which gives us an armature load of

$$\frac{500 - 475{\cdot}3}{0{\cdot}5} = 49{\cdot}4 \text{ amperes.}$$

Hence the insignificant 2 per cent. weakening of the field entails an increase of 65 per cent. in the load on the second armature. This characteristic is even more marked for light loads. Supposing, for instance, the first motor in the same car has a load of 20 amperes, the other motor whose field is 2 per cent. stronger will have a load of

$$\frac{500 - 499{\cdot}8}{0{\cdot}5} \backsim 0 \text{ amperes.}$$

Indeed, it is possible that one motor may run with a back E.M.F. and so lead to the destruction of the other. Such slight differences in the magnetic field, if not extant from the first, may develop later on. Of the numerous causes the following may be instanced:

1. Motors with field regulation must, in order to obtain the necessary tractive force, have strong excitation. As a consequence of this, the coils are often overloaded because

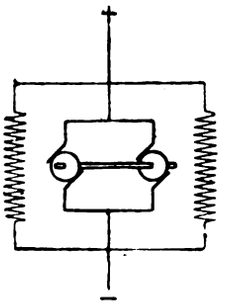

FIG. 3.

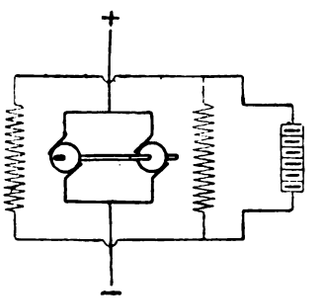

FIG. 4

of the limited winding room at disposal. A gradual charring of the insulation results, with consequent short-circuiting between adjacent turns.

2. The controller serving to regulate the motor and its magnetic field is switched in and out about 1,000 times a day without being examined. Should a contact through which the exciting current is conveyed become defective, a motor may receive damage before the fault is discovered.

3. A small change in the position of the brushes causes a variation in the magnetic field for forward and reverse running. When running in the one direction the two armatures may harmonise perfectly, while in the other direction the case may be different. Special provision must be made, therefore, for adjusting the brushes of each pair of armatures.

4. The exigencies of the work necessitate the interchangeability of the armatures. But these are never sufficiently alike as to possess absolutely equal speeds.

5. In consequence of the overloading of one motor, or the heating of a bearing, etc., it may happen that one of the motors becomes warmer than the other. For a difference

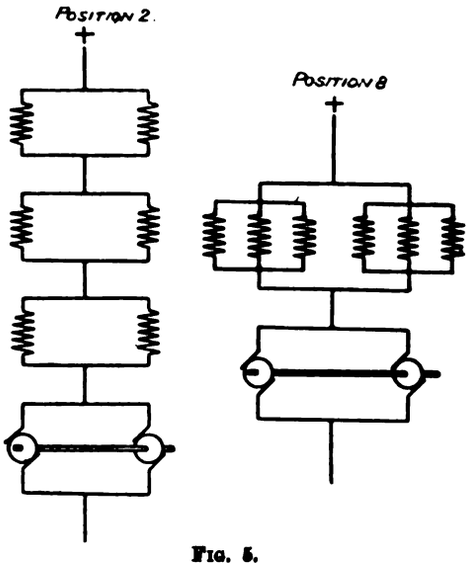

FIG. 5.

of temperature of 2½ per cent. the resistance of the copper is increased by 1 per cent. It is due to this fact that many motors observed to run in harmony, when in a cold condition on their trials, no longer maintain this harmony in service. If the field of one motor once becomes warmer than that of the other, the heating generally continues to increase of itself. The field becomes weaker, and the armature consequently more loaded, and in its turn hotter, thereby again increasing the internal temperature of the machine. Meanwhile, the reverse action is going on in the other motor.

6. Lastly, should the tyres of the wheels driven by one of the driving axles wear more than those driven by the other in consequence of softer material, a variation of the counter E.M.F. will result, which may become dangerous to the motor, or, at any rate, aggravate previous faults.

These numerous possibilities entail the necessity for constant and careful supervision. The initial reconstruc-

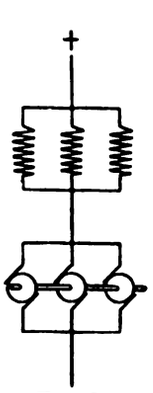

FIG. 6.

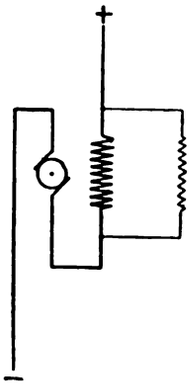

FIG. 7.

tion after repairs have been undertaken offers exceptional difficulties. With shunt-wound motors, and motors provided with compensating windings between the armature and field, the regulation may be effected by the insertion of resistances before the coils; but in the case of the Sprague arrangement this frequently does not effect the desired end, and would, moreover, complicate the apparatus. It is easier to decrease the air-gap by inserting iron sheets between the pole-shoes and magnet frame, which, however, necessitates taking the motor to pieces.

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In addition to the above enumerated defects, shunt-wound motors possess the following serious disadvantages. Should a short-circuit occur on the line, all the motors of the cars which happen to be in motion at the time will work as generators on the same. Besides the automatic cut-out in the generating station, all the car cut-outs must, therefore, be released, whereby the violence of the short-circuit is considerably increased. Apart from this consideration, each of the armatures is itself in danger of being burnt out if the short-circuit is violent enough to cause the brushes to flash over. The same remarks hold for motors provided with compensating windings connected on the Sprague system. Should one armature become short-circuited through

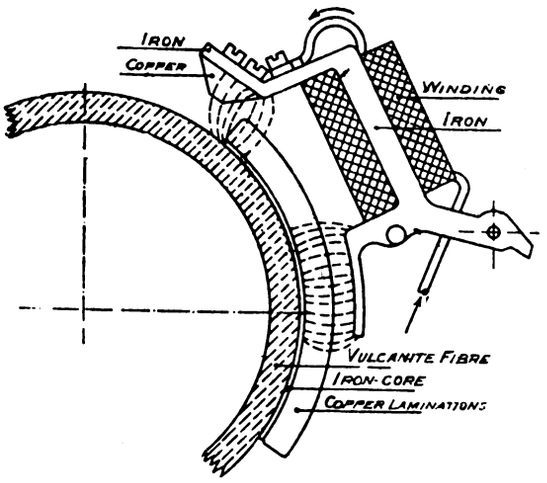

FIG. 8.

any cause, the other will work as a generator and drive it as a motor in consequence of the residual magnetism, an eventuality which frequently results in the destruction of both armatures. Motors excited from an external source certainly possess good tractive force, but for the rest have, in common with the shunt-wound type, the above enumerated faults. Moreover, the potential of the accumulators falls gradually during the running of the cars, while the resistance of the exciting coils simultaneously increases, owing to the heating of the same, so that the motor will develop 30 to 40 per cent. greater speed in the morning than in the evening over the same track. The above-mentioned defects are absent in motors excited by the full armature current.

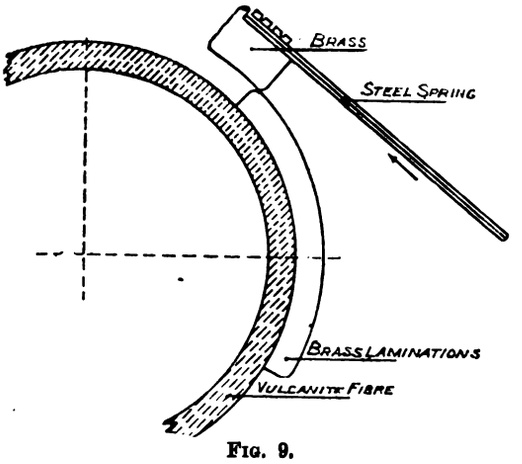

FIG. 9.

In regulating by means of shunts (Fig. 7) an uneven load on the contrary may easily occur, though this certainly cannot be negatived on either of the motors. Should, for instance, one shunt circuit become warmer than the other or a contact arm of the controller make bad contact, considerable differences in the balance of the armature loads may occur. If the field coil contact segment of the controller has become so hardened as to cause contact resistance between the arm and corresponding contact segment, then a somewhat greater volume of current will be diverted through the shunt. Thereby the load on the armature is, however, considerably modified. The slight difference of potential at the point of contact does not suffice to generate enough heat to warn the driver. If the contact arm fails altogether to make contact, then the armature receives the full short-circuit current without its field being excited. The principal reason, however, why this method of connection has been generally discarded must be attributed to the prevailing endeavour to reduce the internal resistance of the motor to a minimum. The number of field coils is kept as low as possible. Such motors would naturally be unable to stand further weakening of the excitation by shunts without sparking. Here may be added in brief the results obtained by the Nürnberg-Fürther Strassenbahngesellschaft in converting the Sprague into the series-parallel system. Sprague controllers, constructed by the Allgemeine Elektricitäts-Gesellschaft in 1896, were used for the conversion. A magnetic spark extinguisher, designed by the author, was attached as shown in Fig. 8. The contact arm, which was originally constructed as shown in Fig. 9, was replaced by a magnet, through the windings of which the current conveyed to the laminations must first pass. In order to close the magnetic circuit, iron plates were placed under the laminations. Since the lines of force are concentrated

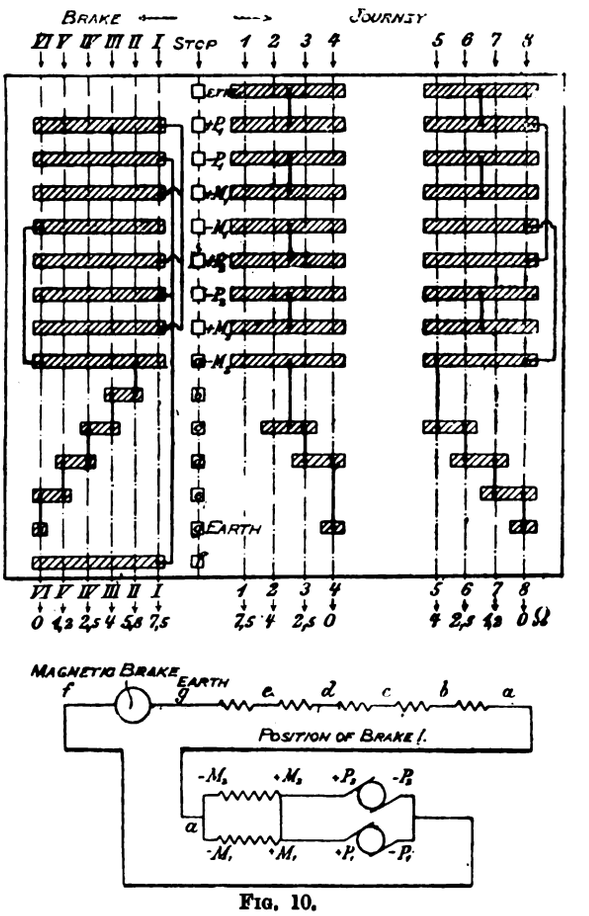
BRAKE
JOURNEY
VI V IV III II I STOP 1 2 3 4 5 6 7 8
EARTH
VI V IV III II I 1 2 3 4 5 6 7 8
0 4,2 2,5 4 5,8 7,5 7,5 4 2,5 0 4 2,5 4,2 0 Ω
MAGNETIC BRAKE
EARTH
f g e d c b a
POSITION OF BRAKE I.
-M₂ +M₂ +P₂ -P₂
a
-M₁ +M₁ +P₁ -P₁

FIG. 10.

at the points where they emerge and are wanted, a few turns only are consequently needed in order to ensure a powerful action. Part only of the contact arm was arranged for spark extinguishing. Fig. 10 shows in diagram form the connections of a lengthened controller arranged for an electrical brake. Before being employed for actual service, this controller will be tested by changing over a few times rapidly from position 6 of the brake to full speed and then back again, both with the car in motion and stationary. Subsequent examination must disclose no marks of burning.

The number of burnt armatures from Feb. 1, 1898, to Feb. 1, 1899, amounted to 42 per cent. per month of the total armatures installed with Sprague connections in the existing cars. In the years 1899 and 1900 this figure was reduced to 21 per cent. by adjusting the air-gaps and then balancing the motors in the manner above described, and by more careful supervision of the gradually decreasing resistance of the coils. Subsequent to the introduction of these measures the transition to a better state of things was so rapid that the 80 per cent. of armature defects

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registered for the month of January, 1899, sunk to 30 per cent. for February of the same year. In as marked a manner the armature defects sunk to a monthly average of 5 per cent. after the introduction of the series-parallel system of control. The period over which observations have been made relative to the latter system extends from March, 1899, to September, 1900. At the same time, the internal temperature of the motors was reduced in some cases 40deg. For newly-wound armatures the monthly average of defects sunk even as low as ½ per cent., and in their case the defects invariably occurred immediately after mounting, being attributable to faulty workmanship Simultaneously with the introduction of the series-parallel system of control, a mean economy of 12 per cent. in the current consumed was obtained.

In conclusion, the advantages and disadvantages of the several systems of connection in vogue may be briefly recapitulated:

1. *Series-Wound Motors with Simple Auxiliary Resistance* (Fig. 1).

Advantages: low internal resistance; low initial cost; small dimensions; low percentage of fault when correctly proportioned for work; small consumption of current for long runs without stop (single motorcars).

Disadvantages: suitability only for single-motor cars and for runs without stops; large starting current.

2. *Series-Wound Motors for Series-Parallel Running* (Fig. 2).

Advantages: low internal resistance; low initial cost; small dimensions; low percentage of faults when correctly proportioned for work; small consumption of current for runs with frequent stops and curves.

Disadvantages: none.

3. *Sprague Connections for Single-Motor Cars.*

Advantages: small consumption of current for runs without stop; moderate starting current.

Disadvantages: high internal resistance of motor for low speeds; increased initial cost; large dimensions; difficulty of giving the motors adequate proportions for all demands owing to limited space; great heating of the motors consequent upon careless manipulation of controller; frequent possibilities of defect despite ample proportions.

4. *Shunt-Wound Motors.*

Advantages: economy due to generating action of motors down hill.

Disadvantages: high initial cost; large dimensions; difficulty of giving the motors adequate proportions for all demands owing to limited space; frequent possibilities of defects despite ample proportions; low starting torque; large starting current; aggravation of danger entailed by short-circuits.

5. *Motors Excited from an External Source* (Fig. 4).

Advantages: small consumption of current in all cases; economy due to generating action of motors down hill.

Disadvantages: high initial cost; large dimensions; difficulty of giving the motors adequate proportions for all demands owing to limited space; frequent possibilities of defects despite ample proportion; high maintenance cost of battery; aggravation of danger entailed by short-circuits; loss of speed due to decreased potential of accumulators and increased resistance of coils.

6. *Motors with Sprague Connections for Two-Motor Cars* (Fig. 5).

Advantages: none.

Disadvantages: high internal resistance of motors for low speeds; increased initial cost; large dimensions; adequate proportions difficult to provide owing to limited space; great heating of the motors consequent upon careless manipulation of controller; frequent possibilities of defect despite ample proportions; large starting current.

7. *Motors with Compensating Windings between the Armature and Exciting Coils for Car Equipped with Two or More Motors* (Fig. 6).

Advantages: simplicity of the connections for multi-motor cars; low internal resistance; low initial cost; small dimensions; moderate consumption of current when grouped in series-parallel.

Disadvantages: frequent possibilities of defect even when adequately proportioned.

8. *Motors with Variable Shunts to the Exciting Winding* (Fig. 7).

Advantages: moderate dimensions; moderate initial cost; smallest starting current.

Disadvantages: defects possible despite adequate proportions.

From the above, it follows that for electric tramways the undermentioned systems only can come into consideration: (1) series-wound motors with variable shunts in the exciting coils for single-motor cars; (2) series-wound motors in series-parallel connection for two-motor cars; (3) series-wound motors with compensating windings for multi-motor cars or trains.

Motors which act as generators down hill come into consideration only for lines with very heavy gradients, more particularly mountain railways. On comparatively level tracks, with numerous stopping stages, the large starting current required more than balances any saving effected through this generating action. Moreover, a portion of the natural momentum acquired by the car on down grades may also be utilised with the series-parallel arrangement, but without the necessity of converting it into current.

INSTITUTION OF ELECTRICAL ENGINEERS.

Capacity in Alternate-Current Working.

BY W. M. MORDEY.

(*Concluded from page 94.*)

In explaining how the wattless current may be reduced and the power factor raised to unity or nearly so, I hope those who prefer the mathematical treatment of such questions will not be impatient at my attempts to express my meaning in the vulgar tongue. In a conductor or circuit having capacity the charging current has a positive phase displacement of 90deg. from the E.M.F., while the current in an inductive circuit has a negative phase displacement of 90deg. from the E.M.F. Thus there is a difference of phase of 180deg between these two currents. This is well known. Its systematic application affords a solution of the problem we are now considering. Imagine an alternator supplying a circuit having capacity. Then if an inductance or choking coil is put in parallel with the capacity, and if it is so designed and adjusted

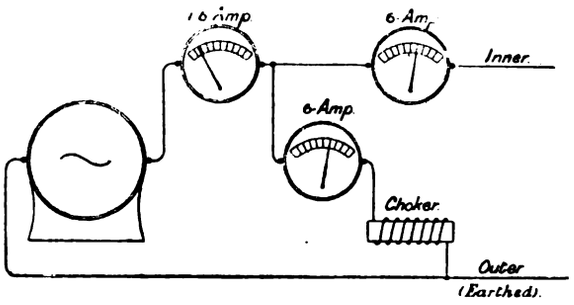

FIG. 4.

that it takes a wattless self-induction current equal in amount to the wattless capacity current of the mains, the two will balance one another, and the generator will not have to produce any wattless current for either the capacity or the self-induction. Each will take its full current, which will pass to and fro between the capacity and the choking coil, being alternately a capacity or charging current with a positive phase displacement and a self-induction current with a negative phase displacement. The generator will only have to keep up the E.M.F. and to produce the energy component of the current for the cable and the energy component of the current for magnetising the choking coil, and for leakage and resistance losses. As these energy currents are in phase with the E.M.F., the alternator will act as if working on a circuit having neither capacity nor self-induction—that is, a circuit having a power factor of unity. This will at least be the case if the balance is perfect. By the kindness of Mr. Sparks and the County Company, I have been able to try some experiments on the 5½ miles of mains already alluded to. The arrangement is shown in Fig. 4. I made a choking coil to take six amperes at 2,000 volts 100 ~. Particulars of this coil are given later on. When working at 2,000 volts 100 ~, the alternator gave six amperes when connected to the cable alone. The current was also six amperes when the alternator was working on the inductance coil alone. When the cable and the

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coil were put in parallel, with ammeters in circuit as shown, the alternator produced 1·625 amperes only, although there was still a current of six amperes in the cable and six amperes in the choking coil. There was not a perfect balance. The true watts taken by the cable and the choker were about 2,000, therefore the alternator current should have been only about one ampere, but I was not able to get a closer adjustment. I must have had very nearly the best balance obtainable, as any adjustment of the choking coil, either in the direction of increasing or of decreasing its current, caused an increase in the alternator current. Possibly the slightly imperfect balance was due to a difference of effect of a sine curve alternator on the choker and on the capacity.* The actual practical result, however, was quite satisfactory, as the choking coil effected a saving on the system of about 9,000 apparent watts, the energy absorbed by it being about 500 true watts. I need not say that the saving under these circumstances is not only "apparent." It is not easy to say what would be a fair estimate of the cost of producing "wattless energy." I venture to think it is not much less than one-fourth of the cost of true energy. Whatever figure is taken, the desirability of economising in such matters will be realised when I point out that at 1d. per electrical horse-power hour one watt for one year costs 1s.,† or, say, £1 capital.

Description of Choking Coil.—This description is not given as that of a very satisfactory example of design, but to show the coil used, and in the hope that it may be of some interest to designers of such apparatus. The main dimensions of the coil used in these tests are given in Fig. 5. It consists of a set of

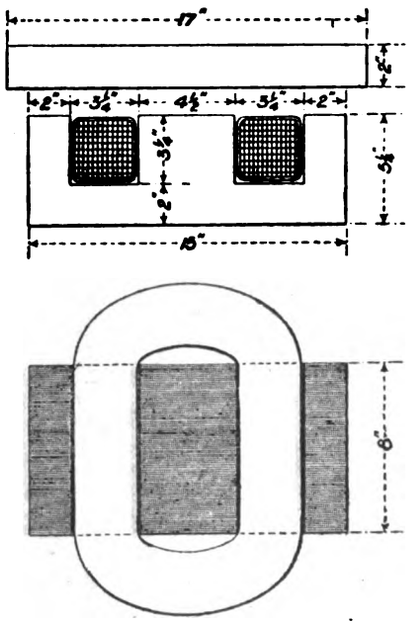
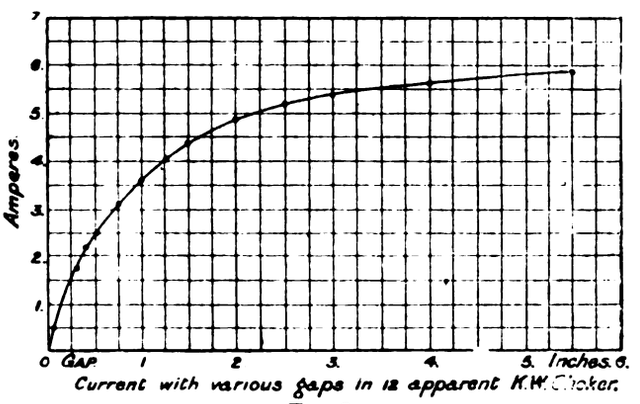


FIG. 5.—Choker for 12 Apparent KW.

E stampings, with a coil wound about the middle projection. The "yoke" is straight and is carried on supports, allowing of adjustment of the gap. Fig. 6 gives the currents with various air-gaps. The current taken by the coil at 2,000 volts 100 ~ with various air-gaps is given by Fig. 3. The form was chosen in preference to the simple straight coil form, as a convenient one for adjustment, and because it gives an external field more suitable for enclosing in an iron core. The cross-section of the core is about 29·76 square inches, or 192cm. of actual iron—weight about 190lb. The winding consists of 756 turns of 0·08in. wire, having a total length of about 2,600ft. and a resistance of about 4·1 ohms. At 2,050 volts 100 ~, N = 6,081,000, B = 3,170. The iron is 0·014in. thick of a quality which would have a loss in a closed-circuit transformer of about 0·55 watt per pound. The iron loss should, therefore, be about 190 × 0·55 = 104·5 watts, with the yoke closed down. With the yoke removed (as used) it should have a loss of about 68 watts if the circuit completed itself through the air. The copper loss with six amperes = $6^2 \times 4{\cdot}1 = 148$ watts. Total, 216 watts. The tests, however, show a loss of about 500 watts. The difference must be due to eddies caused by magnetic leakage. The stray power is higher than would be expected, but it answers its purpose very well. Its power factor is $\frac{500}{12{,}500} = 0{\cdot}041$.

I know of no published information on the losses in choking coils, and suggest it as a useful subject for study. The principal difficulty is in testing apparatus having such low power factors. The weight is about 22lb. per apparent kilowatt.

I have said that in reducing the capacity current required to be produced by the generator, something was effected in ordinary practice, but accidentally, or at least not systematically, by the action of all self-induction in the system—for example, that of transformers or motors. In transformers the effective self-induction is very small. The no-load current is small in good closed-circuit transformers, and the power factor is high—usually from about 0·7 to about 0·85. The wattless component available is therefore very small—at least in modern systems having large and efficient transformers. No doubt if the conditions of a circuit are known from the first, the transformers may be so designed as to provide the capacity current, at least at light load; but it would be difficult to do this systematically, as the conditions in practice are so variable. With a large number of small transformers it may be that the wattless capacity current may be compensated, or more than compensated. I do not think transformers of low power factor should be used. I believe the better plan will be to continue to make transformers with small no-load current and high power factor, and provide separately for any compensation that may be necessary. When motors are used, their large, idle, lagging current is available to compensate the capacity. Where there is a large motor load the idle current will usually be a lagging rather than a leading current, even on mains of considerable capacity. A synchronous motor, as is well known, acts either as a capacity or a self-induction, according to the excitation. When over-excited it acts as a capacity and takes a leading current from the mains; when under-excited it acts as a self-induction, taking a lagging current; when excited to take a minimum current it has no idle component—that is to say, its power factor is unity. Such motors running light are now often used for balancing self-induction, but I have never seen them used for balancing



Current with various gaps in 12 apparent K.W. Choker.

FIG. 6.

capacity. In any case they are a rather expensive remedy, as they have to be practically as large as if they were to do real instead of only apparent work. Their first cost, their working costs, and losses are therefore high. For balancing self-induction they may be necessary. I hope, however, that for this purpose condensers will again be taken up by Mr. Swinburne, or somebody else. Probably their hysteresis loss will not be as great as the losses in motor compensators nor their working cost or first cost as high. But in any case, the running of under-excited synchronous motors is an expensive and clumsy way of compensating capacity, compared with simple choking coils, such as I suggest. Such coils, used with a phase-indicator, should be useful in all systems where the capacity current is large enough to deserve attention.*

There is something very disproportionate and anomalous about the two classes of loss in the dielectric—the insignificant losses due to leakage, and the large apparent and actual losses due to capacity and hysteresis. Let me take for illustration a 10,000-volt cable having one-third microfarad capacity per mile, and working at 50 ~. Its insulation is, say, 2,500 megohms (it may be only a few megohms without affecting the argument). The dielectric has several functions. It acts as a nearly perfect non-conductor. But it does conduct a little; it allows 1/250,000 ampere to pass through it = 0·04 watt per mile. Then there is the electrostatic action. From Table I. we see

* See paper in *Journal XXIX.* p 154, January, 1900, by Alexander Russell, according to whom a sine curve wave gives a smaller condenser current and a larger magnetising current than any of the other wave shapes considered in his paper.

† Or, more precisely, 11·74d.

* I may mention that when I applied for a patent for this method my attention was drawn by that useful institution, the German Patent Office, to the fact that, so far as concerned the treatment of a long transmission line by choking coils placed at intervals, I was anticipated by Charles Schenck Bradley the well-known American electrical engineer (British Patent 20,493 of 1897). Reference should also be made to the proposals of our president of last year, Prof. S. P. Thompson, to compensate the capacity of submarine and other cables to facilitate signalling by placing high-resistance choking coils at frequent intervals along their length. See his British Patents 22,304 of 1891, 13,064 and 15,217 of 1893, and 13,581 of 1894.

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the capacity current is 1·05 ampere, the apparent watts 10,500, and the real watts 1,296, or 32,400 times the watts lost by conduction. This is an interesting state of things. Both dielectric conduction and dielectric hysteresis waste energy in the same way—by heating the dielectric. We use an insulator which reduces the leakage energy loss to ·04 watt per mile, but allows another energy loss 32,400 times as great.

So far as loss of energy is concerned, we should be just as well off, or as badly, with an insulation resistance of $\frac{10,000}{1·05}$ = 9,524 ohms, instead of 2,500,000,000. The energy spent on our dielectric would be just the same, and I suppose we should have no wattless current at all! I point this out to illustrate an anomaly, not to make a practical suggestion. It may be that no low-resistance insulator can be found capable of resisting breakdown under such conditions. I have spoken of the energy component of the capacity current spent on heating as if it were in some way different from the leakage current. It only differs from it in amount. It is not recovered like the true charging current. It does not surge to and fro in the cable. In all practical essentials it is a leakage current. It goes right through the dielectric, and heats it in its passage exactly like the leakage current. The effect of capacity in

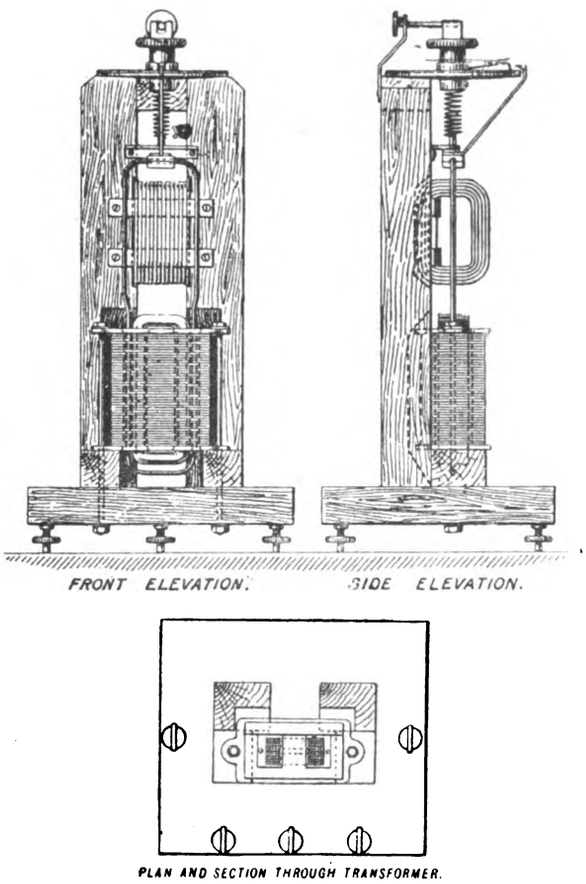

FIG. 7.

allowing the passage of this current is precisely as if it reduced the insulation resistance in the proportion I have suggested—viz., from 2,500 megohms to 9,524 ohms. At least, this is how it appears to me. With aerial lines capacity effects are comparatively unimportant. For example, with wires of $\frac{1}{3}$in. diameter, hung 2ft. apart, the capacity per mile is only 0·018 microfarad. Not only is the wattless current therefore small, but there is no "wattful" current.

An Alternate-Current Wattmeter.—In concluding this paper, I wish to describe an alternate-current wattmeter especially suitable for measurements such as are required in connection with the subjects treated in this paper. In devising this instrument my aim was to get a simple, strong, reliable wattmeter—one that needed no resistance added in its E.M.F. circuit, and that would absorb very little energy in that circuit even for large E.M.F.'s. In such an instrument the E.M.F. coil should have a large force, and at the same time be practically without self-induction, and should be correct with all power factors met with in practice. If possible, it should be correct through a considerable range of periodicity. Long and satisfactory experience of the Siemens dynamometer under workshop conditions made me turn to it as the most suitable type of instrument, and to try to devise means by which it should have the qualities just enumerated. Fig. 7 shows the instrument in elevation and plan. Fig. 8 is from a photograph of an actual instrument. The Siemens dynamometer form is closely followed. The series or current coil is placed in the ordinary position. Under this coil is a small transformer, the primary winding of which is wound for any required E.M.F. Next to this primary winding a space is left at each side—the space usually occupied in a transformer by the secondary winding. In this space a closed coil of one turn of wire is suspended freely—the wire is platinoid, manganin, or some other conductor having a negligible temperature coefficient. This conductor is suspended and controlled exactly like the suspended coil of a Siemens dynamometer. It acts as the secondary of the transformer. As it is closed on itself no mercury-cups are needed. Its circuit external to the transformer consists simply of a loop passing up the front and down the back of the fixed or current coil. The action will now be understood. A comparatively large current of very low pressure is generated in the secondary coil. This current is in opposite phase to the E.M.F. It passes through the field of the fixed or current coil. The suspended conductor is acted on and deflected by the current in that coil, and is brought back to zero by the tension of the spring, as in an ordinary dynamometer. It will be seen that so long as the iron of the transformer is not forced to too high a density by using too great an E.M.F. or too low a periodicity, the secondary current will be proportional to the E.M.F. and independent of the periodicity. The magnetising component of the

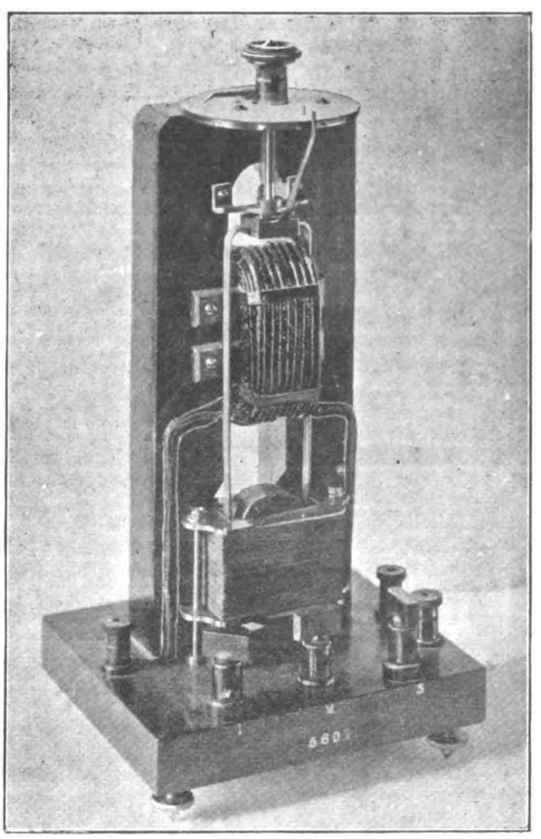

FIG. 8.

primary current and the energy spent in the iron will vary with the E.M.F. and periodicity, but if the self-induction of the secondary coil is sufficiently low, this will not affect the proportionality of the secondary current to the primary E.M.F. The instrument shown on the table is the first I have had made. It has been kindly constructed to my drawings by Messrs. Siemens. By tests made at the Board of Trade electrical laboratory (in connection with which I have to thank Mr. Trotter and Mr. Rennie), I find my anticipations have been verified—the instrument has the same constant with power factors of 1 and of 0·1, and it is proportional all round the scale. This kind of instrument may easily be made for a large range both of E.M.F. and current, as the primary of the transformer as well as the current coils may be variously wound or connected—the suspended secondary conductor being always the same. In the instrument exhibited the current coils are three in number, of varying section—the transformer primary being suitable for any E.M.F. up to 500 volts at 100 ⁓. The range is as follows:

Fine coil, for maximum of about	2·5	amp., constant	1·25	watts per division
Medium	,,	,,	15	,,	,,	6·8	,,	,,
Thick	,,	,,	90	,,	,,	37	,,	,,

This is at 83 ⁓. There are 400 divisions in the circle. I have not succeeded, in this first attempt, in making the instrument independent of periodicity. The variation is about 10 per

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cent. between 30 ⁓ and 90 ⁓. In using the instrument it is therefore necessary to know the periodicity. I hope to greatly reduce this variation, or perhaps get rid of it altogether through a sufficient range for practical purposes. Even as it is, it will perhaps not be considered a very serious objection. The principle of this instrument may be readily applied to other forms, but it would be premature to describe them here.*

In this paper I have not attempted to treat of several aspects of "Capacity in Alternate-Current Working"—matters perhaps as important as those I have tried to make clear. I have avoided comparisons between different kinds of cables. I have considered single-phase only, not two or three-phase. I have said nothing of effects of capacity on regulation, on distribution of potential along lines, on liability to rupture of insulation due to capacity, or on means for reducing such liability. In keeping to one aspect of the subject I have hoped to be of most use to my fellow electrical engineers.

I have to express my thanks, for information or facilities afforded me, to Mr. Gray and the Silvertown Company, to Mr. Edmunds and Mr. Howard (of Messrs. Glover and Co.), to Mr. Nisbett and the British Insulated Wire Company, and to Mr. Gavey (chief engineer of the Post Office); also to Mr. Dallas and Mr. Grafton, respectively of the Silvertown and the County Companies, for assistance in experiments. I have already mentioned my indebtedness to Mr. Sparks and the County of London and Brush Provincial Company.

Discussion.

Prof. W. E. Ayrton said the author had told them that the first part of his paper had been given in order to impress upon central-station engineers that they had in their possession very easy means of measuring the capacities of their cables. By that, he assumed the author meant to imply that up to the present they did not use those means—viz., knowing the E.M.F. and the periodicity, it was only necessary to take the current. If that were the case, then, who was to blame for their not using this method? Was it because they had neglected it? This manner of measuring the capacity of real cables was brought to his (the professor's) notice a good many years ago at the very beginning of the working of the Deptford generating station, when power was transmitted from the Deptford station to the Grosvenor Gallery over six miles of underground cable. Mr. Ferranti once asked him this question. He said: "I find that during the daytime, when practically there is no load on in the Grosvenor Gallery, the ammeter reads high, about 30 amperes; and in the evening, when the full load is on the ammeter doesn't go up for a long time. Why is this?" He (Prof. Ayrton) explained that the reason for this was that the capacity of the cable was being measured with the current obtained during the day. This was the method advocated by Mr. Mordey in the first part of his paper, and the formula given by Mr. Mordey was exactly applicable to Mr. Ferranti's case—viz, the capacity $= \frac{\text{volts} \times \frown\!\!\smile \times 2\pi}{\text{amperes}} =$ farads. Some years ago he had gone into the question in detail together with Dr. Sumpner, and together they measured a considerable number of capacities in the manner described. Their work resulted in a paper which was read before the Physical Society. They did not deal with small capacities such as Mr. Mordey had taken; they were dealing at the time with hundreds of miles of cables so far as capacity was concerned. The paper to the Physical Society was followed by a paper by Major Cardew read before the Institution of Electrical Engineers, showing how to measure capacity in this way and comparing it with the ballistic method.

Mr. Mordey here said he did not pretend to have invented this method of measuring capacity. He had simply pointed out that in Prof. Ayrton's book this easy practical means was not given. It was an engineering method which would probably not occur to people writing books of that class.

Prof. Ayrton thought the interruption absolutely irrelevant. Volume I. of his book did not say one word about alternate currents. Only direct currents were dealt with. The paper read before the Physical Society in 1891, to which he had already referred, was on "Interference with Alternate Currents," and the reason why it had that name was because it dealt not only with the question they were now discussing, but also with the combination of self-induction with a capacity. Mr. Mordey in the second part of his paper had considered this matter. If he took Mr. Mordey's own experiments and the actual values given in his paper, he (the professor) could enormously improve his results. Instead of the current being 1·6, it would be very much less. The reason for this was that Mr. Mordey had used the wrong choker. The choker he should have used was a coil with no iron at all and with less wire. It would then have less resistance and take far less energy, and in consequence the current in the main would be reduced considerably. No doubt Mr. Mordey would ask: "But how is it possible with any coil to reduce the current when you have this dielectric hysteresis loss?" That brought him to the most serious part of the paper—viz, that dealing with the loss in the cable The author had taken the dielectric power factor at 0·124, and he should like to ask him whether he had sufficiently tested either the cable or the Thomson recording wattmeter to feel at all sure that this was correct. He felt sure that either the wattmeter, for reasons set out in a valuable paper published in the *Electrical Engineer* in March, 1893, gave an answer higher than the truth, or else the cable was bad. The question was one of great importance. They had to consider what was the true loss in a cable due to this so-called dielectric hysteresis. The reason why he was inclined to think it was far less than Mr. Mordey had fixed it at, was that in all the cases in which he had measured capacity there had been measurements of power wasted, and in all these instances the power factor had been far smaller than that stated by the author. If the cable that Mr. Mordey tested had really the power factor of 0·124, then the cable was certainly bad. With a proper cable you ought to get the power factor much smaller, and therefore the loss should be much less. The question was of vital importance in connection with power transmission, and it should be rightly decided.

The President said Prof. Ayrton must communicate any further remarks he had to make on the paper for publication in the *Journal*, as the time was getting on. He thought, however, that Mr. Mordey should have an opportunity of replying that night to what Prof. Ayrton had said.

Mr. Mordey had every reason to believe that the power factor he had just put forward was properly determined. He must say, however, that he was astonished at the result himself. The figures that came out from his experiments were very important, and if he had not felt he was confirmed in them, generally and indirectly, he should not have said anything about the power factor.

The discussion was then adjourned.

* I should mention that some years ago Mr. Swinburne proposed or made an instrument in which he pivoted a closed-circuit conductor. This had a current induced in it, and was deflected by the flux in an air-gap in it.

LEICESTER TRAMWAYS REPORT.

Like a good many other towns, Leicester has considered the question of its tramways. A special committee, consisting of Messrs. S. Flint (chairman), T. Smith (vice-chairman), G. Banton, H. B. Bruce, S. Faire, J. H. Marshall, J. T. Walters, and G. E. Mawbey (borough engineer and surveyor), was appointed to report. The result is a most elaborate and painstaking descriptive account of various systems visited and examined, with the conclusions of the committee upon the whole matter. We have long known Mr. Mawbey to be thorough in what he undertakes, but we venture to think this report surpasses all his previous records. The committee visited Prescot, Liverpool, Blackburn, Blackpool, and Bolton in January, 1900; Sheffield, Leeds, Edinburgh in March; and Brussels, Hamburg, Berlin, Vienna, Budapest and Paris in May so as to see trolley, conduit, accumulator, and surface-contact systems in operation and judge of the suitability of each under the particular circumstances governing the district in which it was used. Descriptions of the works thus visited are given, with a number of illustrations. The most important matter for our readers is found in the postcript of the report, which is as follows, and gives the committee's

General Observations and Conclusions.

Overhead Trolley System.—The overhead trolley is a well-tried system most extensively adopted in many countries, and its success has been proved beyond all doubt. It is at once the most efficient, reliable, quick, and economical system extant. The service, compared with the conduit system, is better, quicker, and more elastic. For traffic facilities and minimum failure stoppages it is altogether superior to any other system. We found, as set out in this report, that in the Continental cities we visited, where all the different methods of traction have been well tried, the overhead system was considered by the electrical engineers, and those who had to work it, to be the best in every way, and that the municipal authorities are now agreeing to its construction in many of the most beautiful of their thoroughfares. As was stated in Paris, the objection to it was solely on æsthetic grounds, but familiarity with its appearance, and its successful working, soon conquered the prejudice, and at Liverpool (as an instance in this country), as before stated, the objections are already entirely worn off. It is of all systems the least costly in capital outlay, maintenance, and working expenses, and has the greatest earning capacity. It causes much less interference with the surface of the streets, and with the under-works of the gas, electric lighting, and water departments than either the conduit or the surface contact; and, further, the current consumed in units per car mile

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is substantially less than with either of the other systems, consequently minimising the cost of the power required. Owing necessarily to the great variation in the conditions of different towns, it is difficult to give close statistical information as to the difference in cost between the overhead and the conduit, although from the figures we have obtained from the various towns there is no doubt of the immense saving, both in initial outlay and maintenance, effected by the overhead system; and it may be taken, roughly speaking, that the conduit usually costs from twice to three times as much as the overhead, and often much more than this. On the other hand, there appear to be exceptional circumstances where the difference is not so great. We have been unable to obtain reliable estimates of the cost of the Diatto surface-contact system, but it is believed that it would be substantially greater than the overhead. The overhead system is the one chosen by every provincial town in the United Kingdom which has up to the present time adopted electric traction; and even Birmingham, which, although previously so much in favour of the underground conduit system, has sanctioned the construction by one of the present tramway companies of an overhead line running through Birmingham right into the very heart of the city. They have, however, taken great care not to commit themselves permanently to the principle. They have agreed to buy the rolling stock at a valuation at the end of the lease, but unless they determine to continue the system the poles and overhead wiring are to be cleared away by the company. We have also heard that an application has been made by another of the companies who have running powers in the city for the construction of an overhead line, running from the opposite direction also into the heart of the city, which will probably be sanctioned. This refers to a route which the company works in the city on a lease which has something like seven years yet to run. There is no tramway company whose representatives we have interviewed abroad which would not, if allowed, have adopted the overhead system throughout in preference to any other. In some of the thickly populated and busy suburban thoroughfares of Greater London, the overhead system has been extensively adopted, including, amongst other places, West Ham, East Ham, North Woolwich, Wanstead, and Canning Town, and on the western side in Hammersmith, Chiswick, and out to Hounslow, Twickenham, and Hampton, and also through Acton, Ealing, and out to Uxbridge on the north. From the success which has followed its adoption in such busy cities as Liverpool, Leeds, and Glasgow, and in the busiest thoroughfares of the greatest cities on the Continent, there need be no hesitation in adopting it in Leicester. Given a properly-designed, well carried out scheme, the "overhead" offers, with good management, the greatest certainty of financial success.

Conduit System.—Some of the drawbacks of the conduit system which existed several years ago have been remedied in the later types, and it can now be fairly said to be a success from an engineering point of view. The width of the slot has been somewhat reduced. The working expenses and maintenance, owing to improvements, although still more than the overhead trolley, are not quite so great as in the past. From an æsthetic point of view, it may be said to be preferable to the overhead. In such cities as New York and London, owing to the magnitude of the traffic, and the consequent vast income derivable from the great number of passengers to be carried, they can afford to adopt this more expensive system of electric traction, and, further, with such densely crowded thoroughfares, and owing to the difficulties in the way of overhead construction, it may be quite advisable for them to adopt the conduit system. Nevertheless, it has its disadvantages, some of which are referred to in the sections relating to the respective Continental cities we visited where it is in use. The principal of these disadvantages are the excessive cost of construction, the great disturbance of the streets, and the length of time it takes to carry out the heavy amount of street work, involving much inconvenience to trade. Notwithstanding that the depth of the construction has been reduced to a minimum, still, in many streets, there would be considerable interference with and alteration of underground works of other departments, which both on the Continent and in America have been found to be extremely costly. We were informed that stoppages, owing to accidents to the ploughs, underground conductors, and other causes, were more frequent than with the overhead system, and that sometimes, owing to the plough becoming jammed in the conduit and preventing the car from being moved out of the way, stoppages of the traffic were long and serious, whilst with the overhead such difficulties did not arise. Difficulties were often experienced at the switchings and crossings. The slot at these places has to be a wide one, and would be a great danger to cyclists, and this would be accentuated by our somewhat narrow thoroughfares, as compared with the wide boulevards abroad. Considerable labour and expense is involved in keeping the conduit free from deposit, silt, etc. The conduit is more or less an open surface-water drain, into which a portion of the first washings of the streets is carried by the rainfall. The water, etc., has to be intercepted by a number of sump chambers, from which numerous branch drains have to be laid to the storm-water or foul-water sewer, as the case may be, and in dry weather this conduit forms a receptacle for road dust: therefore, from a sanitary point of view the conduit does not compare favourably with the overhead system. In one city we found that serious inconvenience had been caused by the flooding of the conduits during heavy rains. As far as we have been able to ascertain, no municipality or local authority in Great Britain (London excepted) has itself yet laid down or decided to construct tramways on the conduit system, and no tramway company abroad has done so except under compulsion. This, we ascertained, has been chiefly on account of its great cost and disadvantages in facilities for working compared with the overhead system. It requires much more current to work it than the overhead system. We are of opinion that the cost of the conduit system for Leicester would, financially, kill the undertaking, because we believe the expenses involved in repayment of principal and interest, maintenance and working, would be quite out of proportion to the receipts which the present and prospective traffic would yield. Further, we do not think a town like Leicester ought to burden itself with an unremunerative system for mere sentiment as to the appearance of the overhead work, when it has, on the other hand, such an opportunity for adopting an undertaking which, according to all the experience of other towns, should be a source of great benefit to the ratepayers.

Surface-Contact System.—Many attempts have been made to bring out a satisfactory and workable surface-contact system, and the one which appears to have made the greatest headway is the Diatto, recently adopted on a large scale in one part of the city of Paris. Broadly speaking, this Diatto system has some of the advantages of the conduit, particularly from an æsthetic point of view, without the disadvantages of the open slot, and although, doubtless, more costly than the overhead, is far less so than the conduit, and for this latter reason it was adopted in Paris, as is fully set out in the description of the Paris tramways. The Municipality would not agree to the overhead system in that particular locality, but gave a concession to the Compagnie Générale de Traction to lay down a conduit line. The company, however, in order to avoid the great cost of this, subsequently succeeded in obtaining the consent of the Municipality to lay down the tramway on the Diatto system. It is true that a length of about 3¾ miles has been working at Tours for about a year with more or less success; but at Paris, on the occasion of our visit, the Diatto lines had not been used by the public, but only for trial trips. We are not yet convinced that the system is free from serious disadvantages. This can only be proved by a sufficiently lengthy experience in dealing with the heavy traffic of a large town. We think it possible that the surface studs or buttons (as they are called) may become dangerous by the sinking of the paving around them. They are very numerous, being only a few feet apart. There is also the liability of the getting out of order of some of the great number of automatic electrical connections, which are placed under these studs, and the possibility of the studs being left alive, or, in other words, electrically charged and dangerous, although the inventors

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are very sanguine that this could not happen. The maintenance of all these delicate arrangements would doubtless be costly. We are informed that in case salt were used on the track in time of snow, it would seriously interfere with the working of the electrical apparatus. We think that possibly in a granite-paved street the working of the skate over the studs would cause too much vibration in the cars. This system would, we are afraid, be liable to derangement, and consequent stoppages of traffic, resulting from the necessary frequent excavations and subsequent sinkings of the ground until thoroughly consolidated in connection with sewers, gas and water mains, and their branches, and private service pipes over which the tramlines and the numerous and delicate electrical arrangements would have to be laid more or less. More current is required than with the overhead trolley. We have used every endeavour to get figures as to the actual cost of constructing tramlines on this system, but have not succeeded, and we cannot help thinking that it would in construction, working, and maintenance be much more expensive than the overhead trolley system. Finally, notwithstanding the merits of this Diatto type of the surface-contact system, we think that it would be unwise, even if it were justifiable from a financial point of view, to take the risk of adopting an insufficiently tried system, as has been the case at Paris, where the tramway company had no alternative but the costly conduit system.

Accumulator System.—Much has been expected in the past from the accumulator system, by which each car is a separate and independent unit, carrying its own means of propulsion. The State and municipal authorities of Berlin and Vienna caused this system to be adopted for certain areas in central thoroughfares, where the overhead system was by them prohibited, and also for the purpose of avoiding the disturbance of the streets which the conduit system would have entailed. Unfortunately, it has so signally failed that it is shortly to be abandoned in the city of Vienna, and it is gradually being superseded and will be abandoned as soon as possible in Berlin. Particulars of the working of this system and its drawbacks will be found in the respective sections herein. Amongst some of its disadvantages may be mentioned the enormous weight of the cars and excessive amount of electrical energy consumed, the waste of efficiency, the cost of the accumulator apparatus, the leakage and smell of the acid, which damages the woodwork of the cars and is very much disliked by the passengers, the difficulties of propulsion during snow, and the trouble and expense in the maintenance. We are informed that, financially, accumulator cars are a failure.

Compressed Air.—The perusal of the particulars of this system, as given in the description of the Paris tramways, will, we think, be sufficient to convince you that, however satisfactory it may be in the city of Paris, it is neither so suitable nor desirable for Leicester as is the overhead system.

Cable System.—As fully shown in our detailed report, the cable system as designed, carried out, and worked in Edinburgh, well deserves the highest praise, and is particularly suitable to such a hilly city. In short, it is a system which eminently lends itself to very steep gradients; yet, notwithstanding its advantages under the above-mentioned circumstances, we do not feel justified in recommending its adoption in Leicester.

Reconstruction and Extensions of Existing Lines, and Construction of New Lines.—On going to Parliament for powers, it appears to us highly essential that the scheme should be sufficiently extensive to provide for the requirements of the town for some reasonable time to come; but it does not, of course, follow that the whole of the lines that we have now recommended need be immediately made. This is a question we should prefer to leave for further consideration, and which you may probably not think fit to decide until the full detailed estimates are before you. The practice adopted in other towns is to carry out the work in sections to meet the most pressing necessities for the time being. We are, however, of opinion that the reconstruction, extensions, and new lines which we have recommended, and which are shown on the map accompanying this report, all are absolutely necessary to adequately meet the requirements of the borough. It will be seen that they all traverse important thoroughfares and main roads, where the traffic is sufficiently heavy to warrant their construction. We believe that such a scheme will very largely solve the housing question for the working classes, owing to the great facilities which will be afforded to them to live in the outlying portions of the borough. The lines should be double wherever it is possible, and in some cases, where this if not practicable, parallel routes in adjacent streets will be necessary, but the respective lengths of single and double lines cannot be finally decided until the routes have been surveyed, large scale plans prepared, and the lines carefully designed. In none of the towns visited did we find anyone in favour of utilising the existing tramway rails. This plan was adopted at Bolton, and many were the troubles which resulted therefrom. The rails for horse traction are too light, their surfaces are usually much worn, the grooves too shallow, and the foundations generally insufficient; and even if they could be adopted, a great deal of work would be necessary in alterations and in the electric bonding of the rails.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, JAN. 25.

Physical Society of London.—At 5 p.m., meeting, Burlington House. Papers: "The New Physical Laboratories at the Royal College of Science," by Prof. A. W. Rucker, and "Exhibition of an Experiment on the Migration of the Ions," by Mr. S. W. J. Smith.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting, Westminster Palace Hotel. Paper on "Railway Construction," by Mr. A. Ross.

North-East Coast Institution of Engineers and Shipbuilders. General meeting at Newcastle-on-Tyne.

SATURDAY, JAN. 26.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., meeting. "Boiler-Shop Machine Tools," by Mr. R. Mitchell.

Institution of Electrical Engineers (Students' Section).—Visit to India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown.

TUESDAY, JAN. 29.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be read and discussed: "The Present Conditions and Prospects of the Panama Canal," by Mr. James T. Ford (postponed from Jan. 22).

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., meeting. Paper on "Direct-Current Generators."

FRIDAY, FEB. 1.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Sewage Treatment," by Mr. C. Johnston (postponed from Jan. 25).

Sanitary Institute.—"Mechanical Physics; Laws of Motion, Hydraulics," etc.

SATURDAY, FEB. 2.

Institution of Electrical Engineers.—Students' visit to the Willesden Works of the Metropolitan Electric Supply Company.

THURSDAY, FEB. 14.

Institution of Electrical Engineers.—Adjourned discussion of Mr. Mordey's paper on "Capacity in Alternate-Current Working" (postponed from Jan. 24).

Events Postponed or Abandoned.

INSTITUTION OF JUNIOR ENGINEERS.—Annual dinner announced for the 26th inst.

ROYAL INSTITUTION OF GREAT BRITAIN.—The lectures will be discontinued for the present.

INSTITUTION OF ELECTRICAL ENGINEERS.—Meeting of Students' Section on Jan. 30.—Inaugural meeting of the Birmingham Local Section on Jan. 23 last.—Dublin Section, meeting on Jan. 24 last.

ELECTRO-HARMONIC SOCIETY.—Smoking concert on Jan. 25.

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting on Jan. 26.

SOCIETY OF ARTS.—Meeting on Jan. 23 last.

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THE VICTORIAN ERA.

The shadow of death which has come across the Empire serves but to show the depth of feeling inherent to the Saxon race. Scanty in profession, quicker perhaps in action than in speech, but withal kind, sympathetic, and loving, the sons of the Empire revered their late Queen who so long reigned the noblest monarch ere mentioned in history. The future historian will recognise this reign as beginning a new era. At its commencement

"Did a sable cloud
Turn forth her silver lining on the night."

That silver lining was the precursor of a golden day, and it may be worth while for a moment to consider how grandly progressive that day has been. No words we can say are sufficiently eulogistic to indicate how beneficial the reign has been, and it is needless to say that the Empire owes much of what it has gained to the personality of its late ruler. In 1837, at the time of Victoria's accession, the population of Great Britain and Ireland was about 25,000,000, now it is nearly 40,000,000. The nation's imports for 1836 amounted to the value of £57,230,967, while for 1899 they amounted to over £455,000,000; the exports for the respective years being £53,368,571 and £329,534,658. The iron and steel exported in 1831 amounted to the value of £1,123,372, in 1891 to the value of £26,877,000. The Imperial indebtedness, even with the late war loans, is probably £100,000,000 less than at the beginning of the reign. These figures are proofs there is no gainsaying. But what has given rise to such progress? In 1836 England owned 388 steam-vessels, having a tonnage of 34,314 tons; Scotland owned 95, with a tonnage of 11,588 tons; and Ireland owned 71, with a tonnage of 13,460 tons. There was no Suez Canal, and by steam-packets to Alexandria, thence overland, and again by steam-packets *viâ* the Red Sea to India, letters took sixty days to reach India. We now expect them to reach Australia in less than half that time. It will be seen that the average tonnage of the English vessels must have been under a hundred tons. Three of the Atlantic Ocean greyhounds would now equal the whole steam tonnage of that time. At the Queen's accession railroads in the modern sense were less than ten years old. We say "in the modern sense" advisedly, because as early as 1801 Parliament sanctioned the "Surrey Iron Railway Company," connecting Wandsworth with Croydon. This was really what we call a tramway with horse traction, but for goods only, not for passengers. We take the Manchester and Liverpool Railway, sanctioned in 1826, opened in 1830, to be the first modern railway. Since then over a thousand million pounds capital has been spent on railways, and from the modest twenty miles an hour at that period we now expect an average of at least fifty miles, with a talk of a hundred miles an hour. A writer in 1837, trying to drive home the advantages of railways, made a calculation that on the Manchester and Liverpool Railway the public had saved in hard cash during one year the sum of £241,750, about one-fifth the cost of the railway, besides the value of the

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time saved in the transport of goods and passengers. Ordinarily, the general reader estimates the success of anything by the dividends paid on capital, but this success is frequently small compared with indirect advantages. Imagine, then, the indirect advantages accruing to a nation from the network of railways which now exist. Coming more to matters germane to these pages, we shall not attempt to apportion the position of the work of Wheatstone, Cooke, Alexander, Davy, Morse, Steinheil, or other pioneers in telegraphy; but to say that practical electric telegraphy really commenced in 1837, and all that has been done in its development has been done during her late Majesty's reign. Time has been so far eliminated that we can correspond with America or Australia within a period counted by minutes. Similarly, the developments of electro-metallurgy, starting about the same time with Spencer's discovery when using a Daniell battery, have culminated in huge industrial operations for deposition and extraction of metals. It was at the Glasgow meeting of the British Association in 1840 that Prof. Jacobi read his paper on the propulsion of a boat by electromagnetism, while Davidson's experiments to drive a carriage were made about two years later. Although Faraday had published his experiments earlier, and small machines had been made before 1837, it was really not till many years after that a practical dynamo or magneto machine was made. Here again, then, the whole development of electrical engineering comes within the reign of our late sovereign. We have only incidentally referred to cable work, but all that is since the fifties, hence well within the period. Is there any other similar period in the world's history wherein so great an advance has been made? No one who thinks of these things can wonder at the depth of feeling shown throughout the Empire at the death of the Queen, during whose reign prosperity held sway.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRITISH ELECTRICAL SUPERANNUATION FUND.

SIR,—Some few months ago I made an announcement with reference to a superannuation scheme which had recently been authorised by the shareholders of the British Electric Traction Company, and as the scheme in its early stages attracted much attention, it is possible that many of your readers may be glad to know that the British Electrical Superannuation Fund is now fully constituted, with Lord Vaux of Harrowden and Mr. George Herring as investment trustees, and with a representative committee of six acting as managing trustees.

The staff of the British Electric Traction Company has given the fund satisfactory support, and our associated companies have now been invited to join. I should explain that the rules of the fund have been drawn up expressly with a view to enable any electrical company to participate in the scheme should it wish to do so.

The broad lines of the scheme are as follows: The funds will be invested in the names or under the legal control of the investment trustees. Careful consideration has been given to the investment clause, with a view to secure as high a rate of interest as is compatible with safety. This object has been attained by giving the trustees a very free hand in regard to the character of the investments they may make, but strictly limiting their powers in regard to the proportion of the total funds which they may place in any one company or form of security. The affairs of the fund will be under the immediate management of an elective committee, equally representative of the contributing companies and the contributing members. A quinquennial valuation of the fund by two independent actuaries is provided for, stringent rules ensuring that the report made by the actuaries shall not be disregarded. Speaking generally, each contributing company must make monthly a contribution equal to 3 per cent. of the monthly salary of each contributing member on its staff, and the member himself must make monthly a contribution equal to 2½ per cent. of his monthly salary, plus, in the case of those over 24, a certain extra percentage, varying with age. The "retiring age" is 60, and a member must be of at least 10 years' standing before he is entitled to a pension. Upon retirement a member will receive for every year of service one-fiftieth of the average annual salary received by him during the seven years preceding retirement, the maximum scale of pension being two-thirds of salary. It is important here that service with any and every contributing company counts towards pension, so that an officer can pass from the service of one such company to that of another without injury to his pension prospects.

This scheme, I should add, is intended to apply only to those members of the staff of a contributing company who are on the monthly salary list, and who are between the ages of 18 and 45. For the provisions which exist in regard to members who wish to reckon their back years of service, in regard to members whose percentage contributions are heavy by reason of their age, and in regard to the contributions of and on behalf of the present staff of a contributing company, I must refer any firm interested to the trust deed and rules, which are to be had on application at this address to Mr. W. G. Bond, the secretary of the fund.—Yours, etc.,

E. GARCKE.

Donington House, Norfolk-street, Strand, W.C.
Jan. 23, 1901.

MODERN ELECTRIC LIGHT PLANT.

SIR,—We have read an article in your issue of the 18th inst., entitled "Modern Electric Light Plant," by Mr. R. D. Summerfield, and while thanking him for his kindly reference to the "Economic" boiler as made by ourselves, we cannot understand his saying, "And is now being put down rather extensively, especially in smaller stations."

In this connection we should like to mention that for many years past both the Westminster Electric Supply Company and the St. James's and Pall Mall Company have used these boilers exclusively, while in more recent times the City of London Company, the London Electric Supply Company, and the Metropolitan Supply Company have also become converts. These can scarcely, we think, be regarded as smaller stations.

We enclose you a list of some of the principal stations to which we have supplied, and are supplying, boilers of this type, in addition to a very large number of private firms in London and elsewhere.

List of Some of the Principal Stations installed with "Economic" Boilers—St. James's and Pall Mall Company (26), Westminster Electric Supply Company (20), Borough of Hampstead (14), City and South London Railway Company (12), London Electric Supply Company, Deptford (12), Waterloo and City Railway (5), Metropolitan Electric Supply Company (4), Leyton Urban District Council (4), Aberystwyth and Chiswick Electric Light Station (2), Croydon Electric Light Station (5), Richmond Electric Light Company (2), Maidstone Corporation (4), Southend Corporation (3), Wolverhampton Corporation (2), Windsor Electric Supply Company (3), High Wycombe (2), Folkestone (6), Colchester (3), Great Eastern Railway (11), and many others.

We notice also that he places the "Economic" boiler as third in the list of boilers. We do not know on what principle, unless it be that "the last shall be first," for certainly neither the Lancashire boiler nor the water-tube type can compare with the "Economic" type in fuel and other economies.—Yours, etc.,

THO. H. HARRISON, London Manager.
(for Davey, Paxman, and Co., Limited.)

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THE LATE M. Z. GRAMME.

The man who has done so much for electrical engineering has passed away, to the great regret of his many numerous friends. Comparatively little progress was made in this branch of science between the time Faraday made public his discoveries and the time Gramme patented his machine. True, the principle adopted by Gramme had been previously used by Pacinotti, but the former gave the world a commercially practical machine, while the latter never passed outside of the laboratory. Gramme was a native of Belgium, brought up as a carpenter, but had a mind for greater things, so he attended scientific lectures at Liège, and afterwards went as a mechanician to Paris. Here he made himself acquainted with electrical apparatus, worked under Ruhmkorff, and invented the well-known Gramme dynamo, a type now generally adopted throughout the world. For this invention Gramme received 40,000fr. in prize, half from the French Government, and the other the Volta prize from the Academy of Sciences. He lived to realise the great commercial value of his invention, though we doubt if he received adequate pecuniary reward, and died at Bois de Colombes at the age of 74.

ON TECHNICAL EDUCATION.

BY R. M. WILSON, A.I.E.E.

It has always been my opinion that a great deal of cant is indulged in with regard to the subject of technical education, and it is with considerable trepidation that I may be about to add to the already large stock of the aforesaid cant, that I take up my pen to write a few more words on the burning question of how to prepare our young engineers for the arduous duties which lie before them.

In an article, which really was criticising another on "Technical Education in America," which appeared some time since, it is stated that the entrance examinations of the technical colleges are so high that "shops' boys" are unable to "climb the fence" imposed upon them before they can go through the usual college curriculum. This is certainly a very great objection, and in a great many cases in this country the entrance examination is ridiculously set, and the subjects are not by any means well chosen. For instance, French, Latin, and sometimes even Greek, are subjects which are general favourites with the examiners at most of our technical colleges. Now, only a boy just out of school is able to get through the papers set in these subjects, as if he has some years left school he must (unless possessed of a very retentive memory) start in and "grind" these subjects. Now, say the boy has commenced his apprenticeship on leaving school, and intends going in for a technical college course after he has finished his apprenticeship (or part of it), he has to be learning-up Latin, French, history, and geography perhaps, all of which he had, or ought to have had, learned when at school. This line of study he has to adopt when he should be learning mathematics, drawing, mechanics, chemistry, and the intelligent use of the slide rule and logarithms to fit himself for the studies which he intends taking up at college. I do not for one moment mean to imply that Latin, French, and Greek are not very desirable subjects to know, but I do say that there is only at most one case in ten thousand where the knowledge of these languages proves to be of financial value to an engineer. A man goes through a technical college course *primâ facie* to increase his salary-earning capacity, and the modern engineer has no time, after he has left school or university, to take up subjects other than those directly applicable to his profession.

In the article to which I have referred, the writer states that if the shops' boys were allowed into the college without having to pass a stiff entrance examination, he could help the boy who had entered college fresh from school with his workshop practice, while the latter could assist the shops' boy with his elementary mathematics, etc. This would be a highly satisfactory state of affairs for the teaching staff of the college, who would then be in a position to attend to their private consulting practice without having to be annoyed constantly by the necessity of directing the students in their studies. Would such a system work, however, with the average boy? I certainly think not. In a technical college which I know of, the students, who were in nearly every case boys fresh from school, when left to themselves took much more interest in target practice with chunks of wood and screw nails, either at one another or at the silk hats of pedestrians on the street below, than they ever took in carrying out their experiments. The jointing class was more often found making "flares" with powdered resin than making joints. Is it likely that these youths would have taken up with enthusiasm the teaching of elementary mathematics to shops' boys? I should like to see the following rule adopted by all technical colleges: "No boy just out of school can be admitted to the engineering classes of the college." A technical college cannot teach a lad more than the merest smattering of actual workmanship, and, in my opinion, a boy simply wastes his time at all such work as turning spools, legs for test-tube stands, paper weights, and all work of a like nature. Even laboratory testing is of infinitely more value to a lad who has been in the shops, and can appreciate the value of what he is doing, than it is to a boy who has had no experience, and simply looks upon each experiment as something to be got up for examination purposes. I have taken the trouble to make a large number of enquiries among engineers as to whether they consider it better to enter a technical college before being in the shops or after, and in *every* case the answer has been most emphatically in favour of the latter. In my own case I went to college before serving my apprenticeship, and I certainly think that the time I spent at college would have been of infinitely more value to me had it been put in after I had been through the shops instead of before. As I have heard it neatly put, "A boy from school does not know what he wants to be at," and in consequence wastes about 75 per cent. of his valuable time on work or studies which can never be of the slightest use to him in after years. Now, take the lad who has been through the shops. He is of an age to know that time is money, and having learned that by experience, he does not waste his time. He has jotted down mentally, if not otherwise, many a little point which perhaps troubled him during his apprenticeship, which he has now time to consider fully and experiment upon. He knows what experiments will be useful for him to carry out, and he may be able to do a fair amount of original research work. A youth who has been served his apprenticeship, and who has been studying and taking evening classes in his spare time, is able to take up the more advanced stages when he goes to college, and is in a position to obtain the maximum of benefit from his studies. A great deal is said about technical colleges being far too theoretical. What does a lad go to a technical college for if not to learn the theory of his trade or profession? He certainly does not go to learn his trade. The shop is the place for that. He may learn a miserable imitation of his trade at college, which would almost certainly be scorned by any self-respecting first year's apprentice. In the shop he will learn his trade with proper tools and machines, he will be instructed by men who have spent their lives at their particular branch of work, and he will have to turn out a good job or stand to the consequences. At college he will learn the theory of his profession from teachers who have made a speciality of theory, and who have fitted themselves to teach the theory of the particular trade with which they are connected. Let it be the workshop for practice, and the college for theory. I have no doubt that many an engineer has been pained when passing through some college workshop to see a student chipping a piece of metal, and holding the hammer so near the head that it is in danger of being "choked," while the chisel is held with a grip suggestive of tetanus. Another student is filing, holding his file in some fearful and wonderful position which nobody seems to take any exception to, while another is endeavouring to turn brass with a tool ground in such a manner as to preclude the slightest chance of turning out a decent job. These things can be seen in most of our colleges, and a lad is simply allowed to fall into the wrong way of doing things, which he has to get out of before learning the right way when he enters the

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shops. If it were recognised that a technical college is not intended to teach a lad his trade, but to teach him the theory necessary for the intelligent practice of his trade, technical education would not be the unnatural hybrid process of "playing at work," which it too often is.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

NOTE.—By some mistake the names and addresses of the gentlemen contributing Question 338 and Answer 328 have been mislaid. Letters sent to the supposed authors have been returned. Will the gentleman who signed "F. R. S" to Answer 328 and the gentleman who sent Question 338 kindly send correct addresses.—ED. *E. E.*

QUESTIONS.

345. Explain, with diagrams, the method usually adopted in combined lighting and traction stations for connecting the generators to either switchboard.—A. H.

346. The dynamos used in an electrolytic bleach plant are sparkless at the brushes under normal conditions, but when fumes of chlorine gas are present the commutator exhibit continuous rings of sparks. Why is this?—T. A.

ANSWERS.

Question No. 339.—Describe what you consider the best arrangement of staff for a combined traction and lighting station with a maximum output of 1,500 kw.

Best Answer to No. 339 *(awarded* 10*s.)*.—The answer to this most important question is necessarily a speculative one, as no two given stations and the conditions under which they are run are alike. It will be obvious, then, that the answer must be in very general terms, and must aim at principles of organisation rather than precise details. The staffing of a station is, perhaps, the most important point in the administration of an electrical undertaking, because so greatly does the efficiency and economy of running depend on the staff, yet, strange though it may seem, it is often considered only a matter of secondary importance. It may be looked at in this way: a man may have a physically perfect body, yet if he has not the intellect necessary to properly use his body and keep it in a state of preservation, he will soon lose his power and strength. Just in the same way, a station may be equipped with the most perfect plant, yet if an efficient intellect or staff be not employed to run it, even with good machinery and favourable conditions of working, it will soon become inefficient and uneconomical. The writer has heard manufacturers say that two similar sets of plant at different stations may give very different results and have very great variation in the length of life, owing to the different ways in which they are worked.

In the first place, then, it should be decided to employ trained and efficient men only, and though the cost of such labour may be a little greater than having untrained men, yet it will be found that the economical working of the station and the lessened liability of failure of supply will more than warrant the greater expenditure. Having decided, then, to only employ good men, the next question is their number and relative positions, and it is in this that each particular station will have different requirements. Let us consider a station which would probably be put down to-day for lighting and traction, with a maximum output of 1,500 kw. Such a station would probably have plant somewhat of the following order:

No.		Size.
1	.....	100-kw. set.
2	.....	200-kw. sets.
2	.....	500-kw. sets.
Total... 5	.....	1,500 kw.

To look after this plant, we might reasonably say the following staff would be required:

I.—*During Heavy Load.*

No.	Position.
1	Electrical engineer-in-charge.
1	Switchboard attendant.
1	Experienced engine-driver.
2	Assistant drivers.
2	First and second boiler hands.

II.—*During Light Load.*

No.	Position.
1	Electrical engineer-in-charge.
1	Switchboard attendant.
1	Driver.
1	Assistant driver.
1	Boiler hand.

Having decided, then, the staff required for various loads, we must consider the number of hours the plant requires to be run. In most towns where electric traction is employed, the first cars, generally workman's cars, commence running about 5 a.m., and from this time to about 12 p.m., when the last cars are run, the amount of power required will be such as to necessitate the running of the plant. Now, in a town where the capacity of the station is 1,500 kw, it is more than probable there will be a great number of the streets electrically lighted, and it would be found more economical to run the plant throughout the night than to work on the battery. Thus we might reasonably assume the station will be running 24 hours per day. Of the 24 hours the time of heavy load would probably be between 12 noon and 8 p.m., when there would be a lighting and power load in addition to the traction load. In a manufacturing town, where there would be a good motor load, and where dense fogs would at certain times of the year be expected, it would be necessary to have the staff required for running a heavy load at hand at all times during the day.

Under conditions somewhat as above, the following would be the best arrangement of staff: (A) One chief assistant engineer to assist the chief in the organisation of the undertaking, to act as deputy during his absence, and more particularly to take charge of the generating department. Hours of duty, except when otherwise necessary, to be during the day, say from 9 to 5.30. (B) Three assistant electrical engineers, to take charge of eight-hour shifts. (C) Three switchboard attendants, to work eight-hour shifts. (D) Three drivers, to run engines during eight-hour shifts. (E) Four assistant drivers, to work eight-hour shifts. (F) Four boiler hands, to work eight-hour shifts. Note.—Two boiler hands and two assistant drivers to be always on during heavy load.

In addition to the above, it would be advisable to have a fitter-driver, who would have to keep all plant in repair, and who could run a shift, if necessary, in case of holidays, illness, etc. Also an assistant for this man to work with him, but who, if necessity arose, could take the place as boiler hand or assistant driver. As these last two men would probably be at the works during the morning, in case of a heavy load coming on through fog, etc., they would be available to assist in the engine and boiler houses. It may be thought that the number of boiler hands is inadequate to deal with the amount of steam required, but with boiler plant as erected to-day, having automatic stokers, coal supply, and ash conveyors, the writer believes that two men during heavy load, and one during light load, will be sufficient.

All orders to be given to the men by the chief or chief assistant should be issued through the engineers in charge of the respective shifts, thus all misunderstanding between the engineer in charge and his men will be eliminated. In

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all cases where orders concern the general running of the station, they should be written out and posted up in the assistant's office, so that each engineer will receive the instructions direct, and will not have to rely on the memory of the engineer in charge of the shift when these instructions were issued. In all cases where it can possibly be avoided, orders should not be given to the men direct, otherwise the engineer's authority, which it is most important should be recognised, will be weakened. In exceptional cases, when such orders must be given direct, a copy of these orders should be given to the engineer. It may be considered the last few remarks are a digression, but the writer would urge that some such system of control is recognised at the beginning of the works, otherwise the management is liable to become lax, and then much discontent and trouble might be experienced in inaugurating a system which, if commenced at the beginning of the undertaking, would have been accepted without demur. With further reference to the staff already enumerated above, it might be found possible to dispense with one or two of the men, or it may be found necessary to employ one or two more, according to the particular circumstances of the case. The writer has merely tried to indicate what, from practical experience, he considers necessary for a general case. As the question asked for the staff required for the station only, the list for the outside department has not been included.

In conclusion, it is false economy to cut down the wages costs by employing inferior men or by reducing the staff to an absurdly low minimum, which results in discontent and continual shifting. It should also be remembered that the conditions of central-station work are trying and arduous, and every consideration should be given to the comfort of the staff. This will result in the well-being of the undertaking.—E. T. W.

Answer to No. 339 *(awarded* 5*s.).*—The best arrangement would be, I think, to organise the following departments, each with a responsible and qualified head: (1) generating; (2) mains and public lighting; (3) meter and testing; (4) office and stores; (5) drawing office; (6) tramways management. Department (1) to be responsible for the generation of energy for lighting and traction, and for maintenance of machinery, boilers, station batteries, etc. Department (2) to deal with maintenance of mains, trolley wires, feeders, etc., and to carry out new extensions of mains as required. If the public lighting is not very extensive, it could be looked after by the mains department. If, however, there are a great many arc and incandescent lamps for street-lighting, it will be better to have a separate department for the work. Department (3) to be responsible for reading consumers' meters, testing and connecting new consumers, testing and adjusting new and old meters, also station instruments, ammeters, voltmeters, etc., and for the accounts. Department (4) to deal with ordering of stores, prime cost and station accounts, correspondence, making out paysheets and paying the men, attending to customers, calls, and other clerical work generally. Department (5) to make drawings as required by the engineer, curves of progress of undertaking, maps of mains, etc., and generally supervise new work in progress under the instructions of the chief engineer. Department (6) to be responsible for the running of the cars, and direction and organisation of the tramways generally; also repairs and maintenance of cars and motors. It might be found advisable to let the tramways department have charge of trolley maintenance, leaving underground feeders only to be looked after by the mains staff.

All heads of departments should be given full control of the men they employ, and be responsible directly to the chief or borough electrical engineer, who in turn is responsible to his committee. The above arrangement leaves the chief engineer free to devote a large portion of his time to the general supervision of the undertaking, the designing of new work, and to wait on his committee as required.—E. M.

Question No. 340.—Is there any advantage in driving gas-engines by specially prepared gas instead of by ordinary gas used for lighting purposes? Compare the two methods.

Answer to No. 340 (*awarded* 7*s.* 6*d.*).—Under ordinary circumstances, and where capital cost will allow it, it is more advantageous to use producer or other specially prepared gas in preference to town gas. A little consideration of the two cases will soon make this apparent. Assuming as a fair average the price of town gas to be 2s. 6d. per 1,000 cubic feet, it is found that, exclusive of attendance and lubricating oil, the cost is from ·5d. per brake horse-power hour for large engines working with a full load under the best conditions to 1d. per brake horse-power hour for the usual size of engine running under ordinary circumstances. In some tests made by the writer of a large engine giving 50 b.h.p., the gas used was 17ft. per brake horse-power hour. Thus at 2s. 6d. per 1,000 cubic feet we have

1,000 : 17 : : 2s. 6d. : 1 brake horse-power hour
= ·510d. per brake horse-power hour.

Table I., taken from "Fowler's Mechanical Engineers' Pocket-Book," is interesting.

When the gas-engine first came into use, in nearly all cases "town gas" was used. At the present time nearly all large installations are driven by Dowson or other specially prepared gas. These gases have not so high a calorific value as town's gas, and are often referred to as "poor gases." They are, however, much cheaper to produce. In a recent test of a large modern gas plant which came under the writer's notice, working with producer gas, and extending over a number of hours, it was found that nearly 1lb. of best Welsh anthracite peanuts was used per indicated horse-power hour. The cost of this anthracite delivered was 24s. per ton. Thus, assuming for ordinary working conditions 1lb. of fuel per indicated horse power hour, we have 2,240 : 1 : : 24s. : 1 indicated horse-power hour = ·129d. per indicated horse-power hour. To this cost must be added the extra cost for fuel required for the boilers which supply steam for the generators, and the cost of labour, repairs, depreciation, and interest. Further, the cost of extra attention to be given to the engines themselves. In general terms we may say that, taking the two cases of town gas and special gas, the saving by using special gas will be about 50 per cent. The next table, taken from the same source as Table I, is instructive.

It will be obvious that the larger the installation, the greater will be the saving accruing from the use of special gas. On the other hand, there will be a point where the costs of the two systems will be equal; where the plant is

TABLE I.—Results of Gas-Engine Trials. Town Gas Used.

Name of engine.	I.H.P.	B.H.P.	Mechanical efficiency.	Cubic feet of gas per I.H.P. hour.	Cubic feet of gas per B.H.P. hour.	Authority.
Otto-Crossley	17·1	14·7	0·86	20·7	24·1	Society of Arts Report.
Clerk's engine	9·05	7·23	0·80	24·3	30·4	Clerk's "Gas-Engine."
Atkinson's differential	—	2·6	—	—	25·7	Robinson's "Gas and Petroleum Engines"
Atkinson's cycle engine	5·56	4·89	0·88	19·78	22·5	Prof. Unwin.
Griffin	15·47	12·51	0·80	23·1	28·5	Profs. Kennedy and Jamieson.
Forward engine	5·54	4·8	0·86	20·73	23·97	Prof. Smith.
Simplex	—	8·79	—	—	20·38	Witz.
Wells Bros.' small gas-engine	11·9	8·5	0·71	20·	27·8	At half load. Prof. Goodman.
Wells Bros.' small gas-engine	17·6	13·5	0·76	16·3	21·2	Nearly full load. Prof. Goodman.
		E.H.P.			E.H.P.	
Wells Bros. Premier engine	61	47	0·77	15·27	19·7	Full load. Prof. Goodman.

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TABLE II.—Trials of Engines with Dowson Gas.

Name of engine.	I.H.P.	Anthracite consumed in producer per I.H.P. (lbs.)	Authority.
Crossley Otto	27·5	1·4	Inst. C.E., *Proceedings*, vol. lxxiii.
,, ,, ...	118·7	0·762	*Engineer*, Feb. 12, 1892.
Atkinson's cycle engine	21·9	1·06	—
Stockport gas-engine..	76	0·86	—

smaller than this it will be advantageous to use town gas. Of course, everything depends on local conditions, which is the best system to adopt for medium-size installations, such as available space, cost of town gas in that district, cost of fuel (delivered) for producing special gas, and cost of labour, etc. Also another important factor is the number of hours the plant is likely to be run. One point worth consideration is the advantage town gas has over special gas in being purer, also being available at all hours without special preparation. For installations of less than 50 h.p., town gas would probably be the best to adopt. So great is the divergence between different cases, however, that each case must be studied for itself.—E. T. W.

Answer to No. 340 (*awarded 7s. 6d.*).—The chief advantage in using coal gas in a gas-engine is that its calorific value is much higher than any form of producer gas, while in most cases it can be obtained direct from the mains without the necessity of installing a gas plant. The calorific value of coal gas is about 675 British thermal units per cubic foot; Dowson producer gas from anthracite coal, about 160; Mond producer gas from bituminous fuel, 155; while blast-furnace gas averages about 100 British thermal units per cubic foot. In order to get the same power from, say, Dowson producer gas, we may have to use from four to six times as much as would be necessary if coal gas were used. The supply pipes may therefore have to be enlarged. A low thermal value gas requires special arrangements to control ignition, and the cylinders of the gas-engine must be somewhat larger. The proportion of air used with coal gas is about eight times the volume of the gas, but with producer gas about equal volumes of air and gas. Using coal gas, an engine gave 80 h.p., but when worked with blast-furnace gas only 67 h.p., or 16 per cent. less. On the other hand, where the amount of power used warrants the extra capital expenditure, it will be much cheaper to put down a gas-producer plant with necessary purifying arrangements. A gas-engine worked by Dowson gas plant will cost less than ½d. per horse-power hour, inclusive of all charges. With Mond's latest form of producer, 23·8 per cent. of the energy of bituminous coal can be converted into mechanical energy. A 25-h.p. Crossley gas-engine gave 2,166 horse-power hours per ton of fuel. And, generally speaking, with gas-engines of the best type, 1lb. coal consumed for making gas should give one horse-power hour. The special local circumstances of each case will always determine whether it is worth while to put down special producer plant. Generally in towns and for comparatively small powers it will not pay to do so.—E. M.

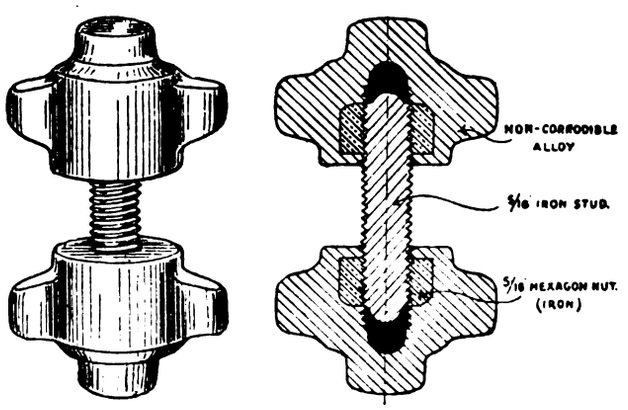
Answer to No. 340 (*awarded 5s.*).—The advantage of employing prepared gas for driving gas-engines, if not a mechanical one, is of the greatest importance at the present day—that is, of keeping down cost of production; and for moderate-size installations perhaps the best-known plant for producing this special gas is the "Dowson," which has been applied and successfully used for many years for various manufacturing processes, as well as driving gas-engines for power plants. Many electric lighting and power stations use this plant, and the fuel consumption per unit of electrical energy generated will compare most favourably with the best results obtained in high-class steam-engine stations. The apparatus is also simple and compact, and occupies very little floor space. The gas is produced by passing a current of steam through a furnace heated with anthracite coal, and can be easily and simply controlled to correspond to the amount of gas required for use in engines of various powers, and is always ready to meet sudden calls for extra power. These gas plants are employed, "among other places," by the Midland Railway at Leicester, and by the Blackpool Tower Company for driving the engines which work machines for supplying about 4,000 incandescent lamps and 100 arc lamps, as well as supplying power to the hydraulic pumps actuating the lifts, the total horse-power being about 800. These plants are also used at Rugby School and by the Urban Council of Leyton, which station contains also 700 h.p., and from tests made at this station as to the total fuel consumed it has been shown not to exceed 2½lb. per unit of electricity generated, including coke used for raising the steam required for the jets.

In the case where ordinary town gas is used, say costing 3s. per 1,000 cubic feet, the working cost of a gas-engine indicating 20 h.p. exceeds the cost of a steam-engine of the same power. At Leicester, with four Crossley engines, each of 50 b.h.p., and two of 25 b.h.p., worked with Dowson gas, the total fuel consumption is at the highest 3lb. per Board of Trade unit generated; and at Halifax two engines, each of 60 b.h.p., drive dynamos and use 1·01lb. of anthracite per indicated horse-power hour and 1·92lb. per unit of electrical energy. Other instances go to show that the consumption of fuel in gas-engines with Dowson gas is much less than in the best type of steam-engine, and compared with ordinary town gas for power purposes, the cost of Dowson is from 8d. to 10d. per 1,000 cubic feet used. The actual cost of the gas itself is only about 2d. per 1,000 cubic feet, but the volume required is four to five times as great as that required of ordinary coal gas to produce equal power in the engine cylinder. The cost of repairs and maintenance of the gas plant of course varies with the size, but for a plant supplying gas for producing from 100 i.h.p. to 500 i.h.p. is only from £7 to £14 per annum, which is spent in the necessary renewal of firebars, hopper valve, and some of the brick lining of the furnace; also the coke in the scrubbers has to be renewed about once a year. Further, the cylinders and valves of engines worked by this gas require more frequent cleaning and attention, consequently the valves and ports of such engines should be constructed so as to allow of easy manipulation and inspection.

Beyond the fact that this gas is corrosive and poisonous, and should not be permitted inside of any buildings, no special knowledge is necessary, and an intelligent labourer can be given charge of a moderate-size plant.—K.

A NEW BOLT FOR CONNECTING STORAGE-BATTERY LUGS.

We have received from Messrs. W. O. Rooper and Robins, Stafford, their new price-list of Epstein storage batteries, in the manufacture of which they have been engaged for some



time. Special attention is drawn to Rooper's patent connecting bolt, by the use of which it is claimed that any plate in any cell may be removed and replaced in a few minutes while the battery is at work, and without the employment of an overhead traveller. The accompanying illustrations show the arrangement of this bolt, but it may be added, in further explanation, that each accumulator plate of the above firm's make has

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a jaw formed on its lug, and through the successive connecting jaws between cells is passed a lead-coated pin, spacing washers being provided to keep the jaws in position, while the whole is tightened up by the firm's patent nuts. The bolts, together with the patent nuts, are intended to displace connectors of the ordinary brass type, so as to prevent the inevitable corrosion which now takes place, with the consequent deposit of copper in the cells. Joints made in the manner described may, it is claimed, be left in strong acid and no trace of corrosion found on removal.

CATALOGUES.

The Electrical Company, of Charing Cross road, have forwarded us the 1901 issues of their price lists Nos. 6 and 7. No 6 deals with the "Luna" arc lamp carbons, which are so well known for their quality and uniformity. The catalogue also gives some particulars of the "Eos" carbons, specially made for the "Luna" enclosed arc lamps both for alternating and direct current working. List No. 7 deals with safety-fuse cut-outs, fuse boards, ceiling

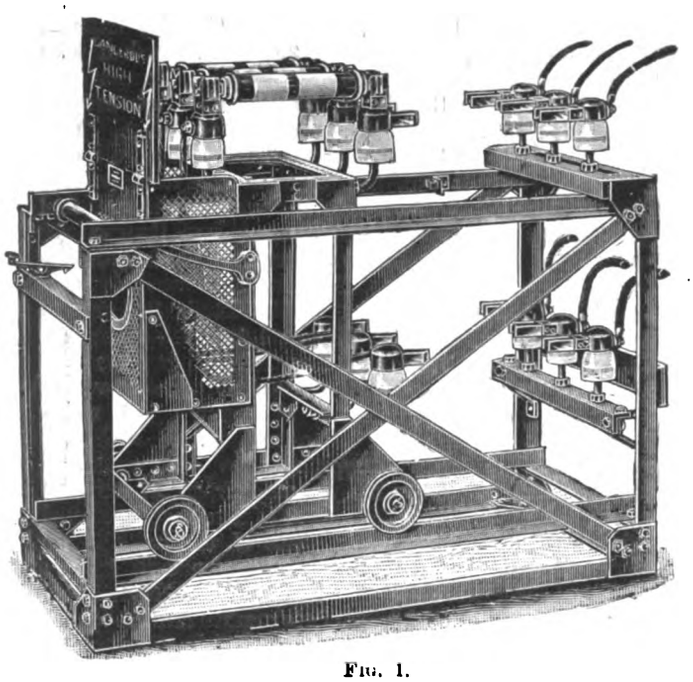

FIG. 1.

roses, and fuse wires. A large amount of space is taken up with the various types of universal fuse blocks, and also with the non-interchangeable fuse plugs. The fuse plugs, which were designed by the Allgemeine Electricitäts Gesellschaft, are so arranged that it is not possible to introduce a heavy fuse into a circuit wire for

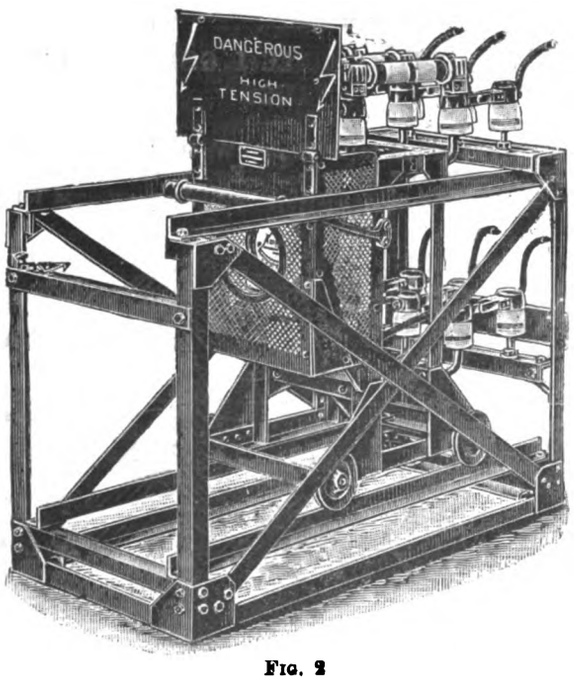

FIG. 2

a small current consumption. The fuse blocks for containing these non-interchangeable plugs can be obtained in a great variety of forms, and are conveniently arranged for mounting on distribution boards. The larger fuses, more particularly designed for high-voltage work and large currents, are also to be obtained from this firm in a number of standard types, which are stocked in order to avoid delay. Amongst the novelties illustrated in the catalogue before us is the trolley fuse for high-tension working. The construction of these can be seen from the two following illustrations. Fig. 1 shows the trolley disconnected. The obvious advantage of this, of course, is that in the event of the fuse getting out of order there is no risk attending the operation of repair. Fig. 2 shows the trolley fuses connected up.

Messrs. W. N. Brunton and Sons, of the Musselburgh Wire, Steel, and Galvanising Works, have forwarded us some illustrations of their new Clincher cable grip, which they are introducing for supporting telephone and other cables. The arrangement made use of up to the present consists of rawhide clips, which are strung on to the steel hawser which bears the weight of the cable. It is not easy with this arrangement to fix new supports if one of the rawhide clips breaks, and the mechanical strength of the clips leaves room for considerable improvement. In this respect the Clincher cable grip, standardised by the above firm, is superior. The hook or rather the two hooks, which embrace the steel hawser, also act as a lock for the strap which passes round the cable. The form of these hooks is most ingenious, as it enables the strap to be adjusted in the first instance to any desired tightness round the cable, after which it is firmly locked by the process of bringing the hooks up into the vertical position over the cable. The weight of the cable then helps to bind the strap, so that any increased weight due to snow, etc., makes the fastening, if possible, more secure.

Correction.—In our notice of the Mackey's Electric Lamp Company's list in last week's issue we stated that "with high-efficiency lamps from 2½ to 3 watts per candle the life will be more like from 200 to 300 hours." As a matter of fact, the average life of these lamps is from 300 to 800 hours and we hasten to correct the above statement, which was inserted in error.

NEW COMPANIES.

The following companies have been registered during the last week:

Middleton Electric Traction Company, Limited.—Capital, £100,000. Object: to carry on business as carriers of passengers and goods, electrical engineers, electricians, manufacturers of and dealers in rail, tram, electric, and other apparatus, etc.

Herne Bay and Canterbury Light Railway Syndicate, Limited. Capital, £2,000. Object: to carry out contracts for making, purchasing, or working railways, tramways, telegraph and telephone lines, electric and other lighting, equipment thereof with electric plant, etc.

Jarman Bros, Sons, and Co., Limited.—Capital, £2,000 in £1 shares. Object: to acquire the business carried on at 23, Hither-green-gardens, Lewisham, Kent, by R. Fawsitt, H. J. Jarman, and W. T. Knott, and to carry on the business of builders, contractors, plumbers, gasfitters, decorators, gas and electrical engineers, etc.

George Jennings, Limited.—Capital, £60,000. Object: to acquire the business carried on by G. H. Jennings and S. Jennings at 65, Palace-road, Lambeth, S.E., and elsewhere as George Jennings, and to carry on the business of metal founders, workers and converters, mechanical and electrical engineers, etc.

James Hodgkinson, Limited.—Capital, £50,000. Object: to acquire the engineering and machine works now carried on at West-street, Salford, Lancashire, by James Hodgkinson, together with the exclusive right to manufacture mechanical stokers, steam generators, etc.

Fermoy and District Electricity Company, Limited.—Capital, £7,500, in £1 shares. Object: to supply electricity in Fermoy, county Cork, and surrounding district, and to carry on the business of electricians, electrical and mechanical engineers, etc.

Crowther and Co.'s Electrical Industries, Limited.—Capital, £10 000. Object: to carry on and continue the business of Crowther and Co. of Manchester and Liverpool, electrical engineers and contractors, and to supply electric light and power plant, etc., and to carry on generally the business of an electrical engineering company, and to lay down and construct all necessary works and appliances for the supply of electricity for the purposes of light, heat, motive power, or otherwise.

APPOINTMENTS VACANT.

Electrical Engineer, Paisley Corporation, £250 per annum and quarters, Jan. 31.

Assistant Electrical Engineers, Keighley Corporation, £2 2*s.* per week, Jan. 26. Devonport Corporation, £130 per annum, Feb. 7. An assistant electrical engineer is also required by Feb. 7. Full details in our advertisement columns.

Assistant Mains Engineer, Manchester Corporation, £200 per annum, Feb. 5.

Manager, tramways department, Ayr Corporation, £200 per annum, Feb. 2.

Draughtsman, £2 10*s.*, applications to be sent to Mr. R. A. Chattock, M.I.E.E., city electrical engineer, Town Hall, Bradford.

Outdoor Assistants, East Ham District Council, £150 per annum, Feb. 10. Full particulars in advertisement columns.

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FULHAM.

At a special meeting of the Borough Council last evening the Lighting, Electric Lighting, and Dust Destructor Committee presented a report stating that they had made arrangements for the switching on of the current by the Mayoress, to take place on Wednesday, Feb. 13, 1901, at three o'clock. The report continues:

We have considered reports submitted by the consulting engineer and resident engineer as to the number of men that will actually be required so soon as a supply of electrical energy is commenced, and recommend that authority be given for the following list of staff and men to be employed—viz: Staff—R F. Ferguson, chief engineer and manager; H. H. E. Wood, superintendent of mains; G. T. Meek, superintendent of destructor; R. W. Liddell, chief clerk; E. Garside, J. Morris, and S. Sheppard, assistant engineers; G. A. Rowe, canvasser; E. G. Hull, assistant clerk. Engine-room—three drivers at 38s. per week; three greasers at 35s. per week; one water-softening attendant at 32s. per week; three switchboard attendants at 25s. per week. Destructor and boiler-house—three chargemen at 40s. per week; 12 stokers at 7½d. per hour; six feeders at 7d. per hour; one mechanical stoker attendant at 7½d. per hour; one lad at 4½d. per hour. Mains department—one carpenter at 10½d. per hour; one carpenter's mate at 7d. per hour; one jointer at 48s. per week; one jointer's mate at 7d. per hour; one plumber at 46s. per week; one plumber's mate at 7d. per hour; one transformer attendant at 35s. per week; one transformer assistant at 30s. per week; one arc lamp trimmer at 35s. per week; one arc lamp repairer at 35s. per week; one meter fixer at 32s. per week. Stores and weighbridge house—one storekeeper at 30s. per week; one weighbridge clerk at 30s. per week; one office boy at 10s. per week.

We have received the following report from the consulting engineer with regard to the combined refuse destructor, electricity supply, and disinfecting scheme, which we submit for the information of the Council—viz.:

Gentlemen,—At the request of your chairman I beg to give you the following financial statement as to the present position and future prospects of your combined refuse destructor, electricity supply, and disinfector scheme. I propose to consider each section of the combined scheme separately in the first instance, and then finally to give you a statement of the probable ultimate net result.

Refuse Destructor.—I do not know whether it is within the knowledge of the committee—but in any event it is a fact—that when the Fulham Vestry entered into this contract with the Horsfall Destructor Company, I urged that one of the conditions of the contract should be an undertaking on the part of the Horsfall Destructor Company to work the destructor for six months after completion at a maximum cost with respect to the number of workmen to be employed and the wages to be paid to them. My recommendation was adopted, and the contract between the Horsfall Destructor Company and the Vestry contains a clause to the effect that the contractors shall work the destructor for six months with a minimum staff, consisting of a foreman at £3 per week, six feeders at 35s. per week of seven days, and 12 stokers at 35s. per week of seven days. The Vestry subsequently engaged a destructor superintendent at £180 per annum, but as his duties are not confined to looking after the destructor alone, but include supervision of the boilers for electric lighting purposes, I propose to charge two-thirds—*i.e.*, £120 per annum—to the destructor portion of the scheme and the remaining third of his salary to the electric lighting portion of the scheme. You have left 18 workmen at 35s. per week each, or a total (including two-thirds of the salary of the destructor superintendent) of £1,758 per annum. I think that £100 of Mr. Ferguson's salary should be debited to the destructor account, bringing up the total cost of burning the refuse exclusive of depreciation, to £1,858 per annum. Last year the amount of refuse produced in the district was 35,000 loads. Four years ago it was 24,000 loads. Building operations in Fulham are very active, so that I propose to take 40,000 loads per annum as the amount of refuse that will have to be burnt by the destructor in 1901. The destructor itself will easily deal with 45,000 loads per annum. Allowing 3d. per load for depreciation we have as the total working expenses of the destructor, exclusive of interest and sinking fund on capital, an annual sum of £2,358 per annum. The present cost of removal of the refuse in barges amounts to 1s. 11d. per load, or £3,833 per annum for the disposal of 40,000 loads a year. Mr. Ferguson informs me that he has already made arrangements with the local contractors to remove the clinker at the price of 6d. per load. Referring again to the contract between the Horsfall Destructor Company and the Vestry, I find another clause on which I rigidly insisted to the effect that the clinker shall not exceed 30 per cent. of the refuse, so that 40,000 loads of refuse will produce 12,000 loads of clinker, giving the Council a revenue of £300 per annum. The present cost of refuse removal by barges is 1s. 11d. per load, so that 40,000 loads per annum amounts to £3,833. Thus we have the following figures as a summary of the results to be obtained from the destructor portion of the scheme: Present cost of disposing of 40,000 loads of refuse per annum at 1s. 11d. per load, £3,833; value of clinker at 6d. per load for 12,000 loads, £300—total, £4,133. Wages and salaries, £1,858; depreciation, £500—total, £2,358. Net profit on destructor alone, £1,775.

Electric Lighting.—The plant at the electric lighting station is estimated to produce 500,000 units per annum for private lighting purposes and 120,000 units per annum for public lighting purposes, so that the total probable output of the central station will amount to 620,000 units per annum. At present there have been erected 86 arc lamps, and it has been decided to credit the electric lighting undertaking with £20 per lamp per annum. The output at Hammersmith last year amounted to 891,301 units, and the total cost per unit amounted to 1·89d. per unit. There is no refuse destructor in combination with the electricity supply works at Hammersmith. It is safe to calculate the calorific value of 20lb. of refuse as being equal to the calorific value of 1lb. of good steam coal, so that 40,000 loads of refuse per annum will save the Council 2,000 tons of coal per annum. From what I have just written it is clear that I am making an error well on the safe side when I assume that if there were no refuse destructor at Fulham, the 620,000 units per annum above mentioned could be easily produced at 2½d. per unit, which is more than 25 per cent. more than the cost of production at Hammersmith. We have, therefore, the following figures for the electricity supply scheme: working expenses—620,000 units per annum at 2½d., £6,458; revenue—500 000 units at 5d. per unit, £10,416; 86 public arc lamps at £20 per lamp per annum, £1 720; 2,000 tons of coal at 16s. (saved by burning refuse), £1,600—total, £13,736. Total probable net profit on electric lighting, £7,278.

Disinfector.—The present cost to the Council of disinfecting amounts to about £1,000 per annum. The cost when the new disinfector is in operation cannot, I think, exceed £500 per annum, so that the net probable profit on the disinfector portion of the scheme amounts to £500 per annum.

Final Financial Statement of Combined Scheme.—It is impossible for me to say what the total capital outlay on the present combined scheme will amount to. I think, however, that £130,000 represents an outside figure. Interest and sinking fund together will amount to 5¼ per cent. per annum at the outside if, as I presume, the capital has been borrowed for 42 years, as in the case of other London local authorities. Five and a quarter per cent. on £130 000 amounts to £6,825 per annum, so that we have the following statement as a final and by no means an optimistic estimate of the ultimate results that may fairly be expected from the combined scheme when your central station is working at full output: interest and sinking fund at 5¼ per cent. on £130,000, £6,825; profit on destructor, £1,775; profit on electric lighting, £7,278; profit on disinfector, £500—total, £9,553. Total net probable profit, £2,728. The following figures show the net profit earned after covering all charges and providing interest and sinking fund by all the London local authorities last year who have erected electricity supply works: Hammersmith, £1,615; Hampstead, £9,357; Islington, £381; Shoreditch, £2 331; St. Pancras, £6,842. It would indeed be singular if your undertaking were to prove the only municipal electricity supply undertaking in London that could not earn a profit in relief of the local rates. I must not be understood to say that the results I have explained will necessarily be obtained during the first year of working. But I have no hesitation in saying they will be equalled, if not surpassed, as soon as your undertaking is working at full output.—I am, gentlemen, yours faithfully, (Signed) F. H MEDHURST.

The consulting engineer submitted the following report: "have to report that since your last meeting the final batch of cables for laying have been tested by me at Prescot, and that these have been dispatched to Fulham. They will be drawn into the ducts at once." The resident engineer reported that since the last meeting applications equivalent to 438 8 c.p. lamps had been received, making the total applications 127 in number, equivalent to 10,529 8-c.p. lamps. The resident engineer reported that during the fortnight ended Jan. 14, 1901, 1,076 loads of refuse had been destroyed, and that 255 loads of clinker had been sold. We have received the resignation, to take effect as and from the 26th inst., of Mr. E. Garside, one of the assistant engineers, which we have accepted. We have instructed the clerk to at once issue advertisements in the technical papers inviting applications for the position, and recommend that as the matter is one of great urgency such applications be referred to us with power to make the appointment. We have considered the tenders received for the supply of stores and materials to the electric light station up to March 25 next, and recommend that the following be accepted—viz., (Section 1) C. C. Wakefield and Co., oils; (1) Middleton Bros., sundries; (2) United Asbestos Company; (3) and (4) J. Knox and Co.; (5) and (6) General Electric Company; (7) Electric and General Contracting Company; (8) General Electric Company; (9) Electric and General Contracting Company; (10) General Electric Company; (11) and (12) Electric and General Contracting Company; (13) S. Z de Ferranti, Limited; (14) General Electric Company; (15) no tenders; (16) and (17) Chas. Straker and Sons, Limited, 5 9, Bishopsgate-avenue. A dispute having arisen between the consulting engineer and the Horsfall Destructor Syndicate with regard to the claim made by the latter for extras in connection with the building of the retaining walls of the inclined roadway, and also with regard to the allowance made for extra excavations for the foundations, we have appointed a sub committee, consisting of our chairman, vice-chairman, and Councillors Avern, Cooney, and Steel, to consider the matter, and recommend that they be empowered to call in expert evidence if they consider it necessary. We recommend that the agreement with Messrs. E. Green and Sons for two yearly examinations, one external and one internal, of their economiser fixed at the destructor, Townmead-road, and for insurance against explosion for the sum of £1,000 in consideration of payment to them of £5. 10s. per annum, be sealed.

In reply to the Council's offer to supply the Fulham Guardians with current at 3¾d. per unit for 50,000 units per annum, made in accordance with the resolution of the Council, dated Nov. 21, 1900, we have received the following communication from their clerk—viz.: "I am directed by the Board of Guardians of this parish to acknowledge the receipt of your letter of the 7th inst.,

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offering to supply them with electric energy at 3¾d. per unit. The Guardians desire me to state that they are most anxious to do whatever can be proved to be in the interests of the ratepayers of Fulham. They have necessarily to incur considerable expense in providing new boilers, chimney shaft, etc., for heating and power purposes at the infirmary, and they find that by a judicious further expenditure of capital they would be in a position not only to light the building by electricity without additional cost, but, further, to somewhat reduce the annual repayment of the loan, with interest, which would be raised to defray the cost of the alterations for heating purposes alone out of the saving which would be effected by dispensing with gas for lighting purposes. If, however, the Council can prove that the interests of the ratepayers would be more effectively served by the Guardians becoming their customers, they (the Guardians) would have pleasure in doing so. In the event of their becoming customers of the Council, they would seek no preferential rate for the supply of electric current, as it appears to them to be immaterial whether they are charged at the same rate as other customers, or nothing. I have, therefore, to request that the Guardians may be furnished as early as possible with the statement, which your Electric Lighting Committee undertook to supply, containing such facts and figures as will enable them to decide what action they shall take in the matter."

The consulting engineer, in accordance with our instructions, submitted a report, of which the following is a copy: "You instructed me at your last meeting to report to you as to why, in my opinion, the Guardians should generate their own power for electric lighting the union, rather than take a supply from the Council's mains. In my report to the Guardians I have shown them why it is cheaper for them to generate their own power, looking at the matter from their own point of view as a separate department of the borough. From the ratepayers' point of view it also is more economical for them to put down their own plant, as the following figures show:

Cost to Ratepayers if Supply is taken from Central Station.

50,000 units at 2½d. a unit	£521
Interest and sinking fund on £11,800 at 5¼ per cent.	619
	1,140
Less proportion of coal saved by destructor	129
	1,011
	711
Difference in favour of union putting down its own plant...	£300

Cost to Ratepayers if Supply Generated on Premises of Union.

50,000 units at 2d. a unit	£417
Interest and sinking fund on £4,200 at 7 per cent.	294
	£711

"In the above the capital charge of £11,800 is one eleventh (this being the proportion of the plant that would have to be set aside for supplying the union) of the capital being expended at the central station and on mains. It may be urged that the mains should not be included, but I have done so, so as to allow for the extra on other mains, sub-stations, etc., that would be required if a supply were given to the union from the central station, but which is difficult to estimate at present. One-eleventh of the present outlay on mains may be taken as very approximately equal to this extra that would have to be incurred. The capital charge of £4,200 is the amount included in my report to the Guardians for plant, etc., for lighting only, but does not, of course, include the cost of wiring the buildings. It should be observed that the rate of interest on the Guardians' side is 7 per cent. and on the Council's side 5¼ per cent."

We have also considered a reference from the Law and Parliamentary Committee, forwarding a report of the solicitor to the effect that if the Council made application to the Board of Trade for a license to supply the Guardians at a preferential rate, it would probably be not entertained, and recommend that the information contained in the above reports be forwarded to the Guardians.

LEGAL INTELLIGENCE.

FACTORY INSPECTOR v. THE BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT COMPANY.

The Protection of Switchboards.

On Friday last, before Mr. Kennedy, at the Greenwich Police Court, the Blackheath and Greenwich District Electric Lighting Company, Limited, were summoned by Mr. Joseph Owner, an inspector of factories, for that at their works, situate at River-terrace, East Greenwich, a person named Arthur Robinson was killed in consequence of their having neglected to secure by fencing certain dangerous machinery, and further, with having failed to register an accident within one week of the occurrence. The man Robinson referred to was killed on Oct. 22 by an electric shock while doing some work at a switchboard on the company's premises, and the jury at the inquest found that he had met his death through lack of proper supervision on the part of the company.

Mr. Gray was counsel for the Treasury, and Mr. Wontner appeared for the defendants.

Mr. Gray said that Robinson was employed in putting a hand-rail round the switchboard; he had taken one bolt out of the board, and while working at another he put his right hand against a bar, the result being instant death. This was the second death with this switchboard. The suit was brought under Section 5, Sub-Section 3, of the Factory Act, 1878, as amended by Section 6, Sub-Section 2 of the Act, 1891, which set out that all dangerous parts of machinery should either be securely fenced, or in such a position or of such construction as to be as safe to everyone as if securely fenced. He (Mr. Gray) contended that all he had to do was to bring the case within that section.

Mr. Wontner submitted that the Act was not intended to protect skilled persons working upon machinery, and this switchboard was on a raised gallery, to which no one was admitted but those who had to work it. The railing which Robinson was engaged in fixing was an additional precaution, and in touching the switchboard when he did he acted in disobedience to orders. He had been told, too, of the danger. The company were most anxious that everything that could be done should be done, and had taken steps to see that it was so.

Photographs and a model of the switchboard were produced, and **Mr. Joseph Owner** was examined as to its construction. He admitted that after the first accident the handles had been raised some 14in.

Prof. Boys, consulting electrical engineer, said that a switchboard, if dangerous, could, in his opinion, be properly called a dangerous part of the machinery of an electric lighting station. It was quite feasible to protect a switchboard, and not at all necessary that highly-charged metal should be exposed all over its face.

Mr. James Swinburne, a vice-president of the Institution of Electrical Engineers, said precautions, such as having the board in an isolated part of the building, having it railed in, providing indiarubber mats, and warning people not to go near it, ought to be taken. But the switchboard itself had to be made safe, and in doing that there was no difficulty. He did not think that a switchboard such as this was safe even to a skilled person, and even the most skilled had moments of inadvertence.

By Mr. Wontner: This switchboard was not particularly bad—the fault was very general in switchboards. With the handles 9in. from the ground persons passing should be safe, but it should be so made that the operator could work it in safety.

Mr. Gray: The switchboard was ordinarily safe, but dangerous to those working it.

The summons was adjourned for a fortnight.

CLAIM FOR DAMAGES.

At the Brentford County Court recently, before his Honour Judge Bagshawe, Q.C., Messrs. Salmon and King, of 8, Cowley-road, Brixton, sued the London United Tramway Company, of High-road, Chiswick, for £3. 19s. 9d., damages to a brake and lamp. Mr. Roes was for the plaintiff and Mr. Randolph for the defendant.

Mr. Salmon, one of the plaintiffs, deposed that on Sunday, May 25, about four o'clock in the afternoon, he was in charge of one of his four-horse brakes, which was driven by Thomas Challen, and was proceeding from Kew to Richmond along the Kew-road. He had lamps fixed on each side. Near Kew corner the road was very narrow, and, when at this point, he stopped on the off side of the road, at the request of a passenger who wished to alight. When about to restart a tram was seen approaching at the ordinary pace, and the driver did not therefore, move. Another reason why the brake went to the off side was because a trap was drawn up on the near side, and therefore right in the way. Witness called to the tram driver to go steadily, as there was not too much room, but the driver did not do anything to check his pace, and the car struck the near side dickey of the brake, tearing part of it away, and smashing the off-side lamp. He spoke to the driver of the tram, who said that he did not understand the road, as it was the first time he had driven on it. He had had his brake repaired, and he had sued for nothing but the cost of the repairs.

Cross-examined: He saw no brake ahead of his, nor did he see the tram back to let one go past, or for any other purpose. From the time he first saw the tram till the collision it did not back. His brake was perfectly stationary the whole of the time. He pulled up on the near side because the passenger, who was lame, asked him. He denied that his horses moved at all as the tram came.

Re-examined: He could not back a four-horse coach.

His Honour: Then I think these brakes are a public nuisance.

Mr. Ross: If your Honour says that, the Coaching Club would have to close.

Corroborative evidence was given, and several witnesses having been called in support of the defendant company,

His Honour, without calling on the plaintiff to reply, said he considered plaintiff had a right to pull to the off side for a legitimate purpose. There was no evidence that the plaintiff's pulling over was so sudden that the driver of the car could not see it. There was a clear amount of evidence for the plaintiff that the driver of the tram was wrong in not pulling up. He gave judgment for the plaintiff for the amount claimed, with costs.

ACTION AGAINST THE BRADFORD TRAMWAYS COMPANY.

A dual action against the Bradford Tramways and Omnibus Company, Limited, was heard on Tuesday by his Honour Judge Bompas, Q.C., at the Bradford County Court. Messrs. T. and J. Smith, carriers and carting agents, Bower-street, Bradford, claimed £15. 9s. 5d. in respect of damages caused to a lurry and

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harness, and of wages paid for a driver. Mr. Thomas Smith, a member of the firm named, also claimed £30 for personal injuries.

Mr. Walter Beverley appeared for the plaintiffs, and the defendants were represented by Mr. Alex. Neill.

Mr. Beverley stated that Thomas Smith was driving an empty lurry on the Wakefield and Bradford road on Nov. 30, 1899, at 10.30 p.m. He was driving in the direction of Bradford. When in Tong-street, Dudley Hill, he suddenly saw in front of him an approaching tramway engine. The night was a hazy one, and he did not see the engine until it was close upon him. He did his best to get out of the way, but was unable to do so, and the engine struck the right side of the lurry. The result was that the plaintiff was thrown on to the causeway, and so seriously injured that he was confined to the house for six weeks. The negligence complained of consisted of travelling at too high a speed, having regard to the hazy condition of the night and of the fact that the road was under repair, and of no bell being sounded or any warning given of the approach of the engine.

For the defence, **Mr. Neill** contended that there had been no negligence on the part of the defendants or their servants. The tramway engineer could not turn to the right or left, but on the front of it were three large headlights, which could easily be seen. Anyone using the tramlines should do so with care. The plaintiff knew the road well, knew that it was under repair, and also that tramcars were frequently passing.

Several witnesses were called on both sides, and at the conclusion of the case his **Honour** gave judgment for the plaintiffs, awarding £25 damages to Mr. Thomas Smith, and £10. 10s. damages to the firm, with costs.

COMPANIES' MEETINGS AND REPORTS.

NERNST ELECTRIC LIGHT.

The adjourned ordinary general meeting of this Company was held last Friday at the Westminster Palace Hotel, Sir Henry C. Mance (chairman) presiding. The proceedings lasted something like 2½ hours, and throughout were of an uproarious character.

The **Chairman** having called upon Mr. B. M. Drake to resume the discussion,

Mr. Drake referred to the charges brought against him by Mr. B. Zusman, and to his reply which had already been circulated. He had a suggestion to make which he felt sure could not fail to commend itself to all the shareholders as well as to Mr. Zusman—viz., that the issues between them should be submitted to the impartial decision of a gentleman eminent alike as a lawyer and as a statesman, and by whose decision he was sure all the shareholders would be prepared to abide. That gentleman was the Right Hon. Mr. Asquith, Q.C., M.P., who would be asked to give his finding upon each of the issues raised after hearing evidence and counsel on behalf of Mr. Zusman and himself. He (Mr. Drake) undertook that in the event of Mr. Asquith deciding that on the whole he had been unable to answer to his satisfaction the charges brought against him, he would pay the whole of Mr. Zusman's costs; but, on the other hand, if Mr. Asquith held him (Mr. Drake) to be successful, he would not ask Mr Zusman to pay a single penny of his (Mr. Drake's) costs. He was exceedingly anxious to clear his reputation, and if this course were adopted the matter could be settled in a short time. If the matter were fought out in the High Courts the Company's interests might suffer, and therefore he thought his proposal would meet with general approval. He undertook to retire from the Board if the charges were substantiated against him, but Mr. Zusman must give a similar undertaking in the event of his failing to make out his case. If Mr. Asquith were unable to act, he would suggest the name of Sir Robert Reid, Q.C., M.P.

Mr. Zusman absolutely refused to agree to any such proposal. The issues between Mr. Drake and himself were not of a personal character, and in bringing these charges against Mr. Drake he had the interests of the Company solely at heart.

Mr. J. G. Dalzell then moved an amendment to the effect that the meeting intimated their desire that Mr. Drake's proposal should be adopted.

Mr. J. G. Fort seconded, and a long and heated discussion took place, the majority of the speakers holding the view that although Mr. Asquith might be able to give his opinion on a purely legal technicality, he was not the proper person to say whether the gentlemen on the Board were competent to conduct the Company's business. Other speakers described the proposal as a trick, and condemned the Board for allowing such a suggestion to be made.

Mr. Zusman said it was "a trick to shut his mouth."

In the result the amendment was lost by 20 votes to 17.

Mr. Drake then read a lengthy statement in reply to the various allegations of Mr. Zusman, in the course of which he said that he was pressed by Mr. Zusman to join the Board, who at that time was full of praise for the lamp. He himself saw the lamp, and formed a very favourable opinion of the possibilities of the invention. He was mainly influenced by the fact that the Allgemeine Company, Westinghouse, and Ganz and Co. had already acquired the rights for the rest of the world. He had always had the one object in view—namely, to build up a sound lamp industry, and to put their Company on a dividend-earning basis as speedily as possible. Immediately the Company was issued the directors realised that the Company would have considerable difficulty in acquiring the English rights. It was proposed therefore that he (Mr. Drake) should be elected sole managing director instead of having two. His colleagues would confirm that in accepting that post it was on the clear understanding that he could only devote a portion of his time to the work, but that he would undertake for them the organisation of the business. The business now was advancing most satisfactorily, and he could not believe that the shareholders, on account of the charges made against him, would allow the present organisation to be upset. With regard to the charge that he had brought about Prof. Nernst's resignation by his personal tactlessness, that statement had been flatly contradicted by the professor himself, and at the present moment the professor was on the best of terms with him and his co directors. Mr. Drake then went on to reply at length to the other charges made by Mr. Zusman, the text of which was given in his circular issued a short time ago. Dealing with the allegation in respect of his interest in the Resistance Company, Mr. Drake remarked that his holding in the Nernst Company was upwards of 6,000 shares, and in the Heating Company some 250 shares, so that they would hardly believe that he would favour the latter at the expense of the Nernst Company.

Mr. Zusman then proceeded to deal with the statements of Mr. Drake as set forth in that gentleman's circular. Mr. Drake had within the last few days circulated a copy of a letter from Prof. Nernst, stating that he was completely satisfied with the lamp as now produced to him. He (Mr. Zusman) was deeply sorry that Prof. Nernst should have thought fit to put his pen to paper in that fashion, but he believed a great deal of pressure had been brought to bear upon the professor to induce him to do this, as well as to lodge his proxy in favour of the Board. Mr. Drake had told them that day that at the time he was approached by him with a view to his becoming managing director of the Company he guaranteed that the Company would obtain the British rights. That was absolutely untrue, and it was impossible for him to give him any such guarantee.

Mr. Drake: You did not guarantee; you said we should have them without doubt.

Mr. Zusman said that it was impossible for him to say that. The speaker then dealt with his statement at the previous meeting that Mr. Drake had not exerted all his efforts to secure firms to tender for the Company's lamp parts, and to prove this he quoted a letter which had been dictated by the works manager to a typist in the office, remarking that there was no doubt it was at the instance of the managing director.

Mr. Drake repudiated all knowledge of any such letter, and Mr. Sheppard, the works manager, corroborated his statement.

Mr. Zusman, referring to the attitude of Prof. Nernst, said he was deeply distressed to find that such a distinguished man should be made a tool of by desperate men. Despite tremendous efforts put forward by the Board in sending out two lots of proxies, and also forms for cancellation of proxies given to Mr. Cohn and himself, and despite all the daily literature poured forth by them, they had, apart from Prof. Nernst's and their own holdings and those of their immediate friends and dependents, only managed to secure a miserable 20,000 shares out of a total in the hands of unbiassed shareholders of 250,000.

The **Chairman**: We have got nearly 100 000 shares.

Mr. Zusman: I am speaking apart from the holdings of the directors and their friends.

The **Chairman** said, with regard to the position of Prof. Nernst, Mr. Zusman must be aware that that gentleman's complaint arose from the misapprehension that the Company had the German patents for the Resistance Company's heaters. Mr. Zusman had posed as an honest, hard-working, energetic director. He had claimed unrestricted access to the books, and taken copies of documents, in order that he might do his duty, as he said, to the shareholders—and very properly—but was it doing his duty to the shareholders on discovering, as he thought, that irregularities existed, instead of coming to the Board and getting them put right, keeping them up his sleeve for months, and then bringing them forward at a general meeting? With regard to Mr. Zusman's amendment, proposed at the last meeting, it was really not an amendment at all, but simply a negative to the resolution for the adoption of the report and accounts, and he would, therefore, now put the original motion.

The motion was then put, and declared carried by 30 votes to 11.

Mr. Zusman demanded a poll, which was later declared as follows: in favour of the resolution for the adoption of the report and accounts, 120,766 shares; against, 46,871.

Mr. Dolbey suggested that it might be a way out of the difficulty if both Mr. Drake and Mr. Zusman retired from the Board.

Mr. Wigan was convinced that it would be a serious calamity for the Company to get rid of Mr. Drake.

The suggestion was dropped.

Sir Henry Mance, the retiring director, having been re-elected,

Mr. E. Hess proposed the appointment of Mr. J. H. H. Duncan, the late chairman of the New Sunlight Incandescent Company, to the Board as an additional director. The firm of Messrs. Japhet, of which he (Mr. Hess) was a member, represented nearly 100,000 shares, and it was their desire to have a representative on the Board.

Mr. J. L. Reed seconded, but owing to considerable opposition on the part of some of the shareholders, Mr. Hess withdrew the motion. The poll having been taken and declared as above, the proceedings terminated.

METROPOLITAN RAILWAY.

The report of the directors states that the total receipts for the half-year ended Dec. 31, 1900 (deducting the Company's proportion of the revenue of the City lines and extensions), have been

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£422,459 and the expenses £212,461, leaving a profit of £209,997. The receipts show a decrease of £12,316, and the expenses an increase of £13,312, as compared with the corresponding half-year of 1899. In July last the Central London Railway commenced working, charging the low fare of 2d. between Shepherd's Bush and the City, a distance of 6½ miles, and this competition has very seriously affected the receipts on the Circle and Hammersmith and City lines. Certain changes in the working have been made, and others are under consideration with a view to economies being effected which, it is hoped, will mitigate the result of this competition without impairing the efficiency of the undertaking. The traffic on the northern lines continues to show steady and satisfactory development. The working of the half year has again been prejudicially affected by the very high prices of coal and other materials, to which cause the increase in the expenses is mainly due. The net revenue account, after providing for the interest upon the debenture stocks and other fixed charges, shows a balance of £167,045, which will suffice for the dividends upon the preference and guaranteed stocks, and leave a sum of £92,281 available for dividend upon the ordinary stock. The directors accordingly recommend that a dividend be declared upon the ordinary stock for the half-year at the rate of £2. 10s. per cent. per annum, and to carry forward the balance of £20,633 to the next half-year's accounts. The Surplus Lands Committee announce that the dividend on the surplus lands stock for the past half-year will be at the rate of £2. 15s. per cent. per annum. The proprietors are aware that experiments have for some time been going on with the object of proving the adaptability of electrical traction to meet the requirements of the traffic of the railway, and in August last the Electrical Traction Joint Committee appointed by the Boards of the Metropolitan and District Railway Companies invited leading electrical traction firms to submit proposals for working the Inner Circle by electricity. Nine proposals or tenders have been received and reported upon. The committee, however, before coming to any definite decision, have requested the engineers, Sir W. H. Preece, K.C.B., and Mr. Thomas Parker, to make a thorough examination of the system proposed by one of the firms, which appears to possess special advantages both as regards cost of construction and working. Should this examination prove satisfactory, and the report of the engineers be favourable, the directors believe the proprietors will have no cause to regret the delay that has taken place in the application of electricity to the working of their system. Resolutions will be submitted at the special meeting providing for the creation of the capital authorised to be raised by the Metropolitan Railway Acts, 1881 and 1882, and the exercise of the borrowing powers conferred by those Acts. The Board anticipate that these powers, with those now available, will be sufficient to provide the necessary funds for liquidating the debit to the capital account, and for the installation of electrical traction on the railway. The following Bills have been deposited for the next session of Parliament, and will be submitted for approval at the special general meeting which will follow the half-yearly meeting: A Bill to confer further powers upon the Metropolitan Railway Company in relation to their own undertaking, and upon that Company and the Harrow and Uxbridge Railway Company, in relation to the Harrow and Uxbridge Railway, to revive and extend the powers for the purchase of land and the completion of certain authorised railways and works by the two companies, and for other purposes; and a Bill for authorising the sale of the undertakings of the East and West Junction, the Evesham, Redditch, and Stratford-upon-Avon Junction, and the Stratford-upon-Avon, Towcester, and Midland Junction Railway Companies. Several Bills have been deposited affecting the interests of the Company, principally for electrical underground railways in London, which will receive the watchful attention of the Board.

DIRECT UNITED STATES CABLE.

The half-year's revenue, after deducting out payments, amounted to £50,533, as compared with £56,800 for the corresponding period of 1899, showing a difference of £6,266 against the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of cable repairs, amounted to £20,826, leaving a balance of £29,707 as the net profit, making, with £3,761 brought forward from the previous half year, a total of £33,468. For the corresponding period of 1899 the working expenses and other payments amounted to £20,416. Interim dividends of 3s. per share for the quarter ended Sept. 30, 1900, and of 3s. per share for the quarter ended Dec. 31, 1901, together amounting to £18,213, have been declared, and after setting aside £10,000 to the reserve fund account, the balance of £5,255 on the revenue account has been carried forward. The reserve fund account has been debited with £2,500 for cost of cable repairs, and after being credited with interest on the investments and amount set aside from revenue, the balance of the reserve fund account taking the investments at cost price, now amounts to £433,105.—*Financial News.*

EASTERN TELEGRAPH.

The directors in their report for the half-year ended Sept. 30, 1900, state that the revenue for the period amounted to £642,145. 17s. 10d., from which are deducted £131,862. 13s. 8d. for the ordinary expenses, and £45,582. 0s. 4d. for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £6,572. 1s. 4d. for depreciation of spare cables, and £10,526. 10s. 2d. for income tax, there remains a balance of £447,602. 12s. 4d., to which is added £1,924. 17s. 6d. brought from the preceding half-year, making a total available balance of £449,527. 9s. 10d. From this balance there has been paid: interest on mortgage debenture stock, £27,275. 0s. 7d.; dividends on preference stock, £31,319. 19s. 4d.; two interim dividends of 1½ per cent. each on the ordinary stock, £100,000—total, £158,594. 19s. 11d. After carrying £10,000 to the reserve fund for maintenance ships, and £250,000 to the general reserve fund, there remains a balance of £30,932 9s 11d., which is carried forward to the next account. The revenue includes £23,225. 5s. 8d. dividends for the half-year upon the Company's investments in other telegraph companies. The large sum placed to reserve is to provide for the payment of certain of the instalments on account of cables now being laid by this Company between Great Britain, the Cape, and Mauritius, which in conjunction with the cables undertaken by the Eastern Extension, Australasia, and China Telegraph Company, will form the new through route between Great Britain and Australasia. One of the cables above referred to—viz, that from Porthcurnow, in Cornwall, to Madeira—has been lately opened for traffic, and the Madeira-St. Vincent section is in course of being laid. When this section is completed, the third route to South Africa will be materially strengthened. Of the three routes, one is triplicated as far as Aden, and the other two, in conjunction with the cables of the Western Telegraph Company, will be triplicated as far as St. Vincent. The tariff to South Africa was reduced from 4s. to 3s. 6d. per word on the 1st inst. The "standard revenue" fixed by the Cape-Australian cable agreement, for regulating the Australasian tariffs, having been maintained, further reductions were brought into force on the 1st inst. for telegrams exchanged with South Australia, Western Australia, and Tasmania, as follows: 3s. 6d. per word for ordinary telegrams, 2s. 6d. per word for Government telegrams. Since that date the Government of New South Wales has accepted the agreement, and messages exchanged with that State will, therefore, be entitled to similar reductions on and after Feb. 1 next. It having been found necessary, from time to time, to nominate directors of this Company on boards of associated companies, the shareholders will be asked to amend the articles by passing the resolution set forth in the annexed notice convening an extraordinary general meeting to be held immediately after the ordinary general meeting.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Eccles.—The Corporation invite tenders for a 40-kw. steam alternator. Tenders by 28th inst.

Bournemouth.—The Town Council invite tenders for 42 electric cars. Tenders by March 2. Details in our advertisement columns.

Mortlake.—The Barnes Urban District Council invite tenders for wiring their electricity works at Mortlake. Tenders by Feb. 11.

Edinburgh.—The Corporation invite tenders for engine and dynamo. Tenders by Feb. 9. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for surface condensers, air and circulating pumps. Tenders by Feb. 8. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for four electric motorcars for the pier electrical tramway. Tenders by Feb. 6. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the electric lighting installation at the public baths, Portobello. Tenders by Feb. 6. Details in our advertisement columns.

Aberdeen.—The Tramway Committee invite tenders for the electrical equipment of their bathing station route. Tenders by Feb. 13. Details in our advertisement columns.

Oldham.—The Electricity Committee invite tenders for supply, delivery, and erection of engines and dynamos. Tenders by Jan. 29. Details in our advertisement columns.

Great Yarmouth.—The Town Council invite tenders for the supply of 800 tons, or thereabouts, of steel girder tramway rails of from 80lb. to 90lb. per yard. Tenders by Feb. 6.

Brighton.—The Council invite tenders for the overhead trolley construction and equipment on the whole of the tramway routes. Tenders by Feb. 14. Details in our advertisement columns.

Wigan.—The Electric Light and Tramways Committee invite tenders for dynamos, Korting condensers, switchboards, etc. Tenders by Feb 2. Full details in our advertisement columns.

Bradford.—The Tramways Committee of the Corporation invite tenders for the complete electrical overhead equipment of over five miles of tramway. Tenders by Feb. 2. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Canterbury.—The Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 30. Details in our advertisement columns.

Tynemouth.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Tynemouth, of one 450-kw. steam dynamo. Tenders by Jan. 31. Details in our advertisement columns.

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Beckenham.—The Council invite tenders for boilers, steam alternator and combined engine dynamo and motor, pipework, batteries, and switchboard. Tenders by Feb. 25. Details in our advertisement columns.

Hull.—The Works Committee of the Corporation invite tenders for the supply of one multipolar generator, to be coupled direct to a Belliss high-speed engine. Tenders by Feb. 8. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of boilers, with mountings, gangway, feed and drain pipes, etc., complete. Tenders by Feb. 15. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for the supply and installation of the complete motor and electrical plant of the central station of the town electrical works. Tenders by April 1. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Long Eaton.—The Urban District Council invite tenders for producers, gas-engines, dynamos, switchboard, feeder and distribution cables, and conversion of street lamps. Tenders by Feb. 18. Details in our advertisement columns.

Stirling.—The Town Council invite tenders for engines and dynamos (first extension), two sets each of about 350 h.p., and Lancashire boilers (first extension), 28ft. long and 8ft. diameter. Tenders by Feb. 15. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for coal conveyor and elevators and coal-discharging plant, including hoist, automatic weighing machine, tower, and bridge over roadway. Tenders by Feb. 21. Details in our advertisement columns.

Wallasey.—The Urban District Council invite tenders for the erection and completion of car-sheds, stores, workshops, and dwellings at their tramway depôt, Seaview-road, Liscard, Wallasey. Tenders by Feb. 21. Details in our advertisement columns.

Eastbourne.—The Electric Light Committee invite tenders for the erection and completion of a proposed electric lighting station, with administration block. Plans, etc., may be seen at the Borough Engineer's Office, Town Hall, Eastbourne. Tenders by Feb. 4.

Batley.—The Corporation invite tenders for the supply, delivery, and erection at the proposed electricity works of three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Feb. 9. Details in our advertisement columns.

Halifax.—Tenders are invited for the electric light installation required at three houses, Manor Heath. Plans can be seen and specification obtained at the offices of Messrs. Richard Horsfall and Son, architects, etc., 22A, Commercial-street, Halifax. Tenders by 4 p.m. on 28th inst.

Wallasey.—The Urban District Council invite tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. Tenders by Feb. 21. Details in our advertisement columns.

Bournemouth.—The Corporation invite tenders for the supply of three steam dynamos and two steam-driven surface condensers, and other works in connection therewith. Specifications, etc., may be obtained of Mr. F. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by March 2.

Luton.—The Town Council invite tenders for wiring for electric lighting purposes the Council-chamber, town hall, free library, corn exchange, and baths. Sketches of designs and full details of the proposed works to be given. Further information can be obtained of the Borough Engineer. Tenders by March 4.

Islington.—The Electric Lighting Committee invite tenders for the erection of a water-tower, tanks, and sundry additions to the central electric lighting station, Eden grove, Holloway, N. Plans, etc., may be seen at the office of Mr. A. Hessell Tiltman, F.R.I.B.A., 51, Russell-square, W.C. Tenders by Feb. 12.

Wimbledon.—The Urban District Council invite tenders for the supply and erection of steam and exhaust pipes, etc., and the moving of two boilers, feed pumps, feed-water heater, and storage tank, an independent surface-condensing plant, and two water-tube boilers. Tenders by Feb. 18. Details in our advertisement columns.

Poplar.—The Guardians invite tenders for the provision and construction of the necessary brickwork flues, and settings, etc., for two Lancashire boilers (28ft. by 6ft. 6in.), and an economiser about to be erected at the new buildings in course of construction adjoining the union buildings in High-street, Poplar. Tenders by Feb. 6. Details in our advertisement columns.

Southwark.—The Electric Light Committee invite tenders for the supply and erection of the following plant for their electric light station at Penrose-street, Walworth-road, S.E.: (Section A) One 400-kw. high-speed engine and dynamo and accessories; (B) two water-tube boilers, fitted with mechanical stokers, and extension to the steam and water mains. Tenders by Feb. 18. Details in our advertisement columns.

Huelva (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's ambassador at Madrid, stating that tenders are invited by the Spanish Government not later than Feb. 21 for the establishment of a telephone system in the city of Huelva. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Glasgow.—The Corporation invite tenders for the supply of the following material: (1) 1,000, 2,000, or 3,000 tons steel straight track rails, 100, 200, or 300 tons steel curved rails, 50, 100, or 150 tons steel fishplates; (2) 50 tons steel tiebars. The rails and fishplates will be a separate contract from the tiebars. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Feb. 22.

Valletta (Malta).—Tenders will be received at the office of the Receiver-General and Director of Contracts, Valletta, until 11 a.m. on Feb. 15 for supply of 75,000 arc lamp carbons. Tenderers in England not having a representative in Malta are to deposit with the Crown Agents the sum of £50 as surety. The tenderer whose tender will be accepted may be compelled to carry out the obligations arising from his tender, notwithstanding that he may not have signed the contract. Particulars, specifications, etc., may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

RESULTS OF TENDERS

Greenwich.—The Guardians have accepted the tender of Messrs. Robert Dawson and Co., Limited, of the Hartley Works, Stalybridge, London, and Glasgow, for the electric lighting of the Grove Park Workhouse.

Nuneaton.—The Nuneaton and Chilvers Coton Urban District Council have received the following tenders for the erection of a new electric lighting station, comprising engine-house, boiler-house, accommodation-room, etc.:

W. Cunliffe, Kingston-on-Thames	£2 873 6 8
J. Shilton, Nuneaton	2,825 16 6
J. Dalton, Blackheath, Staffs	2,530 0 0
T. Smith, Nuneaton (accepted)	2,509 11 0

Brighton.—The tender of the Union Cable Company, 23, College-hill, Cannon-street, E.C., agents for the German Berlin Cable Works, to supply, deliver, and maintain such quantities of cable, of the several sizes and descriptions specified in the amended specification annexed to such tender, as may be ordered of them by the electrical engineer during the year ending Dec. 31, 1901, at a total of £11,986, has been accepted, subject to the sureties proposed by the contractors for the due performance of the contract being approved by the committee.

BUSINESS NOTES.

TRACTION.

Keighley.—The tramways have been sold to the Corporation for £8,900.

Luton.—The Town Council are considering the question of applying for a tramways provisional order for the borough and district.

Hurst.—The District Council have resolved to apply for sanction to borrow £13,538. 8s. 9d. for the purpose of the proposed tramways.

Farnworth.—The Urban District Council have now placed the contract for the tramcars to the specification of Messrs. Lacey, Clirehugh, and Sillar.

North London Tramways.—The company have informed the London County Council that they are not prepared to name any price for the surrender of their lease.

Brighton.—The Town Council have approved the specification prepared by the tramways engineer for the overhead trolley equipment of the tramways. Tenders are invited.

Hampton.—In connection with the London United Tramways Company's Bill, the District Council have resolved to present a memorial to Parliament in order to secure a *locus standi*.

Queensbury.—It is expected that the new tramline from Bradford to Queensbury will be ready for running by Whitsuntide. A large number of men and horses are at present engaged on the work.

Haslingden.—In connection with the question of local tramways, the Town Council have received letters from the town clerks of Rawtenstall and Accrington. These have been dealt with in private council.

Folkestone.—The last meeting of the Chamber of Commerce discussed the tramways question. It was stated that although the Corporation were applying for the conduit system, Cheriton might adopt some other system.

Whitehaven.—The Rural District Council have passed a resolution *re* the West Cumberland electric tramways, approving of "anything that will afford facilities to the public of travelling from one end of the district to the other."

Dublin.—Last week an enquiry was concluded at Bray into the engineering merits of the proposed Dublin, Scalp, and Enniskerry tramways and Bray tramways. The inspector will submit his report to the Board of Works in due course.

Dunkerque.—The horse trams are about to be replaced by vehicles drawn by electricity. The only mishap in connection with the trolley system since its establishment occurred in 1899 on the Boulevard du Jardin-Botanique, owing to the breakage of a cable.

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Central London Railway.—Lord Rayleigh's Committee, which is to consider the vibration question, held meetings on Friday and Thursday last. At the first meeting nothing but procedure was discussed. The procedings yesterday were too late for us to report in this issue.

Houghton-le-Spring.—At a meeting of the Tramways Committee various details in regard to the management of the system were settled. It was decided to go over the extension routes to decide questions relating to pavement, and also as to when the work should be commenced.

Watford.—The Rural District Council have received a copy of the resolution passed by the Rickmansworth Rural Parish Council expressing themselves in favour of the tramways scheme, provided that the line were taken over Scott's Hill, and were extended to Mill End within two years.

Southampton.—Arrangements are now nearly complete for the commencement of the tramways extension through St. Mary-street and district, which, by resolution of the Town Council, has to be paved with wood blocks. In connection with the work application is to be made to borrow £3,998.

Ayr.—A start was made on Monday with the work of forming the permanent way for the electric tramways. The causeways for the width of a single line were lifted from the whole length of the new bridge, and a considerable portion of the track was laid with cement. The progress of the work was watched with considerable interest.

Metropolitan Railway.—We hear that Sir Wm. Preece, who has just returned from Budapest, where he has been inspecting the Ganz electric railway on behalf of the Metropolitan Railway, will present his report shortly. Pending this, he does not consider it right to make any statement as to the result of his enquiries.

Halifax.—The Burnley-road section of the tramways was further extended on Thursday, when the cars ran beyond Tuel-lane top to Friendly. The fare from Tuel-lane to Friendly will be 1d., so that from Halifax to Friendly will be 3d., but only the same fare will be charged to Luddenden Foot when the line is opened thus far.

Burnley.—The Town Council have passed a resolution to authorise the Tramways Committee, in the event of difference between the Corporation and the Burnley and District Tramways Company, Limited, as to the value of the company's undertaking, to apply to the Board of Trade for the nomination of a referee to determine such value.

Wolverhampton.—On Saturday the British Electric Traction Company, Limited, issued a notice stating that the service of steam-cars between the depôt at Sedgley and Wolverhampton would be discontinued for the purpose of electrically equipping the line. The electric cars to and from Dudley and the depôt will continue to run as usual.

Dulwich.—A committee, consisting of owners and occupiers of property in Dulwich who are of opinion that the proposed tramway is not needed, and would tend to destroy the quiet and suburban character of the neighbourhood, has been formed with the object of ascertaining the opinion of the residents with regard to the proposal of the London County Council.

Blackpool.—On Monday an enquiry was held with respect to the application of the Council for the sanction of the Board of Trade to the borrowing of £76,780 for the construction and equipment of a portion of the electric tramways, and also the sum of £5,500 for the building of an accumulator-house, offices, and car-shed. The tramway is to run round the district of Marton, and is a little over two miles in length.

Gildersome.—The District Council have received a copy of a resolution adopted by the Farnley Independent Labour Party calling upon local authorities to oppose the applications of syndicates for provisional powers for the supply of electrical power and the construction of tramways, on the ground that any benefit which was derived from such undertakings should go to the inhabitants and not to private individuals.

Islington.—With regard to the proposal of the City and South London Railway Company to construct from their Torrens-street (City-road) Station to the Royal Agricultural Hall a subway for foot passengers, the Parliamentary Committee of the Borough Council have directed the surveyor to report as to the technical details, and they recommend that meanwhile the Council should lodge a petition against the company's Bill.

Liverpool Overhead Railway Co.—The accounts of this Company for the past half-year show an available balance of £15,829, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 3½ per cent. per annum on the ordinary shares against 5 per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward, £4,080; against, £4,592.

Aberdeen.—On the question of the railway crossings over South Market-street to the premises of the Caledonian and Great Northern Companies coming before the meeting of the Streets Committee last week, the convener of the Tramways Committee explained that his committee were anxious that if the crossings were approved, such approval should be granted without prejudice to the Council at some future time asking parliamentary powers to extend the tramway system to Torry. The suggestion was adopted.

Leeds.—It was decided at a meeting of the Tramways Committee on Monday to visit Accommodation-road on Monday next with a view to arranging for the extension of the tramway line from Park-road to Easy-road. In the event of the scheme being sanctioned, horse cars will be put on the new route until such time as the line is equipped for electric traction. The committee have acceded to an application by the tramway employés for a grant in aid of the recreation-room and club that they have lately established.

Worthing.—The Electricity Committee are making very satisfactory progress with the preliminary negotiations in connection with the electric trams. Two firms at least are understood to have offered to equip and maintain a comprehensive and up-to-date system of electric tramways in the borough, and one of the firms is also willing to go further and extend the system to Arundel and Shoreham. The current required would be taken from the Corporation at an agreed price. The length of the lease has been put at 30 years.

Dundee.—At the meeting of the Tramways Committee this week, it was agreed that there was no foundation for the objections of the North British and the Caledonian Railway Companies and of certain private persons to the new tramways provisional order. It was resolved that free tickets for the tramcars should be issued to councillors. The question of workmen's fares is under consideration. The committee were of opinion with regard to lighting the tops of electric cars, that everything was being done that could be reasonably expected.

Sunderland.—The intention is, we understand, to open the electric tramway routes which are approaching completion—Hylton-road, Southwick, and Hendon—simultaneously. It is expected that all will be ready by the end of the month. It is probable that the committee will shortly have to consider an organised demand for an increase of wages from some of its employés. The conductors are paid 22s. 6d. a week, less shortages, The conductors are in some instances of the opinion that the amount they get is not a living wage. The motormen get 30s., with a rise to 32s. 6d.

Norwich.—At the last Town Council meeting, on the proposal that a special committee be appointed to report at the next Council meeting as to the best way of securing a roadway not less than 20ft. wide on the east side of Orford-place, free of tramway lines, the matter was referred to the Tramways Committee. At the Town Council meeting last week the Town Clerk read a report by the city engineer upon the cost of the work done by the Corporation in connection with the tramways, and it was stated that the total cost of the new streets and street widenings was about £95,000. The proportion falling upon the Corporation was £53,886.

Newcastle.—At the beginning of the week a commencement was made with the construction of the new tramways in Grainger-street, Newcastle, at the junction with Market-street. At the meeting of the General Purposes Committee last Friday plans were submitted and arrangements made authorising the engineer to deal with the North-Eastern Railway Company in diverting the tramway traffic in new Bridge-street during the alterations for making a new line of railway across that thoroughfare. Arrangements are also in progress to divert the traffic over different sections of the new lines during the time the remainder of the lines are being laid down in the heart of the city.

Paisley.—A special meeting of the Town Council was held on Tuesday to confer with Mr. Murphy regarding the proposals embraced in the new Paisley and District Tramway Bill promoted by him. Amongst the conditions under which the Council would agree to support the Bill were these: that the terms of purchase be the same as last year; that the former agreements be incorporated in the measure as far as possible; and that the portion of the tramway between the Cross and the east terminus be withdrawn from the Bill, Mr. Murphy at the same time to have running powers over this portion of the lines. Mr. Murphy having agreed to certain modifications, the Council adjourned to considers his offers.

St. Marylebone.—The Parliamentary Committee have presented a report to the Borough Council on deposited plans in connection with the Charing Cross, Euston, and Hampstead Railway, the London County Council tramways and street widening, the London United Tramways, and the West and South London Junction Railway. The committee recommended the Council to present a petition in Parliament against each of the Bills promoted by the companies in order to be able to protect the interests of the borough in the matter. The Council were also recommended to petition against the Metropolitan Railway Company's Bill providing for the revival and extension of time for the compulsory purchase of lands and construction of works under their Acts of 1896 and 1898.

Brighton and Rottingdean Seashore Electric Tramroad Co.—The Corporation of Brighton have decided to cause to be removed so much of the tramroad of this Company as shall be necessary to enable to be carried out the work of erecting an additional groyne opposite the west side of Lewes-crescent to the full extent and the extension of the existing groynes opposite Eaton-place and Chichester-terrace, in respect of which the surveyor has received instruction to prepare an estimate of cost, etc. We are informed that to take the rails further out to sea would put them into much deeper water, making a very expensive alteration, and negotiations are now in progress to extend Volk's electric railway to the eastern boundary of the borough, and remove the part of the seashore railway within the borough, the two lines connecting at the boundary.

Richmond.—It is rumoured that a new tramway scheme is occupying the attention of the Town Council. Shortly, it is that electric tramways for Richmond, Mortlake, and Barnes should be

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constructed, under agreement with the Richmond Town Council and the Barnes District Council, at the instance of the Richmond Electric Light and Power Company, with a purchase clause to enable the Councils to take over the undertaking at the time that the Richmond electric lighting concern becomes purchaseable. The work would not actually be done by the electric light company, but by a new company to be formed for the purpose under their auspices, the existing company to supply the motive power from their works. It is reported that the promoters are prepared to take over the existing line, from Richmond to Kew, as soon as it falls into the hands of the Town Council, and they will be willing either to maintain it as it is, or apply electric traction to it.

Rome to Naples Electric Railway.—Although it is said that the scheme for the construction of an electric railway between Rome and Naples has been temporarily postponed, the German Consul at Naples thinks it worth the attention of persons and firms interested in the construction of such railways. He reports that a plan has been worked out by the Neapolitan engineers Ferrara and Guerra and submitted to the Minister of Public Works for investigation. The projected line, which was originally suggested by the King of Italy, will have a double track, and will run along the coast line through Cancello, Mondragone Minturno, Garigliano, Formia, Fondi, Terracina, and Cistirna to Rome. A branch line *vid* Marano-Quagliano will connect it with Capodimonte, the Royal summer residence in the mountains. The total length of the proposed line will be about 215 km. (134 miles); curves and inclines will be avoided as far as possible. The address of the engineers mentioned above is 2, Vicolette Berio, Naples.

London County Council.—The report of the Highways Committee recommends that the resolution of the Council of July last year, so far as it relates to application for parliamentary powers for the construction of a tramway from St. John's-hill, Clapham Junction, to the Surrey Tavern, be not further acted upon. With regard to the proposed extension of the tramways from the present terminus at Tooting to the county boundary, however, the committee recommend that the scheme be proceeded with. It was originally expected that this extension would be worked in conjunction with the tramways in respect of which the Wimbledon Urban District Council contemplated obtaining powers. The Wimbledon Council, however, have decided not to proceed with the proposal for the present. The committee consider that the extension from the Tooting terminus will be advantageous, inasmuch as it will enable improvements to be effected in the existing tramway service.

Darlington.—Speaking at the Northgate Assembly Hall last Saturday, Councillor A. Henderson said that by this time they ought to have had a system of tramways different from the one now possessed. During the past few weeks the services of one of the leading experts on the subject—Prof. Kennedy—had been taken. He had issued his report, and that was in favour of the ratepayers owning and working their trams. Notwithstanding, however, that favourable report, there was still a disposition on the part of some of the members of the Council to hand over this valuable asset to the Imperial Tramways Company. He trusted that the ratepayers of Darlington would withhold their support from this. They could put down three main lines—from the Market-place to Harrowgate-hill, to Eastbourne, and to Cockerton—for between £60 000 and £70,000, which would at the most mean an increase of 6d. in the pound. That did not mean that they were going to have that increase always, for there were loans to the extent of £20,000 that were falling in within the next six years, and that meant 2d. in the pound as a set off. He urged the ratepayers to look after their own interests and see that negotiations with the company were broken off.

Barrow.—It is reported that at a meeting of the General Purposes Committee last Friday the tramway company proposed to sell their undertaking to the Corporation for £30,000. If this sum were accepted the company would agree to run the trams on a three years' lease, and at the expiration of that time, if they felt so disposed, the company would renew the lease for a further length of time. The Corporation, in addition, were asked to thoroughly equip the line, and put down a proper system, and during the three years' lease they would guarantee a percentage. The Corporation, however, decided to take no further steps in the matter. It is said that supposing the Corporation had bought the line on the terms offered, and had agreed to run a 10 minutes' service, each car would have had to take 17 passengers to pay interest and redemption, without taking into consideration the wear and tear on line and stock. The tramways company are bound by their order to supply a reasonable tram service, the minimum number of runs to each terminus being 12 each way per day, Sundays and other days excepted. This section of the order applies to that portion of the system other than that on Barrow Island, where the provisions are of a different nature. It is probable that some alteration may be made in the service of cars, but there does not appear to be any possibility of the trams ceasing altogether.

Nottingham.—Good progress is being made with the Bulwell section of the electric tramways. The line is practically complete from the Bulwell Market-place to the Basford gasworks, which is close to the old tram terminus. No poles for the electric service have as yet been placed in position, but the poles will be fixed at the side of the road, and will thus obviate any disturbance of the roadway. In the Alfreton-road however, which is of ample width, the poles are to be erected in the centre. Whether they will be used for electric lighting as well has not yet been decided. With the exception of Chapel Bar, the whole of the section from the Great Market-place to the Bulwell Market place will consist of a double line, but no commencement will be made with the running of the electric cars until the whole of the section is complete, the same method being followed in this direction as in the case of the Sherwood route. The cars will be similar in description to the Sherwood ones, and will carry the same number of passengers. The power for working the Bulwell section will also be derived from the present electric lighting station, the plant for which is now being laid down. It is hoped that the new trams may commence running by the end of May. Whereas the present electric cars accommodate only 56 persons, it is intended that the new Trent Bridge cars shall be capable of seating 75. It is, however, improbable that any electric cars will be running down to Trent Bridge this year.

Manchester-Liverpool Electric Express.—The engineers of this proposed railway have prepared for Parliament a detailed estimate of the cost of the scheme, as it will be put forward during the ensuing session. The total length of the proposed railway from its commencement on the west side of Deansgate to its termination in Liverpool, near the entrance gates of the Blue Coat Hospital in School-lane, is 34 miles 3 furlongs 3 chains. Owing to the route followed, it is one furlong shorter than the scheme of last year. The estimated cost of construction is £1,776,821, as compared with £1,748,940, which was the estimate of last year's scheme. The details of this estimate show that the scheme, as now put forward, is, from an engineer's point of view, materially different to the rejected scheme. The cost per mile for laying the permanent way, which last year was put at £18,000 per mile, is now reduced to £13,500, and the cost of the stations, which was estimated at £67,600, is now brought down to £30,000. The cost of viaducts, which under last year's scheme would have absorbed £175,300, is now put at only £72,868, whilst tunnelling is also reduced from £61,200 to £55,360. The savings effected by these alterations are more than absorbed by public improvements. Thus, in the place of 48 bridges over or under public roads, estimated to cost £36,200, it is now proposed to provide 108 bridges at a cost of £120,410, whilst accommodation bridges, which were estimated to require the expenditure of £44,340, will now be put up at a cost of £80,750. Although 30 acres less land will be required for the new scheme, the cost of acquiring it is estimated to absorb £588,515, as compared with £451,600. The capital required to be raised for the new scheme is £2 100,000, which is an increase of £100,000 compared with the rejected scheme.

Charing Cross, Euston, and Hampstead Railway.—In view of inaccurate statements having been made with regard to the extension of the company's authorised line to Golder's Green, Messrs. Douglas Fox and Co., the engineers to the railway company, make public the following facts in a letter to the *Times*: "The company is absolutely prohibited by a clause in the Bill from opening up or using any of the surface of Hampstead Heath. The total length of the line under the Heath proper and the Avenue is about 320 yards Of this distance over 200 yards are under roadways. At no point under the Heath is the depth from the surface to the top of the tunnel, as shown on the deposited plans, less than 150ft. from the surface, and under the Avenue it is nowhere less than 120ft. The tunnel will be constructed under the Heath and the Avenue deep in the London clay. There will consequently be no risk of draining the Heath, or of injuring the trees or grass. It is proposed that the railway be worked by means of light motors on the carriages and not with heavy locomotives. There will therefore, be no danger of vibration. It is proposed, subject to parliamentary sanction, to acquire private property adjacent to Jack Straw's Castle for a passenger station. Care will be taken in every way that the elevation of the station buildings shall harmonise with the adjacent property. It is proposed that the railway should connect with the North-Western Railway at Euston Station and with the Central London Railway at Tottenham Court-road (thus giving access to the East and West of London with the Brompton and Waterloo Railway, and the South-Eastern Railway at Charing Cross, and also with the Midland Railway at Kentish Town) The time taken from Hampstead to Charing Cross will not exceed 20 minutes, and trains will run every five minutes, or oftener if necessary. It is not intended to erect any hotel on the Heath. While the local opponents have raised many objections to the proposed extensions, they have omitted to point out that at the present time the company have the right to construct a generating station at the junction of Heath-street and High-street." Supposing the fears which have been expressed by the residents had any foundation in fact, the letter proceeds: "Would it not be wiser for them to concur in the removal of the generating station from their midst to a distance of a mile northward of the summit of the Heath? In connection with this extension, it has been found possible to lower the levels of the authorised railway, thereby improving the gradient and placing the tunnels deep in the London clay, instead of, as authorised, in the overlying water-bearing strata of sand and gravel."

Tube Railways.—On Tuesday Mr. Alban G. H. Gibbs, M.P., presided, in the absence of Alderman Sir Horatio Davies, M.P., over an influential meeting of the owners and occupiers of property in Bishopsgate and the neighbourhood, to take measures for mutual self-protection in view of pending applications to Parliament by the Central London and other railway companies. The Chairman said they were all aware that there were at that moment three projects to run tube railways through Bishopsgate, which meant six tubes running below the street, and they had all heard from the people who had the misfortune to live near the Central London Railway how their houses had been shaken and their comfort destroyed. He did not suppose they would go so far as to say that under no circumstances would they have a tube railway near them, but they were entitled to say to the companies

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"If you do damage to our property, you must pay for it." After the evidence which experts had given respecting the total absence of vibration in the case of the Central London Railway when the Bill was before the committee, he hardly thought they would be content with such statements again, and what was required was the insertion of a clause in any new Act of Parliament which would make provision for compensation for damage. The great fight would be in committee, and it was necessary to subscribe the requisite funds so that counsel might be employed. Mr. F. G. Fitch announced that £1,000 would be required, and that £450 had already been subscribed. A resolution was unanimously adopted protesting against the scheme unless proper clauses were inserted in the Bill to protect the interests of the owners and occupiers of property in the neighbourhood. A further resolution was passed appointing a committee. Many subscriptions were added to the fund. A joint vestry meeting of the united parishes of St. Mildred, Broad-street, and St. Margaret Moses was held in the vestry-room of St. Mildred's Church on Wednesday last week to consider the notices, plans, and books of reference deposited by the promoters of four tubular railways proposed to be made through the parishes, and known as the North East London Railway, the Victoria, City, and Southern Electric Railway, the City and West-end Railway, and the Piccadilly and City Railway. It was resolved: "That, considering the serious damage and great annoyance caused by the Central London Railway, this united vestry is of opinion that none of the proposed Bills for tubular railways through these parishes should be allowed to pass until further experience has been obtained as to the effect of underground electric railways upon surface property, and what alterations in the conditions of working or in structure can be devised to remedy noise and vibration arising therefrom, and that in any case proper clauses should be inserted for providing compensation for damage."

LIGHTING AND GENERAL.

Harrogate—Several new mains are to be laid before Easter.

Share Market.—Electric shares were steady during the week, but very little business was done.

Swansea.—The County Council's agreement with the National Wiring Company has been signed.

Surbiton.—The District Council intend to apply for a loan of £50,000 for purposes of electric lighting.

Abersychan—The Urban District Council have decided to apply for an electric lighting provisional order.

Dumbarton.—The Town Council have petitioned against the schemes of the Caledonian Electric Power Company and the Clyde Valley Electric Power.

Barnsley.—A further number of arc and incandescent lamps are to be erected in various streets in order to replace 20 Bray's and 28 ordinary lamps.

Kilsyth—The Town Council have decided to petition against the provisional order sought by the Caledonian Electric Power Company to erect works in the parish.

Kingston (Surrey).—We are pleased to note that there was less opposition than we anticipated at the recent enquiry into the Corporation's application to borrow £17,800 for electric lighting extensions.

Whickham—It was reported at the Urban District Council meeting last week, that the National Telephone Company were now prepared to put in an exchange at Whickham if they could get six subscribers.

Birmingham.—The Corporation have, at the suggestion of the National Telephone Company, appointed a sub committee to discuss the causes leading to the complaints which are being made about their service.

Liverpool.—The substitution of electric for hydraulic haulage power on the quays and warehouses bordering on the Mersey is being suggested The scheme has not yet been seriously entertained by the Dock Board.

Croydon—The Lighting and Electricity Committee have arranged to allow interest at the rate of 3 per cent. per annum upon deposits made by intending consumers or others in connection with electric lighting or motive power.

Johannesburg.—As a result of the attack of Boers at Brakpan, three out of the four dynamos at the electric lighting station have been destroyed. As a result many of the suburbs of Johannesburg were in complete darkness on Tuesday.

Post Office Electric Sparks Minstrels.—The above troupe held their twelfth annual concert at Hope Hall, Liverpool, on Saturday evening, under the presidency of Mr. C. Nottingham, assistant superintendent of telegraphs

Stock Exchange.—The Stock Exchange Committee has appointed Jan. 30 a special settling day for the County of London and Brush Provincial Electric Lighting Company, Limited, further issue of £100,000 4½ per cent. debenture stock.

Canterbury.—At last week's meeting of the General Purposes Committee it was stated that the electric lighting undertaking had made a profit on the last quarter's trading of £268 so that the undertaking had not been a charge on the rates, but a profit.

Mansfield.—Steps are being taken to execute an electric lighting scheme and to obtain a site for works in Rock Valley, belonging to the Duke of Portland. The Midland Railway Company are to be approached with the object of getting a siding into the works.

St. James's and Pall Mall Electric Co.—The directors recommend a dividend for the half-year ended 31st ult. of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making, with the interim dividend, a distribution of 12½ per cent. and a bonus of 2 per cent. for the year.

Dalkeith.—The Commissioners have resolved definitely to approve of the application of Messrs. Crompton and Co. for a provisional order under the Electric Lighting Acts, 1882 to 1899, and to consult Mr. Campbell Swinton as to the arrangement of the arc and incandescent lamps.

Dukinfield—On Monday evening a special meeting of the Town Council decided to abandon the idea of utilising the Flatts in Stalybridge as a site for the generating station, and the representatives of the Corporation were requested to look at and support the selection of some more suitable site.

Annual Dinner.—The workmen of the Stockport Gas and Electrical Works held their annual dinner at the White Lion Hotel on Friday evening, when about 150 attended. After dinner Councillor William Johnson took the chair, assisted by Harold Copp (the assistant engineer) as vice chair.

Yorkshire.—The Farsley and the Bingley District Councils have decided to join with other local authorities in opposing the Yorkshire Electric Power Bill, and to ask the County Council if they were disposed to promote a scheme for providing all the local authorities in the West Riding with electric power.

Huddersfield.—There are now 1,331 consumers (249 more than in January, 1900), and it has been decided to reduce the charge to 1d. per unit if the consumers of energy for motive power will guarantee a consumption equal to three-quarters of the full load of appliances for not fewer than 1,200 hours per half year.

Folkestone—The Chamber of Commerce have been asked by the Margate Chamber of Commerce to co-operate with them in endeavouring to get certain defects in the telephone system remedied. It appears that the Margate Chamber had communicated with the National Telephone Company, who threw the onus on the Post Office authorities.

Montrose—The report of the Lighting Committee, which has been adopted, recommends the Council to adopt Scheme E, which provides for the erection of 20 arc lamps, at an estimated cost of £284. 12s. Two arc lamps are to be lit from 5.30 p.m. to 6 a.m. during the winter months, at an extra cost of £24, and a number of arc lamps will be erected at different points before deciding on their exact permanent positions.

Wigan.—The formal opening of the combined electric lighting and traction station and of the Markland Mill Bridge section of the electric tramways was arranged to take place on Thursday last. Owing to the death of the Queen the proposed ceremony was abandoned. The trams will commence running regularly from to-day. The permanent way was inspected for the Board of Trade by Major Druitt, R.E., last week, and Mr. Trotter examined and passed the electrical arrangements on Tuesday last.

Eastbourne.—The agenda for the special meeting of the Town Council on Monday contained the following recommendation by the Electric Lighting Committee: "That application be made to the Local Government Board for power to borrow the amount required for the proposed new electric light station at Roselands, new transformers, plant, mains, and public arc lighting, etc.—viz., £50,882 as set forth in Mr. Hawtayne's revised estimate of Dec. 22, 1900, and included in paragraph 4 of the *Proceedings* of the Electric Light Committee at their meeting held on Jan. 8, 1901, in lieu of the resolution authorising application to the Local Government Board for power to borrow £33,412, passed by the Council on Oct. 22, 1900." On the suggestion of the Chairman, it was agreed that this matter should be withdrawn and brought up very speedily on a future occasion.

Kensington.—At a meeting of the Borough Council on Wednesday, the Notting Hill electric lighting scheme was discussed. Under this scheme one of the electric supply companies seek powers to acquire sites in Napier-road and Holland-mews, Kensington, for the erection of works for generating or distributing electricity. The Law and General Purposes Committee were of opinion considering the residential character of the district in which the selected sites were situated, that the scheme should be opposed by the Borough Council, unless the promoters would agree to the insertion of clauses in their Bill whereby the sites in question would not be used for generating stations, but be restricted to the purpose of storage and transforming stations. The Council decided to address a letter to the promoters intimating that unless they were prepared to consent to the insertion of clauses as above, the Bill would be opposed by the Council.

Walsall.—Instructions have been given that the maximum charge for current supplied for motor purposes is in future to be reckoned on 300 hours a quarter, instead of 340 as heretofore. At the meeting of the Council last week the resolution to apply for sanction to a loan of £3 000 was approved, and also the recommendation of the Finance Committee authorising the town clerk to raise on mortgage a sum not exceeding £20 048 for the purposes of the electric lighting undertaking. He said that this was necessary in order to pay for an extension upon which depended the success of the electric lighting undertaking The total amount they had spent up to Dec. 31 last was £29,385. 5s. 8d., and the outstanding loans and stock in respect of it amounted to £24,402. 14s. 6d. The total number of consumers supplied on Dec. 31 last was 169. The total units registered on the meters were 36,166. The machinery was run for 475 hours during the past month.

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Glasgow.—The Council have agreed that the centre-pole system in Great Western-road be adhered to; if that road be lit by electricity by means of the traction poles, the poles from Kelvin Bridge to Hyndland be so lit with 50 arc lamps of seven amperes each at an estimated annual cost of £670.

St. Marylebone.—At the meeting last evening the Council were recommended to present a petition to Parliament against the Marylebone Electric Supply Company's provisional order. The necessary notice has been given of the Council's application to the Board of Trade for an electric lighting provisional order.

Hampstead.—At the meeting of the Borough Council on Thursday last week, a letter was received from the Hendon Urban District Council stating that they were about to carry out a scheme of electric lighting for their district, and enquiring, before deciding upon the extent of the works, whether a supply of energy can be afforded by the Council for a term of years, and, if so, at what rate. The matter was referred to the Lighting Committee.

Southwark.—The Borough Council are proceeding with the cable extensions in the side streets, which had not been pressed forward in consequence of the delay in securing new generating plant. The laying of the cable through Doddington grove down to the Kennington Theatre is in progress, and on the completion of this work cables will be laid in Elephant-road, Rodney-road, Elstead-street, Alvey-street, Westmoreland-road, East-street, and a portion of Beresford-street.

Broadstairs and St. Peters.—The Urban District Council have been notified that the light railway company have paid the Board of Trade the necessary deposit of £1,000 under Clause 7 of the electric lighting order, and made all necessary arrangements for completing the lighting before next season. The plant for generating the light has been erected in the power-house at St. Peter's, and the laying of the distributing cables and erecting the public street lamps now only remains to be done.

Redditch.—At last week's meeting of the Urban District Council the electric lighting accounts were criticised, and it was stated that last year £3,000 had been spent upon the undertaking, and £2,000 received back, so that there was a loss of £1,000. The Chairman of the Lighting Committee pointed out what should have been evident, that it was most unreasonable that the ratepayers should expect the scheme to pay at so early a point in the work. He was quite satisfied that in a few years' time the scheme would pay.

Bradford.—As announced in our last issue, Mr. R. H. Bicknell held an enquiry last Friday into the proposal of the Corporation to borrow £140,000 for the extension of electric lighting facilities within the city. The Town Clerk stated that outstanding loans amounted to £1,295,162, of which £287,204 (£205,244 actually raised) was on electricity account. The total now applied for was £140,000, but it was impossible to separate the amount to be allocated to lighting from that required for traction purposes. Detailed plans and estimates were produced.

Horsham.—The Electric Lighting Committee have reported to the Urban District Council that they had gone through the list of suggested reductions in the quantities for the electric lighting stations, and the total estimate of the scheme now stood as follows: accepted tenders for plant and works, £8 710. 5s. 6d.; extra for extension of mains to new site, £46. 1s. 10d.; tenders for buildings, £2,909. 12s. 5d.; meters and house communications, £1,000; free wiring, £1,500; engineers and architects' fees, printing, and sundries, £1,040; purchase of land, £300—total, £15,505. 19s. 9d.

Eastern Telegraph Co.—The fifty-seventh half-yearly ordinary general meeting of this Company will be held on 28th inst., at 1 p.m., at Winchester House, to receive the directors' report and accounts, elect directors and auditors, and transact the ordinary business of the Company. An extraordinary general meeting will be held on the same day and at the same place, immediately on the conclusion of the ordinary general meeting above convened, for the purpose of considering, and, if thought fit, passing a resolution altering part of the articles of association referring to directors' remunerations.

Barnstaple.—The Town Council have received a supplementary report from Mr. W. P. Adams on the electric lighting. Details are given of three schemes. No. 1 provides for water-power and gas-engine plant with public lamps—the cost is set down at £26,320; income, £3,534; expenditure, £2,278; and profit, £756. The second scheme provides for water-power and steam-engine with public lamps, and the figures are £28,850, £3,534, £2,202, and £332 respectively. The third scheme provides for steam plant for 8,000 lamps, with public lamps, at £24,800, £3,434, £3,304, and £104 respectively.

Personal. — We understand that Mr. Norman Rogers, of Newark, who has been engaged at Messrs. Ransome's works, Beacon-hill, has been accepted for service in South Africa with the Electrical Engineers. He passed his examination this week, and the Government are urging the departure of the corps as speedily as possible. His father, Lieut.-Colonel E. Rogers (late Staff Officer of Pensioners), is the author of an interesting *brochure*, entitled "Royal Visits to Netley and Woolwich Hospitals," as well as "Campaigning in Western Africa and the Ashantee Invasion," "Machine-Rifle Batteries for Volunteers," "A Modern Sphinx," "Sportive Adventures at Home and Abroad," etc.

Dewsbury.—Recently the Corporation made large reductions in the rates for electric light. Consumers still pay on the Brighton rebate system, but the time during which electricity is charged for at 6d. is reduced from 1½ hours to one hour per day. The effect of this reduction will be that practically all consumers will benefit by the rebate, and the number of units to be charged for at 6d. will be one-third less than previously. The Corporation have also fixed considerably lower charges for meter rents. Towards the end of last year the mains were extended from Wellington-road to Westtown, and already there are 300 8-c.p. lights burning in this district. There are now 15,558 8-c.p. lamps in the borough, 2,530 having been added since March last year.

Dartford.—Tenders for the electric lighting scheme have been accepted, and the Council are desirous of raising the requisite loan of £20,000. The Public Works Loan Commissioners stated that they were unable to grant such a loan, owing to the limited funds placed at their disposal by Parliament having been largely drawn upon for other loans. Application was then made in turn to the Prudential Assurance Company and the Ecclesiastical Commissioners for a loan for 32 years if necessary, with the option for the Council to pay off the whole of the loan at any time. The former offered the loan at 3½ per cent., and the latter at 4 per cent., but both objected to the condition as to repayment at any time. The Council are considering in committee the feasibility of issuing public stock for the amount required.

Brighton.—The Workhouse Stock and Visiting Committee reported to the Guardians on Thursday last week that they had under consideration the letter from the Town Council, dated Sept. 16, 1900, with its report from Mr. John Christie, resident engineer of the Brighton Corporation electricity works, to the Lighting Committee of the Town Council relative to the lighting of the workhouse by electricity, which was referred to them by the Board on Sept. 18 last. Before reporting thereon, and with a view of obtaining further practical information, the committee applied to several electrical engineers enquiring upon what terms they would be prepared to inspect the workhouse premises and submit a scheme and report to them upon the question. After considerable discussion, it was resolved that Mr. G. R. Peers, of Manchester, be asked to report.

Cleethorpes.—At a recent meeting of the Electricity Committee of the Urban District Council the letter from Mr. J. Glenn, engineer to the tramways company, respecting proposed additions estimating to cost £415, to the plant of the power station proposed to be subsequently acquired by the Council, was discussed. The Council were asked to guarantee the sum before the work was put in hand, whether they acquired the plant for electric lighting purposes or not, as the additions would not be required for traction purposes. It was decided to instruct the surveyor, Mr. E. Rushton, to communicate with Mr. C. S. Vesey Brown, electrical expert to the Council. The committee have decided upon the positions to be occupied by the arc lamps from Park-street to Brighton-street, to be used in connection with the proposed electric lighting scheme for the town.

Norwich.—The Council's agreement with the Norwich Mutual Telephone Company, Limited, has been sealed by the company and a copy of it has been forwarded to the Postmaster-General, with a request that he will grant a license to the company to provide in Norwich exchange area a system of public telephonic communication upon the conditions of the agreement. An arrangement has also been made with the National Telephone Company, Limited, to embrace in one agreement (instead of several agreements) the whole of the overhead wayleaves granted from time to time to the company by the Corporation, consisting of poles on highways, attachments to sewer ventilating shafts and Corporation buildings, at rentals fixed by the committee and specified in the agreement, each wayleave being subject under the agreement to termination by three months' notice.

Llandudno.—The question of supplying current to the Lady Forester Convalescent Home was recently before the Urban District Council. The engineer read to the Council an estimate, charging 4½d. per unit, the minimum charge for 15,000 units for lighting purposes which he considered a fair average, the sum of £282. 7s. 6d. would be yielded, and this added to other charges for laundry and lift consumption would yield a total of £346. 2s. 6d. He estimated the cost of laying the cable, a length of 1,800 yards, at £765, and the expense in addition with other items would total at £847. 10s. The interest and repayment of loans at 10 per cent. would be £84. 14s., and the cost of production £166. 13s. 4d., a total cost of £251. 7s. 4d. This would leave a profit of £94. 15s. This offer will be communicated to the trustees, who had almost decided to put down machinery for the purpose themselves.

Newport.—"On Friday last a new class of defaulters appeared at the end of the Police Court's business. This was a group of four tradesmen and electric light users who had been remiss with the June to September quarter's accounts. In two cases payments on account had been made, and in all orders for payment forthwith were obtained. The total of the amounts for which the summary process of the law was invoked represents about the smallest coin of the realm as a percentage, there being a gross income for that quarter of about £2,800. June to September quarter is what is known as a light quarter; the heaviest quarter of the year, owing to November murkiness and December festivities, is the September to December quarter. In that quarter at Uskside there were equal to 40,000 8-c.p. lights in use, the eight-candle being the standard. The number of users totalled 475 to 480, and the quarter's gross income was £3,500, sufficient to encourage the Corporation to proceed with the much-needed development of their area." The *South Wales Daily News*, to which we are indebted for the above, asks what about the wiring of dwelling-houses on the deferred payment system?

Paisley.—We clip the following from the *Paisley Gazette*: "We understand that Mr. Francis Teague, burgh electrical engineer, has intimated his resignation to the Electric Lighting Committee

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of the Corporation. His letter of resignation, addressed to the town clerk, is as follows: 'Now that the action at my instance against Dr. Russell, a member of the Corporation Electricity Committee, has been satisfactorily disposed of by a jury, under the guidance of Lord M'Laren, it is my intention to quit the service of the Corporation, and I hereby tender my resignation of my appointment as Corporation electrical engineer, which will, of course, take effect, in terms of my engagement, on Feb 28 next. This step on my part has been in contemplation for some time past, and has been in the knowledge of certain members of my committee, but I have refrained from taking it until the disposal of the action against Dr. Russell in vindication of my good name and character. Allow me to take this opportunity of thanking the chairman and certain other members of the committee for their unfailing courtesy and kindness to me during my term of service with the Corporation.'"

Wrexham.—The new electric works at the Old Willow Brewery depôt are nearing completion, and they will soon be in readiness for a trial of the street arc lamps. The cost of the site has amounted to £8,200, and sanction has been obtained to the borrowing of £20,000 for the electric light installation and £2,000 for a refuse destructor. A considerable portion of the internal fittings and supports were taken over with the buildings, and wherever possible they have been utilised. On the ground floor have been put up two sets of Willans engines coupled to Lancashire dynamos, each of which will have an output of 125 kw. Steam will be generated by two Babcock boilers. These are fed by an automatic chain grate and stoker, and are capable of developing 200 h.p., each at a working pressure of 160lb. to the square inch. In the battery-room there are 270 accumulators. There are two switchboards, the larger one for distribution pure and simple. The smaller switchboard controls the entire street-lighting and the electricity station itself. In the streets there are in all 36 arc lamps of 2,000 c.p. each, and on the controlling board is a switch for each nine lamps, as well as a lever, controlling the whole 36, to extinguish the arc lamps at 11 p.m. and light the incandescent lamps instead.

Alfreton.—The Urban District Council have applied to the Board of Trade for a provisional order to enable it to supply electric light for public and private purposes in the Alfreton Ward. It is proposed at present to restrict the light to the Alfreton Ward, and for the ratepayers there to bear the expense of the scheme and also to derive any profits which may accrue from it. The application of the Council, however, embraces the whole of the parish, so that should it be necessary at a future time to extend the light, power to do so will have been obtained. The scheme is estimated to cost £13,500, including £1 000 for free wiring into private houses. Objection has been lodged on behalf of some ratepayers, who claim that there is not a sufficient demand for electricity within the district to justify the expenditure contemplated, and that therefore it would be a burden on ratepayers who do not desire electric light and would not derive any benefit from it. However, some time ago a vote was taken of the ratepayers in the ward, with the result that a majority decided in favour of the electric light. The Alfreton Gaslight and Coke Company have also lodged an objection to the provisional order, urging that should the application of the Council be adopted the gas lamps in the street would be thrown upon the hands of the company.

Indiarubber.—Prices in the indiarubber market during the past year have undergone great fluctuations. Closing prices show a decline from last January of 8d. to 9d. per pound on fine Para, 9d. to 10d. on scrappy negrohead, 6d. on Cametas and Island negrohead. The supply of all medium rubbers has been large, and prices generally show a decline of 6d. to 9d. per pound for the year. The supply from Brazil continues to increase, and is the main supply. Peruvian rubber has largely increased; much of the ball was poor quality and not liked. Bolivia sent less, but quality was good, and it met a ready sale. From Venezuela there have been trifling supplies. Ample supplies came from Central America, and owing to the war scarcely any from Columbia and Ecuador. Africa as a whole shows an increase of 1,000 tons. Rangoon exported less, but the quality was good; also Penang, but the shippers of these not accepting the current fall, the sales are much less. Assam was in reduced supply, and much of inferior quality; good demand. Borneo has sent a moderate supply, and fair quality. Pontianac came in large lots, and was irregular in price. French Cochin China and Lower China sent several parcels, arriving of fair quality but heated, which sold cheaply. From Ceylon reduced supplies sold well. A very small supply came from Java and New Guinea; the latter found much favour.

Private Bills.—The Examiners of Standing Order Proofs commenced their sittings on Friday last. The following unopposed Bills were passed: Metropolitan Railway and Metropolitan Electric Supply. The opposition to the Brompton and Piccadilly-circus Railway (Extensions) and Metropolitan District Railway Bills has been withdrawn. Consideration of the London County Council (Tramways and Street Widenings) Bill, which is opposed, has been deferred until Feb. 1. The consideration of several other Tramway Bills has also been put off to that date. At the second sitting of the committee there was no opposition in the case of the Brighton Corporation, the City and South London Railway, and the Islington and Euston Railway Bills. These measures will also be reported for first reading. The Kingston-upon-Thames Corporation Bill and the Victoria, City, and Southern Electric Railway Bill were marked on the list as "dead." It will be remembered that the object of the latter Bill was the construction of an electric railway on the tube principle from St. George's (Hanover-square) to Cannon-street, *viâ* Ludgate-hill, and thence to Camberwell, and Rye lane, Peckham. The promoters, whose names were set forth in the Bill, were Mr. Robert Jewell, Mr. R. H. Spence Browne, and Mr. Robert Roby Jewell, and the capital proposed to be raised was £3,300,000, with borrowing powers to the extent of £1,100,000.

Ormskirk.—The Guardians have received a report on the proposed electric lighting of the workhouse from Mr. G. R. Peers, of Manchester. The report stated that the number of lamps required to light the whole of the premises would be 611 of different candle-power, the total being equivalent to 400 lamps of 16-c.p. each. The estimate of cost was as follows: Engine-house accumulator-house, and alteration to existing boiler-house, £330; Cornish boiler, 18ft. long, 5ft. 6in. diameter, including fixing, £260; two engines and dynamos, 40 b.h.p. each foundation, piping and feed-water heater, booster for charging accumulator, £1,280; wiring, including underground cables, £900; accumulator and switchboard, £480; contingencies and engineering fees, £243—total, £3,493. The annual cost was estimated as follows: 40 tons of coal at 12s. per ton, £24; extra wages of engineer, 10s. a week, £26. 10s.; oil, waste, and water, 2 per cent. on coal account, £4. 8s.; renewal of lamps, £10; interest and sinking fund, calculated at 6 per cent., £209. 10s.—total, £274 8s. In a supplementary report, Mr. Peers went into the question of the application of electric power to the pumping of water at the workhouse. He found that the amount of coal used for this purpose was 14cwt. per day, which at 14s. per ton equalled £3. 10s. per week, to which must be added the wages of the engineer. He estimated if an electric lighting plant was put down, the surplus energy in the daytime, when the engine was charging the accumulators, could be used for driving an electrically driven pump, which could be controlled from the lighting station. The cost would be about 6s. per day, or £2. 2s. per week - a saving of £73 per annum. At the next meeting it will be proposed that the report of Mr. Peers be adopted and the work proceeded with.

London County Council.—The Council have agreed to the following applications for extensions of mains, etc.: Brompton and Kensington Electricity Supply Company (low-tension mains along a portion of Cranley-place); County of London and Brush Provincial Electric Lighting Company (low-tension mains along both sides of New Church-road, and in Southampton-street, Bonneville-road (both sides), Abeville-road and to lay high and low tension mains and construct a transformer box in Wharf-road, St. Luke's); Notting Hill Electric Lighting Company (mains along portions of Kensington-road and Argyll-road); St. Pancras Borough Council (mains along Southampton-villas, Highgate, Prince of Wales-crescent, along Regent's Park-road, across Gloucester-road and along Caversham-road, Highgate-road, and along and across Pratt-street, and across High street, Camden Town); Blackheath and Greenwich District Electric Light Company (low-tension mains along King George street, Hyde-vale, Royal-hill, Blisset-street, South-street, Blackheath-road, Lewisham-road, Albion street, and Connington-road); Brompton and Kensington Electricity Supply Company (to lay mains along a portion of Earl's Court road); Metropolitan Electric Supply Company (low-tension mains along Shaftesbury-avenue, across High-street, St. Giles, along Charing Cross-road, Little Earl street, Tower-street, St. Martin's lane and place, Great and Little Newport streets, Lisle-street, Cranbourn-street, Leicester-square, Chandos-street, King William-street, the Strand, Trafalgar-square, and Northumberland-avenue); Notting Hill Electric Light Company (to lay mains along portions of Gloucester-walk and Church-street). The Council have also received applications to lay a number of mains by the Hackney and Hampstead Borough Councils.

Haslingden.—At the meeting of the Town Council last Friday the Town Clerk read the following letter from the Lancashire Electric Power Company, in which some interesting figures are given: "Dear Sir,—I write to inform you that the Lancashire Electric Power Company are preparing plans for distributing electric energy in bulk, in accordance with the powers given in their Act of last session. The company is prepared to negotiate for a supply upon the following terms, which are 20 per cent. below the maximum rates which they are entitled to charge under the Act. Rates of charge for a supply in bulk: for a supply averaging 300 hours per quarter, 1·87d. per unit; 400 hours, 1·60d.; 500 hours, 1·44d.; 600 hours, 1·33d. The following figures show the cost per unit at which electric energy is generated by the various local authorities who have generating stations within the area of supply. The figures are calculated from the official returns for last year, and include interest on capital, etc., expended on generating plant, and a proportion of the expenses of management, but do not include the cost of distribution or the interest, etc., on the capital expended upon distributing mains. Cost of generating electric energy in those towns in Lancashire which have generating stations within the company's area: Southport, 2·23d.; Burnley, 2·40d.; Oldham, 2·50d.; Bolton, 2·59d.; St. Helens, 2·65d.; Nelson, 2·67d.; Bury, 2·69d.; Blackburn, 2·73d. It will be seen that in nearly every case a large saving would be made if a supply were taken from the company on the terms offered above. If this is the case in the larger towns, a still greater saving will be obtained by smaller places, where the generating costs must necessarily be greater. I shall be glad to know whether your Council is prepared to negotiate for a supply to their district, and shall be glad of an opportunity to furnish any further particulars." The matter will be considered at the next meeting.

Hackney.—The Borough Council last evening received the following report of the Electric Lighting Committee: "(Section A) We beg to submit to the Borough Council a pamphlet, prepared

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by the engineer, Mr. Hammond, on the electricity supply undertaking, as to its advantages, conditions, and cost of supply, together with the following forms—viz., general conditions of supply, form of preliminary application for supply, form of application for supply, form of requisition for supply to places outside the compulsory area. A copy of the pamphlet and forms have been supplied to each member of the Borough Council. We are of opinion that the best means of bringing the electric lighting of the borough before the inhabitants, and inducing them to take a supply, is by circulating these pamphlets and forms, which contain all details and particulars and indicate the method of proceeding to obtain the electric current on the premises. We beg to recommend that the pamphlets and forms be approved and adopted, and that a sufficient number be printed and circulated amongst the whole of the ratepayers by the rate collectors, they being authorised to obtain the necessary assistance in the distribution. (Section B): We beg to report now that all the contracts for works required to complete the original scheme have been tendered for (except the wharf crane and coal stores) and the contracts entered into, and we submit hereunder a statement of the estimated capital expenditure on the electricity and refuse destructor works, based on the amount of the contracts entered into, etc., amounting to £262,740. The original scheme adopted by the late Vestry on March 1, 1899, authorised an expenditure of £242,367. The following is a statement of estimated capital expenditure: refuse destructor, including boilers for electricity works, £24,495; buildings for electricity works and refuse destructor works, £31,589. 3s.; machinery and plant—engine house plant £22,735, feed pumps £733, condensing plant £4,749, cooling apparatus £1,960, pipe work £5 065, switchboard and instruments £5,136, travelling crane £638, workshop equipment £772; accumulators, £7,665; wharf crane and coal stores, £2,000; supply mains (first contract), £75,000; ditto (second contract), £45,000; 320 arc lamps for public lighting £11,506; 2,400 house meters, £8,714; general charges, engineering, architect's and quantity surveyor's fees, £14,283—total, £262,740. We now beg to recommend the Borough Council to give authority for the capital expenditure to be increased by £20,000."

PROVISIONAL PATENTS, 1901.

JANUARY 14.

856. **Improvements in and relating to winches for raising and lowering arc lamps.** James Dewar, 96, Buchanan-street, Glasgow.

916. **Improved means for supplying electric energy to railway vehicles.** Ernest Rowland Hill, Westinghouse-buildings, Norfolk-street, Strand, London.

923. **Improvements in switches for electric point and signal apparatus.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société Anonyme de Force et Lumière Electriques, France.)

924. **Multiple electric contact-making and breaking apparatus for railway signals.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société Anonyme de Force et Lumière Electriques, France.)

JANUARY 15.

946. **Horizontal sliding tension clip for use with flexible electric light fitting.** Geo. Stevenson and William H. Farnsworth, 7, Acourt street, Hyson Green, Nottingham.

947. **Improvements in the materials for electric cables.** Alexandre de Pont and Silvius de Pont, 146, Longmoor-lane, Liverpool.

969. **Improvements in or relating to electrolytic electricity meters.** Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

972. **Cover and circular motion for arm for electrical car top.** William Denison and Herbert Denison, 21, Springfield-street, White Abbey-road, Bradford.

973. **An electrically-illuminated portable travelling case.** Major Alfred Roswell, 53, Jerningham-road, New Cross, London.

974. **Improvements in or relating to the means for adjusting or regulating the shades, reflectors, or screens employed in connection with electric lights, gas lights, and others for the purpose of concentrating and diffusing the light therefrom in any desired or required direction for the purpose of facilitating photography, and apparatus for effecting the same.** Nathan Smedley Kay, 8, Quality-court, Chancery-lane, London.

988. **An improved support for aerial electric conductors and the like.** Johann Skopec and Franz Ondra, 89, Princess May-road, London.

992. **Improvements in electrical measuring instruments.** Kenelm Edgcumbe and Edgar Isaac Everett, 22, Charterhouse-square, London.

998. **Improvements in electric brakes.** Frank Clarence Newell, Westinghouse-building, Norfolk-street, Strand, London.

1011. **Apparatus for testing electric meters.** Pedro Dario del Nero and José Camino, 4, South-street, Finsbury, London. (Complete specification.)

1012. **Improved method of and ingredients for the manufacture of a substance suitable for insulaters, ornamental, and other purposes.** Bernard Weaver, 166, Fleet-street, London.

1016. **Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

1017. **Improvements in electric transformers.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter S. Moody and William Le R. Emmet, United States.) (Complete specification.)

JANUARY 16.

1023. **Improvements in or connected with incandescent electric lamps.** Albert Louis Reinmann, 15, Water-street, Liverpool.

1024. **Improvements in or connected with incandescent electric lamps.** Albert Louis Reinmann, 15, Water-street, Liverpool.

1025. **Improvements in or connected with incandescent electric lamps.** Albert Louis Reinmann, 15, Water-street, Liverpool.

1038. **Improvements in paper for cleansing telephones.** Hermine Henckel and Armin Henckel, 4, Corporation-street, Manchester.

1049. **Improvements in induction electric motors and method of operating the same.** The British Thomson-Houston Company, Limited, and Hans S. Meyer, Bush-lane House, Cannon-street, London. (Complete specification.)

1087. **Improvements in electric meters.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

JANUARY 17.

1103. **Improvements in telephonic and other switchboard apparatus.** Frederic William Francis, Audley House, Brockley Hill-park, Forest Hill, London.

1122. **An automatic corrector for step-by-step mechanism driven or controlled by electrical impulses.** Charles O. Janney, 823A, N. King's-highway, St. Louis, Missouri, U.S.A. (Complete specification.)

1134. **Electric-vibrating-retouching apparatus.** Daniel von Olegar, 41, Fairlawn-avenue, Chiswick, London.

1156. **Improvements in or in connection with car trucks applicable for electric tramway cars and other purposes.** John Jacob Nef and John Edward Anger, 6, Lord-street, Liverpool.

1167. **Improvements in electric meters.** Wilhelm August Rasmus Mathiesen, 18, Buckingham-street, Strand, London. (Complete specification.)

JANUARY 18.

1181. **Improvements in electric switches.** Alexander Spark, 35, Summer-street, Aberdeen.

1189. **Improvements in carbon brush holders for dynames and motors.** Frederick William Stansfield, 26, Sinderland-lane, Dunham Massey, Cheshire.

1193. **Coin-freed delivery apparatus for electric current.** Rudolph Haensel, 4, Wielandstrasse, Charlottenburg, Berlin. (Complete specification.)

1219. **Self-contained electric motor.** Herbert Luzerne Todd and J. Dunham-Massey, 8, Princes-street, Bank, London.

1224. **Improvements in receiving apparatus for electro-dynamic so-called Hertzian waves.** Bela Benjamin Schaefer, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1225. **The procedure and apparatus for indicating and registering electric or magnetic signals.** J. Ch. Schäfer and Co. and Eric Marx, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1232. **Improvements in electrical measuring instruments.** Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

1237. **Improvements in trolleys for collecting current from overhead wires.** William Humphrey Wheatley, 40, Chancery-lane, London. (H. Dufray and Co., France.)

JANUARY 19.

1267. **Improvements in prepayment electricity meters.** Ernest Schattner, 55, Chancery-lane, London.

1280. **Improvements in electric cables.** Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Feb. 9.

1899.

24624. **Perforators for use in connection with automatic telegraph transmitters.** Fraser, Judd, and Draper.

1900.

814. **Method of and installation for operating two-phase electric motors.** Lamme. (Date applied for under International Convention, June 14, 1899.)

2947. **Automatic electric switches or cut-outs.** Eckstein and Mellis.

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2164. Electric railways and tramways on the surface-contact system. Stamp.

2638. Rontgen-ray apparatus and interruptors applicable for use in connection therewith, or for other purposes. Davidson.

2767. Long-distance relay magnetic telephones. Nessel and Gouin.

3237 Electricity meters. Chamberlain and Hookham, Limited, and Holden.

3461. Electromagnetic brakes. Westinghouse Brake Company, Limited. (Newell and Herr.)

3922. Holders for electric incandescent lamps. Krull.

3937. Apparatus for indicating and recording electric pressure and current. Kelvin.

4287. Telephone intercommunication systems. Aitken.

4527. Multiple-contact telephone transmitters and circuits relating thereto. Adams-Randall.

5928. Telephone divided multiple board systems. Aitken.

6693. Electric transformers. British Thomson-Houston Company, Limited. (Moody.)

9955. Transformer systems of current supply for electric railways. British Thomson Houston Company, Limited. (Potter.)

11943. Regulation of electric motors. Lundell.

13874 Automatic electric circuit controllers. Whittingham.

13892. Heating bodies for exciting electrical incandescence bodies made of second-class conductors. Feeny. (Allgemeine Electricitäts Gesellschaft.)

15389. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz and Emmet.)

17670. Method of combining a telephone with a system of electric bells. Alexander and Hunter.

19496. Induction electric meters. British Thomson-Houston Company, Limited (Steinmetz)

21028. Electric railways on sectional conductor or road-contact systems. British Thomson-Houston Company, Limited. (Farnsworth.)

21645. Electric switches. Clarke, Chapman, and Co., Limited, and Forster.

21701. Telephony. Sterne. (Fowler.)

21704. Systems of electrical distribution. British Thomson-Houston Company, Limited (Berg.)

21732. Method of automatically cutting out main conductors of powerful electrical currents. Siemens Bros. and Co, Limited. (Siemens und Halske, Actiengesellschaft.)

21862. Methods of securing pole-pieces to electric machines. British Thomson-Houston Company. Limited. (Reist)

22605. Plate holders for electric accumulators. Müller.

22606. Process for chemically consolidating the active material of electric accumulators. Müller.

22607. Electric accumulator cells. Müller.

22779. Mounting telephonic instruments and accessories so as to admit of interchanging or renewal of the various parts. Byng and Bell.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900
		£	£	£	£	£
Aberdeen Corp'rat'n	Jan. 29	572	525	+ 47	23,192	19,948
Birmingham Trams.	,, 19	4 060	4 084	- 24	10 923	—
Blackburn Corp'rat'n	,, 13	1 191	—	—	2 724	—
Blackpool Corporatn.	,, 17	151	129	+ 22	28 723	21,086
Blackpool-Fleetwood	,, 19	127	140	- 13	391	423
Bolton Corporation..	,, 20	1 194		—	—	4 185
Bradford City Trams	,, 13	754	354	+ 400	1,473	692
Bristol Tramways Co.	,, 18	2,747	2 715	+ 32	—	—
Carlisle Tr'mw'ys Co	,, 12	—	—	—	221	—
Central London Ry.	,, 19	5,982	—	—	133 985	*a* —
City & South London	,, 20	1 995	1,111	+ 884	6 054	3,379
Cork E. T. and L. Co.	,, 17	*833	—	—	837	—
Dover Tramways ...	,, 19	163	149	+ 14	465	454
Dublin & Lucan E.R	—	—	—	—	—	—
Dublin U.T., elec. cars	,, 18	3,254	2,864	+ 390	—	—
Dublin S.D. Electric	,, 18	686	608	+ 78	—	—
Dundee Tram Co. ...	—	—	—	—	—	—
Glasgow Corporation	,, 19	8,494	8,341	+ 153	—	—
Halifax Corporation	—	—	—	—	—	—
Hull Corporat'n E.S.	,, 19	1 535	660	+ 875	56 838*b*	—
Liverpool Corporat'n	,, 12	7,697	6,631	+ 1,066	16,174	13 406
Liverpool Overhead	,, 20	1,482	1,471	+ 11	4,537	4,455
Portsmouth Corpn...	,, 19	609	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 20	2,642	—	—	—	—
Southampton Trams	,, 17	624	282	+ 342	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—

a From July 30, 1900. *b* Since April 1, 1900. * From Jan. 1.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	10½-11½
—— 40,001-70,000	5	—	11-11½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅞-6⅛
—— 5 per cent. Mortgage Debentures	100	—	100-106
British Electric Works, Ordinary, 50,001-96,000	1	—	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅛-¼
—— 4½ per cent. First Mortgage Debentures	100	—	96-97
British Westinghouse Elec. and Manuf., 6 per cent. Pref...	5	—	4½-4⅝
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2⅛
—— 4½ per cent. Debenture Stock	100	..	105-110
—— 4½ per cent. 2nd Debenture Stock	100	—	101 103
Callender's Cable, Debentures	100	—	109 113
—— Ordinary	5	—	12-14
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	2	—	2¼ 4
—— 5 per cent. Debentures	—	—	99-103
Edison and Swan United, Ordinary	2	—	1⅞-2⅛
—— 5 per cent. Debentures	5	—	3½-4⅛
—— 4 per cent. Deb. Stock, Red.	100	—	88-90
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	—	96 100
Electric Construction, Limited, Nos. 1 to 113,100	2	—	1⅞-2⅛
—— 7 per cent. Cumulative Pref.	2	—	2½-3
—— 6 per cent. Perp. 1st Mort. Deb.	100	—	101-104
W. T. Henley's Telegraph Works, Ordinary	5	—	13½-14½
—— 4½ per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21½
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	38-42
—— 5 per cent. Bonds	100	—	100-108
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	—	10½-11⅛
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6⅞-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	—	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5	—	6½-6⅝
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5⅛ 5⅜
Chelsea Electricity Supply	5	—	6½-7
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (60 p.c. pd.) Red.	—	..	61-63
County of London and Brush Provincial, Ordinary	10	—	8¼-9½
—— 6 per cent. Cum. Pref.	10	—	11½ 13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	106 109
Edmundsons' Electricity Corporation, Ordinary, 1-17,600	5	—	4½-5½ xd
—— 4½ per cent. First Mort. Deb.	100	—	101-103
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7⅛-7½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	—	1½ 2
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1⅛-1⅜
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	—	5½-6
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5⅝-6½
River Plate Electric Light and Traction, Deb.	100	—	70-80
Royal Electrical Company of Montreal	$100	—	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	..	90-90
South London, Ordinary	5	—	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	15-16
—— 7 per cent. Pref.	5	—	8½-9½
—— 3½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	—	13¼-13½
—— 30,001-109,437	5	—	12 13
Electric Railways.—			
Central London, Ordinary	10	—	8½-9
—— Pref. Half-Shares	5	—	4⅜-5⅛
—— ,, ,, deferred	5	—	3⅛-3⅝
City and South London, Consolidated Ordinary	100	—	52-56
—— Ordinary	10	—	4½-5½
—— 4 per cent. Debenture Stock	100	—	115-120
—— 5 per cent. Pref. Stock '91	100	..	138-142
—— ,, ,, ,, '96	100	—	180-185
Liverpool Overhead, 5 per cent. Pref.	—	—	13½-13¾
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9⅞-10⅛
British Electric Traction, Ordinary	10	..	12½-13⅛
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	11½-12⅛
—— 5 per cent. Perpetual Debenture Stock	100	—	120-125
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4½-4⅝
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	—	..	95-98
Kidderminster and District Lighting and Traction, Pref.	10	—	9⅞-10½
New General Traction, Ordinary	5	—	3½-4
—— 6 per cent. Cum. Pref.	5	—	4⅞-5⅛
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17
—— 5 per cent. Cum. Pref.	10	..	10⅛-10⅜
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	102-105
Telephones.—			
National Telephone, Ordinary	5	—	4⅛-4⅜
—— 6 per cent. Cum. First Pref.	10	—	12-14
—— 6 per cent. Cum. Second Pref.	10	—	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	—	4⅛-5⅛
—— 4 per cent. Deb. Stock, Red.	100	..	97-100
—— 3½ per cent. Deb. Stock, Red.	100	—	94-97
Oriental Telephone and Electric Company	1	—	⅜-1⅛

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NOTES.

Electrical Standardising, Testing, and Training Institution.—The next session of this institution will open on the 20th prox., when, we understand, a fresh course of instruction will be introduced.

Paris Automobile Exhibition.—On Friday last the Paris Automobile Exhibition was opened in the Grand Palais. The number of exhibits was much superior to that seen at any previous show, and it is regarded as the most important automobile exhibition that has ever been held in France.

Physical Society.—In consequence of the death of Queen Victoria the ordinary business of the meeting of the Physical Society last Friday was postponed. Mr. T. H. Blakesley (vice-president) occupied the chair, and it was decided to forward a vote of condolence to his Majesty the King.

Institution of Electrical Engineers.—The meeting of the Dublin section of this Institution was adjourned without the transaction of business on the 24th inst., a resolution being passed recording "the deep grief with which we have received the news of the death of our late beloved sovereign, Queen Victoria."

Accident.—An accident occurred on one of the electric cars at Southport last Friday, which caused some alarm to the passengers. The current had just been switched on, when the trolley caught in one of the clips of the overhead wire and remained fast. The wire did not come down, but the trolley was dragged from its place, carrying with it a portion of the roof of the car.

Institution of Junior Engineers.—At a numerously attended meeting of this institution last Friday the chairman, Mr. Percival Marshall, made a feeling allusion to the great loss which the nation had just sustained in the death of Queen Victoria. A resolution was passed in silence tendering to his Majesty the King and to the other members of the Royal Family "expressions of sincere and respectful sympathy on this sorrowful occasion."

Iron and Steel Institute.—At a special meeting of the council of the Iron and Steel Institute, held on Wednesday, the president (Sir William Roberts-Austen, K.C.B.) in the chair, it was unanimously decided to present an address to King Edward VII. offering to his Majesty and the other members of the Royal Family the expression of the meeting's profound sympathy in the irreparable loss which has been sustained in the death of our revered sovereign Queen Victoria.

Cable Interruptions.—The cost of upkeep of ocean cables in the East Indian Archipelago and similar seas must be considerably greater than in more normal climates. The reason for this apparently is that interruptions by earthquakes are extremely common in these places, and more damage to cables is probably due to this cause than to any other. Recently the cable from Galveston to the Mexican coast failed, and it was discovered during the repair operations that the breakdown was due to an earthquake.

Royal Society of Edinburgh.—We have before us a copy of the *Proceedings* of this society during the session 1899-1900. The volume contains an interesting paper by Lord Kelvin "On the Motion produced in an Infinite Elastic Solid by the Motion through the Space occupied by it of a Body acting on it only by Attraction or Repulsion"; "Contributions to the Craneology of the People of India," by Prof. Sir Wm. Turner, in abstract form; and "The Action of Silver Salts on Solution of Ammonium Persulphate," by Dr. Hugh Marshall. Two other papers—"Hyperbolic Quaternions," by Mr. Alexander MacFarlane; and "The Theory of Skew Determinants and Pfaffians in the Historical Order of its Development up to 1857"—are also given.

Experiments with Wireless Telegraphy.—Mr. H. Hodgson Wright recently gave two lectures at Halifax on Röntgen-ray photography and wireless telegraphy. On the latter subject he emphasised the fact that there were three known methods of communicating without the aid of wires—viz., the conduction, the induction, and the wave methods. Having shown how wireless messages were dispatched and received, the lecturer gave a striking experiment of the power of Hertzian waves, by means of which a small motor was started at the opposite end of the room. Perhaps the experiment which was applauded the most was that in which a small charge of powder, some 20ft. or 30ft. away from the lecturer, was exploded by wireless telegraphy.

Scottish Electrical Contractors' Association.—At a meeting of the electrical trade in Glasgow last November it was decided to form an electrical contractors' association, and we are pleased to see that the decision has now been carried out. Under the name of "The Scottish Electrical Contractors' Association — Glasgow Centre," it has already a membership of over 30. Mr. James M. Davies, of 168, St. Vincent-street, Glasgow, has been appointed secretary, and he intimates his desire to communicate with kindred associations which may have been formed or with parties who propose forming such associations, with a view to co-operation or joint action where necessary. The first business meeting of the association takes place on Feb. 7 next.

White Lead Production by Electricity.—Mr. E. Bailey, residing in York, has invented a means of producing white lead and other metallic compounds by electricity. This is done by the use of the electric arc, the lead to be treated being kept in a molten state. The metal is acted upon by gaseous vapours, which produce carbonate of lead or any other required lead compound. The fumes produced are blown over into chambers having canvas or fine fabric cloth covers or roofs. The fine dry powdered white lead falls down and the uncondensable gases pass through the fine canvas roof, thus dispensing with grinding, washing, and drying processes. It is claimed that there will be at least a saving of 50 per cent. in production by this process, which has been patented both in England and abroad.

Canadian Reception of the Pacific Cable Contract.—We now begin to hear how the news that the contract for the Pacific cable had at last been awarded is being received in different parts of the Empire. The utmost satisfaction is expressed in Canada, and the Canadians claim that it has only been by very steady insistence on their part that the final stage has been reached. The scheme is regarded there, however, as the forerunner of bigger things in the future. The necessity for a complete national system of telegraphic communication is generally admitted. The outlines of such a system have already been sketched by the distinguished Scotch-Canadian engineer, Sir Sandford Fleming, and it is urged that every effort should be made to persuade Governments to act decisively in the matter.

The "Morse" Submarine Boat.—It now appears that the French submarine boat "Morse" is not such a success as at first concluded by some correspondents to the daily Press. The equilibrium of the vessel under water is nothing like what it ought to be. An ounce of water ballast, more or less, it is stated, will sink her further or

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send her to the top. The change in position of one of her crew has had unlooked-for effects on the centre of gravity, and above all, when such disturbance has taken place, the submerged boat will not tend to right herself. The electric accumulators also do not give a speed of more than six or seven knots, while the zone of action is limited to 120 nautical miles. We presume that this is when they are new. The "Français," which was launched a few days back, is of the same type as the "Morse."

American Manufacturers.—A *résumé* of the work done by the General Electric Company at Schenectady during 1900 is a good indication of the trend of electrical design in the United States. This report shows that considerable improvement has been made during the past year in central-station apparatus, and that larger units of higher efficiency have been introduced in many stations replacing smaller generating stations. In electrical railway work we gather that there is a tendency towards the use of four motors on each car instead of two, in order to get greater power, higher speed, and more economy in starting. A great advance has also been made in the equipment of large manufacturing works, and we gather that it is usual to provide one motor for practically every tool in the most recently designed workshops. Transmission work also shows a considerable increase owing to the success which has been obtained in long-distance transmission in California. Thus an 80-mile transmission with only an 8 per cent. line loss is an accomplished fact, and in consequence a number of water powers which had previously been deemed inaccessible are now considered to be valuable properties.

Illegal Telephones.—By an ingenious arrangement of an electric battery, a telephone, and several wires, the late head of the detective office at Lyons had for some considerable time previous to his dismissal been constantly informed of all that took place in the prefecture of that town. Owing to the illness of this official, and his unwillingness to hand over the keys of his office, a search of his papers was made, which disclosed a number of letters showing that the several attacks on the prefect and the French Government in certain Nationalist papers of Lyons had been inspired by him. A box also was opened, inside which was found the electrical apparatus which was his chief aid in carrying on this systematic theft of private information. The wires were found to be joined up to the prefect's apartments. One pair went to the prefect's office, and to a microphone under his table; another into his dining-room, and still another pair into his bedroom. It is confidently assumed that this elaborate network of telephone wires could not have been laid by the head of the detective office alone, and the police are now looking out for possible accomplices.

Foreign Competition.—We notice in the *Financier and Bullionist* for last Saturday an interview with Lieut.-Colonel R. E. Crompton on the question of foreign competition. We think it is a pity that a proof of the interview in question was not forwarded to Colonel Crompton for his corrections before the publication, as we do not think that he would speak of the new detachment of the Electrical Engineers (R.E.) Volunteers Corps about to proceed to South Africa as the "Engineers' Cyclist Corps." Otherwise some interesting points are made in the interview, and Colonel Crompton sums up his reasons why the English manufacturer lags behind his American and German *confrères* under the following heads: "(1) Because there is not sufficient touch between the capitalist who has money to invest and the manufacturer who desires to use it as a means of production. (2) The policy of the trade unions has succeeded in making English labour dear, although the rate of wages is not specially high. They have not allowed the workman to work to his fullest capacity, through a mistaken idea that they would ensure a longer duration of the work. (3) The English producer, when he has manufactured his goods, does not take nearly the same trouble to distribute as his rivals. He quite forgets that there are ups and downs in trade, and that, though his shops are now full of orders, it is necessary to provide against the time of less brisk trade by extending the market for his goods by pushing them into new countries through the medium of scientifically-trained distributors."

The Glasgow Engines.—The engines for the Glasgow tramway station, over the order for which there was so much excitement raised about a year ago, will have to be in place soon to enable the tramways to be got into running order before the beginning of the Glasgow Exhibition. It will be remembered that after a considerable amount of discussion the Corporation of Glasgow placed the order for two of these engines with Messrs. J. Musgrave and Sons, Limited, of Bolton, while the order for the other two went to an American firm. We now gather from the Bolton papers that the first of the Musgrave engines is almost ready for delivery. These engines are to be of 5,000 h.p., and the following dimensions will be of interest: height of engine 35ft., weight about 800 tons; driving shaft, diameter 36in., weight 85 tons; high-pressure cylinder, 42in. diameter, 5ft. stroke; two low-pressure cylinders, each 60in. diameter, 5ft. stroke; flywheel, 24ft. diameter, weight 140 tons; total weight of bed-plates, 135 tons; heaviest casting, 45 tons. The engines are intended to run at 75 revolutions per minute. Owing to their size, a new erecting shop has had to be specially constructed for their reception. In view of the strong opposition which took place for this order, and the way it was divided between English and American engine builders, we hope that Messrs. Musgrave and Sons will succeed in their endeavours to be up to contract time. The most interesting results, however, will be those obtained after the engines have been at work a reasonable time. In two or three years hence we may expect to have from Glasgow reliable figures as to the relative cost of upkeep of the two types.

Electromotive Efficiency of the Elementary Gases. — In a paper on this subject, Mr. Emil Bose gives a general review of the work done on gas cells, and a discussion of their theory. The chief problems treated by the author, as they appear in the Chemical Society's *Journal*, are: (1) In what condition are the gases present in the electrode? (2) What is the part played by the electrode itself? (3) How do the metallic electrodes transmit the electromotive efficiency of the gases? (4) How far is agreement attained between measurements made with the same gas and electrolyte, but with different electrodes? The conclusions of the paper are as follows: The electromotive efficiency of the elementary gases is determined by their solubility in the electrodes. The gases in the electrodes, on account of the high dissociating power of the latter, are to be regarded as wholly or partly dissociated into single atoms; the ions of an electromotively active substance are already present in the electrode. The electrolytic solution pressure is the product of the osmotic pressure of these ions and a factor which is a constant for each solvent, and termed by the author the electrolytic partition coefficient. The saturation of the electrode with a gas is an extremely slow diffusion process. Grove's gas battery is reversible, but its E.M.F. with the gases under atmospheric pressure has certainly a higher value than that usually given. In the acid hydrogen-oxygen cell, the water is formed at the oxygen

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electrode, in the alkali hydrogen-oxygen cell at the hydrogen electrode. The second electrolytic decomposition point of water corresponds with a non-reversible process.

Electric Delivery Wagons.—Mr. Max Loewenthal in the last issue of the *Electrical World* for the old century has an interesting article on the electric delivery equipment of a large New York store. It seems that the firm in question commenced to experiment with accumulator vehicles in 1897, and that since then they have been gradually adding new types until they have now 12 electric delivery vans in actual use. In order to make the whole of their delivery vehicles electrical, no less than 121 new wagons and 14 trucks would be required. We do not propose here to go into the types of the various vehicles which the firm has tried. It is interesting, however, to notice that in every case, the article states, they are capable of delivering a distance of from 20 to 30 miles from one charge of the battery. In spite of this one reads elsewhere in the descriptive matter that the speed of the wagons is 7½ miles per hour, and they cover about 19 miles daily, which would seem to show that they would do the day's work on a single charge. The idea of the firm was that they could charge these vehicles in the morning by means of the lighting plant, and in this way obtain a much more even load for their engines and dynamos. It has been found, however, that the batteries would not last a full day without recharging, and it is now the practice of the firm to charge them three times a day—*i.e.*, after every delivery trip. In consequence of this, the firm have had to put down a new generating unit, as the recharging has to be done in the winter at the same time that the lights are being used in the station. There are no figures given in the article as to the cost of upkeep of these vehicles, but the fact that they have been added to recently seems to show that the firm are satisfied with the commercial results obtained.

The U.S.A. Pacific Cable.—At a recent meeting of the New York Chamber of Commerce a resolution was passed in favour of the American trans-Pacific cable being carried out by private enterprise. The Chamber of Commerce also gives its approval to the Bill now being introduced into the House of Representatives by Mr. Sherman on the subject. A committee of the chamber reported on four reasons why private control was to be preferred to State ownership. The first of these is on the ground of cost, which is put down at three million sterling, while the next claims that the annual upkeep would be some £300,000 per annum. We do not see why on either of these grounds private ownership is to be preferred. It is next urged that to make the cable profitable there should be connections to Japan and China, and that the Governments of these countries would be less likely to grant the right to land the cable to the United States Government than they would be to private individuals or companies. This, also, we fail to agree with. The fourth reason against State ownership given by the chamber is that a large amount of expert knowledge is required in laying, maintaining, and operating all ocean cables, and that the Government at present has no department with experts having experience in submarine cable work. This is, perhaps, the most valid objection, but from what we know of the remuneration paid by cable companies to experts, it is in every way probable that the Government of the United States has only to advertise for applications in order to obtain experts of the highest class who are quite willing to accept positions under a stable government rather than remain with a private company. The real objection which the New York Chamber of Commerce has to the State ownership of a trans-Pacific cable appears to us to be that it would compete with vested interests already in private hands. It will be remembered that exceedingly strong opposition was brought against the English Pacific cable for the same reason.

Electric Coast Lighting.—In a contribution to the *Electrical World* Mr. Geo. E. Walsh deals with the different signalling lights employed along the coast of the United States to warn mariners of possible dangers. Although electricity has only recently figured to any great extent in this departure, to-day the majority of United States lighthouses are provided with electric light. There are, however, exceptions, the chief reason for this being the increased cost over other means of lighting, and acetylene gas has been employed in many a lighthouse located where it is not considered wise to establish an electric plant. While, of course, this lighting agent is not to be compared with electricity, it gives a much better effect than common illuminating gas, and it is used entirely in buoys round the coast where gas only is supplied. Recently the Lighthouse Board carried out some successful experiments with electric buoys in New York Harbour. The dangers of night navigation were entirely removed by means of an electric cable connecting the line of buoys marking the channel. The passage up the harbour was made as easily as in daytime, and in time this method of illuminating harbours at night time must be universally adopted. Shipping interests would benefit greatly, for at the present time the delay of incoming steamers and ships in a port like New York on account of the danger of navigating a narrow crooked channel in comparative darkness is a matter of considerable commercial loss. Nearly all the future lightships placed by the United States Lighthouse Board will have an electric light plant on board to furnish sufficient light to warn ships off dangerous places. Notable features of these vessels will be that, unlike the old-fashioned lightships, they will have hollow iron masts, at the top of which will be grouped half a dozen incandescent lamps, each of 100 c.p. Two complete sets of electrical apparatus will be provided, so that if one should be deranged the other may take its place. The cost of maintaining the United States lighthouse service varies from about £750,000 to £1,000,000 a year.

Submarine Boats in the United States.—The failure of the General Board of the U.S. Navy and the Construction Board to include submarine torpedo boats in their building programme for this year, "may be accepted as conclusive evidence that they did not consider it advisable at this time to increase the number above those now authorised.' This is the explanation given by the Naval Board on Construction, which has just filed a report with the Secretary of the Navy on the subject. It regards submarine boats as experimental, and asserts that the tests of the "Holland' at Newport last year were interesting, and answered the purpose for which they were intended—namely, to instruct the crew—but nothing more. In these experiments the "Holland" made a surface run of seven miles outside Newport Harbour, in charge of her naval crew only, and succeeded in getting within striking distance of the battleship "Kearsarge" without being discovered, due, no doubt, to her small size. She was ruled out, however, as the "Kearsarge" had already been put of action by another ordinary torpedo boat, which also got within striking distance unperceived, and it has been stated that on account of the latter the vigilance of the lookouts on the "Kearsarge" had been relaxed when the "Holland" made the attack. "Be that as it may," the report proceeds, "the conditions by no means simulate

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the actual warfare, and the 'Holland' was not on that occasion used as a submarine boat, nor did she accomplish more than an ordinary torpedo boat." The conclusion arrived at by the Board is that the utility of the boats of this class has not been sufficiently demonstrated to warrant the construction of others than those already authorised—eight in number—which are considered a sufficient number to experiment with. In the event of the Congress seeing fit to authorise any more submarine boats, the Board is of the opinion that no special type should be specified, but that the Secretary of the Navy should have discretion to contract for such boats as in his judgment are likely to prove the most efficient and the best suited for naval purposes, thus opening up competition and giving other inventors a chance.

Cape-to-Cairo Telegraph. — The work of constructing this line is making good progress in spite of the many hindrances and interruptions that are met with. It is stated, however, that by this time probably some 100 miles from the south end of Lake Tanganyika have been completed, but for telegraphic purposes, Kasanga, a point 50 miles distant from the base, is at present the last station on the route. According to a statement made by a gentleman lately connected with the staff of engineers engaged in this work, and published in the *Natal Mercury*, the principal difficulty met with by the contractors has been in the supply of materials, and, of course, this difficulty must increase as the work is proceeded with. Again, the nature of the country through which the line is passing is hilly and thickly wooded. The use of the trees for posts instead of the iron standards now being erected is favoured, probably on account of the difficulty experienced in transmitting heavy materials into the heart of Africa. At the present stage there are always some 50,000 or 60,000 loads of goods awaiting transport. The iron poles, which come from Europe, are transferred at the mouth of the Zambesi to river steamers and conveyed up the Zambesi and Shire Rivers to Patima or Katungas. Here, owing to the rapids, there is a porterage to Mpimbi or Matoppo, on the upper Shire River, and here occurs a great delay owing to the lack of carriers. A few transport wagons have been placed on the road, but no real effort has been made to break the block in the traffic. The informant states that as matters at present stand the telegraph company's interests will be subordinated to the necessities of the civil administration. For instance, if 1,900 carriers are available, the company will naturally only get what the administrator could spare. Again, there is no incentive to the collector or administrative officer to push forward the telegraph work. The construction has now been carried well into German territory, and the material is being handed over to the Germans at the Kalambo River, some 20 miles from the southern corner of Tanganyika. This arrangement, however, is not understood to be permanent, and some scheme for carrying all material through British territory is being talked of.

Telegraphic and Telephonic Communication.—This question is likely to be severely dealt with at the ensuing conference of the Association of Chambers of Commerce in London. Several of the leading chambers of the country have given notice of strongly-worded resolutions as to the present insufficient telegraphic and telephonic service all over the Empire. The Newcastle-on-Tyne Chamber has worded its resolution in these terms: "That whilst expressing satisfaction that after numerous delays the negotiations connected with the formation of an all-British Pacific cable have progressed sufficiently to enable a contract for laying the same to be entered into, this association would strongly urge on the Government the absolute necessity that exists, both on account of the defence of the Empire and the promotion of its commerce, that immediate efforts should be made and actively continued until all parts of the Empire whether colonies or dependencies, have lines of telegraphic communication with each other, as well as with the mother country, without such lines passing through any foreign countries or possessions." The Liverpool Chamber has also a motion down on the agenda paper to the same purpose, urging that every reasonable support be given to the Imperial Telegraph Committee of the House of Commons in its enquiry into the question of telegraphic communication. As already stated in these columns, this chamber, in view of the growing trade with the Continent of Europe and also of the active competition for such trade which its merchants have to maintain with those of other countries, presses the Government to establish without any further delay additional and improved cables between the United Kingdom and the Continent, and to arrange for more direct wires to principal European centres of commerce and manufacture; and that a more efficient telegraphic and telephonic service between the commercial and the manufacturing centres of the United Kingdom is imperatively necessary. The Southampton Chamber asks that the telephone trunk line service should be expedited and greater facilities given, while the Wakefield chamber proposes that the address of not exceeding four words should be allowed free of charge in all British and Colonial telegrams, and that telegraphic communication should be extended to rural districts where practicable. The Cardiff Chamber supports a similar resolution, and the Walsall Chamber will protest against the present Post Office regulation with regard to the posting of circulars produced in imitation of typewriting.

Steam Plant Economy.—In the review on electric lighting which appears in the first issue of the *Electrical World* for the new century, Prof. Dugald C. Jackson has much to say on the wastefulness of our present means of producing electrical energy. He, of course, refers to the steam-engine and steam-boiler as used in the present day. To quote literally, the professor states that "a net ton of good bituminous coal may be assumed to hold an amount of available energy which is represented by 25,000,000 heat units. Not less than 22,500,000 of these heat units are lost in the successive processes of converting the available energy of the coal into the heat energy of steam in a boiler, into mechanical energy by means of a steam-engine, and finally into electrical energy by means of a dynamo. Of this great loss, an overwhelming proportion is due to the steam-engine. A small proportion of the remaining energy, which is now equivalent to 2,500,000 heat units, is lost in the transmission to the lamps, so that perhaps less than 10 per cent. of the original total energy is delivered to the lamps. Here is a shining mote in the eye of the designer of the steam engine and boiler. The waste of 90 per cent. of our fuel which is caused by the extravagant process of generating electrical energy through the intervention of the steam engine and boiler, is sufficient to plunge all coal users who are acquainted with the limits of the world's coal supply into pessimism." This is not the first time that we have had to call attention to the misleading ideas which can be given by the too literal translation of exact science. If Prof. Jackson were asked, he would quite agree that the steam engine and boiler of the present day are practically as economical as they can be made. The poor results which he states are obtained from these engines and boilers are only so because he puts alongside them the results which could be obtained if unobtainable conditions were at our command. Because

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the absolute zero of temperature enters into the formula of the efficiency of a steam or heat engine, it does not follow that this absolute zero of temperature is available in the condensers of the every-day steam-engine. While we quite agree with the professor that better results could be obtained if lower temperatures were available, we do not think it is right to give expression to the absurd figures contained in the article in question. The rest of the review is devoted to a consideration of the comparative efficiencies of electric lamps with other means of illumination. The Nernst lamp is mentioned as likely to give a considerable saving in the near future, and Prof. Jackson states his opinion that more diffused and uniform illuminators is also to be desired. He also hopes that more of the energy supplied to lamps will be converted into light than is the case at the present time.

Motor-Starter Specifications.—A large number of types of motor-starting gear, combined with automatic interruptors to act in the event of the supply current being discontinued, or of the current taken by the motor exceeding a certain maximum, have been designed. A good many of the types now on the English market come from America, and it is therefore interesting to quote the following specification for a motor starter which Mr. H. Ward Leonard has drawn up as embodying the most essential features of such gear. These are the requirements, as given in a letter to the *Electrical World*: "The starter must stand without injury or alteration a current of 50 per cent. in excess of the full load motor current when passed through the entire resistance when cold for one minute. The starter must stand without injury or alteration a current which is double the full load motor current when passed through the entire resistance when cold for 20 seconds. The resistance must be of metallic alloy of high fusing point, and having a temperature coefficient not greater than that of German silver. Resistance materials whose resistance alters greatly when heated, such as copper, iron, and carbon, will not be acceptable. The resistance material must be surrounded by, and mechanically held in position by, a high-class insulating material, so that in case the conductor be melted by excessive current, or broken by mechanical strain, the conductor cannot move. It must be absolutely impossible to make a fire in case the resistance be burned out by overload current. The insulating material must not smoke, smell, steam, or suffer any alteration or depreciation when tested as above provided. The starting arm of the motor starter must have an efficient retractile spring constantly tending to insert the resistance and open the circuit to the motor, and which will invariably do so when the arm is released by the automatic 'no voltage' device. In all starters whose full-load current is over 30 amperes the spring must be supplemented by an auxiliary device such as a 'hammer blow' to start the arm against the friction of rest when it is released. The starting arm must be held in its full-speed position by a 'no voltage' device which will be unaffected by any variation in the load, but which will invariably release the starter arm when the supply voltage fails. The starter must be provided with an overload magnetic circuit breaker whose action is entirely independent of the 'no voltage' device and which will open the circuit to the motor whenever the current exceeds a predetermined maximum, either while the operator is starting the motor or after it is at full speed. This circuit breaker must be so arranged that it cannot be closed, except when the starting arm of the starter is in its open-circuit position. In all starters of 10 h.p. and larger, the circuit breaker must be provided with an auxiliary final break, upon which the arc is broken, so that the switch contacts of the circuit breaker will not be burned when the circuit breaker opens."

Electric Power Distribution.—We have just received the January issue of the *Journal* of the Franklin Institute, which contains the valuable discussion which took place in November last on the electrical distribution of power in workshops. Prof. F. B. Crocker, of Columbia University, New York City, opened the discussion with a brief *résumé* of the various advantages and disadvantages which the electric system of power distribution possesses. He pointed out, for instance, that while the cost of power in most factories was only from 1 to 3 per cent. of the total expenses, there was a considerable saving to be made in the consumption of power by the use of electrical distribution. The cost was likely to be higher than with belting or shafting, but the buildings need not be so expensive, and the depreciation was, he considered, less than with mechanical transmission. It also enabled the most economical arrangement of plant to be made, as the machines need not be placed with their axes parallel, as was the case with belt driving. Another great advantage was the freedom in the space above the machines, which in older factories was cumbered with belts and striking gear. The other advantages instanced by Prof. Crocker were less frequent and less serious breakdowns, and more ease in obtaining speed control. The most important advantage was left to the last, and was that in consequence of the clear headroom and of this improved speed control, the output of a manufacturing establishment is materially increased by use of electrical driving. The next speaker, Mr. S. M. Vauclain, the superintendent of the Baldwin Locomotive Works, bore out the last contention, and stated from experience that in his works the labour charges on the manufactured product were reduced by from 20 to 25 per cent. by the electrical driving. Again, the Baldwin Locomotive Works would require 40 per cent. more floor space were they to go back to belt transmission. Another speaker, Mr. W. H. Tapley, spoke of the advantages which had accrued to the Government printing office during the last five years from the introduction of electrical motors. There are in this office just over 200 motors with an aggregate output of 854 h.p., or about 4¼ h.p. per motor. These offices also have about 5,000 lamps of 16 c.p., and current is used for heating purposes. We are surprised to find, however, that the maximum load required is only 320 e.h.p., which makes the ratio between horse-power required and horse-power connected about 1 to 2·67. Under the average conditions the ratio is even less favourable. The figures obtained in this installation for cost are worthy of careful note. For instance, the total cost for coal and gas in 1894, when electric light was used in certain parts of the office, but no electrical motors, was £5,562; while the cost in 1899, when the whole of the printing machinery was electrically driven, was only £1,123. This shows a saving of no less than £4,439. The speaker remarked that the actual power demanded had more than doubled since 1894, and the number of lamps required had correspondingly increased. Again, since the introduction of electrical distribution they have been able to add 40 new printing presses, which, owing to the methods of driving, could not have been put down under the old system. A conservative estimate of the increased output is that a printing press will do 10 per cent. more work when changed over to electrical driving. It was also stated in connection with this installation that about 3¼lb. of coal were required per kilowatt-hour for driving the motors, the figure being ascertained after careful trials. These figures should do much to encourage the introduction of electrical distribution in this country

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WIGAN ELECTRICITY WORKS.

The history of the electric lighting at Wigan goes back to 1890, when a provisional order was obtained from the Board of Trade. As was the case in a number of orders granted in the earlier days, the town was anxious to keep the matter in their own hands, but had not sufficient confidence in the financial prospects of municipal electric lighting to carry out the scheme immediately their order was obtained. The matter was considered again in 1896 without any conclusion being come to. In 1897, however, a committee was appointed to investigate the whole matter with a view to commencing work, and the committee having to report on the best means of carrying out the undertaking, a number of towns were visited and interviews took place with engineers, both connected with these towns and also with independent consulting engineers. The committee who had the matter in hand were also responsible for the gas undertaking of Wigan, and the gas engineer was instructed to prepare a scheme on which tenders were obtained, but none of these tenders were finally accepted. The Council then decided to have an independent Lighting Committee, and this committee, after a careful deliberation, determined that

COUNCILLOR THOMAS WORTHINGTON, J.P., CHAIRMAN OF THE ELECTRICITY COMMITTEE.

THE MAYOR OF WIGAN, COUNCILLOR T. EVANS.

MR. H. COLLINGS BISHOP, BOROUGH ELECTRICAL ENGINEER.

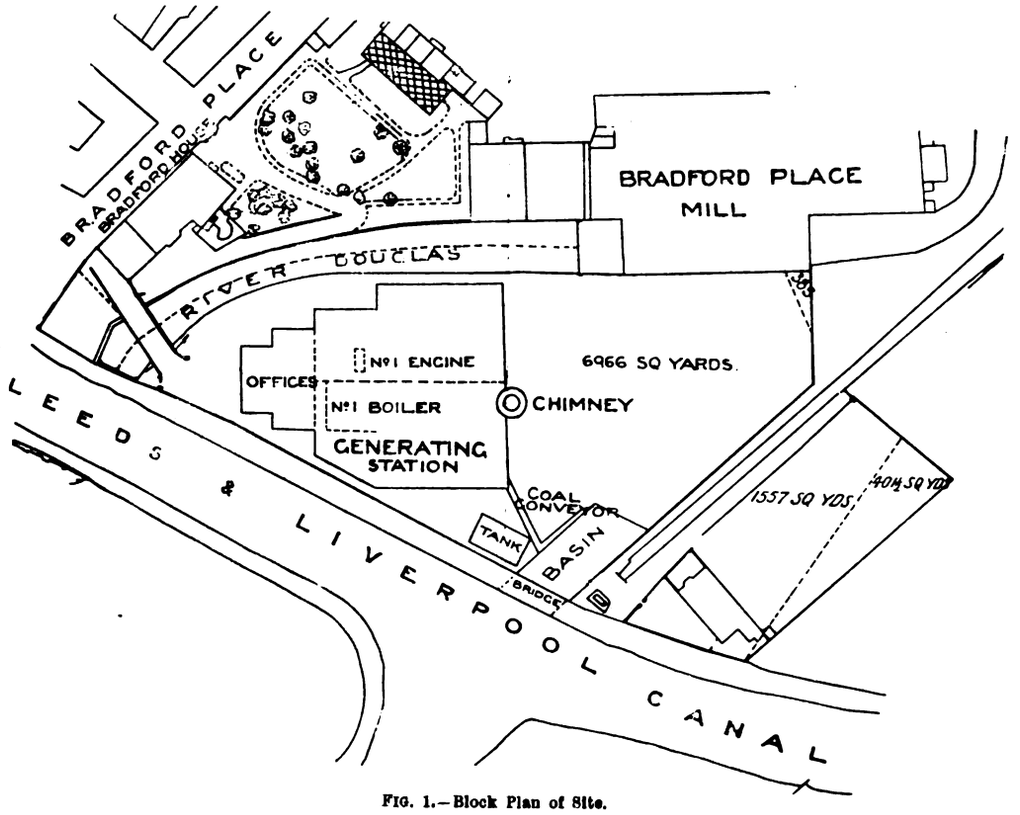

FIG. 1.—Block Plan of Site.

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it would be best for the town to engage a competent engineer, who would design and carry out the works, and afterwards be responsible for the running of the same. In consequence, advertisements were inserted in February, 1899, in the electrical papers asking for applications from electrical engineers. Naturally a large number of applications were received, and after the short leet had been selected and personally interviewed, Mr. H. Collings Bishop, who was then engineer and manager to the Leyton undertaking, was appointed to the post, commencing his duties in Wigan on March 10, 1899. Mr. Collings Bishop promptly drafted out a scheme and issued specifications, on which tenders were received. In November of that year powers were

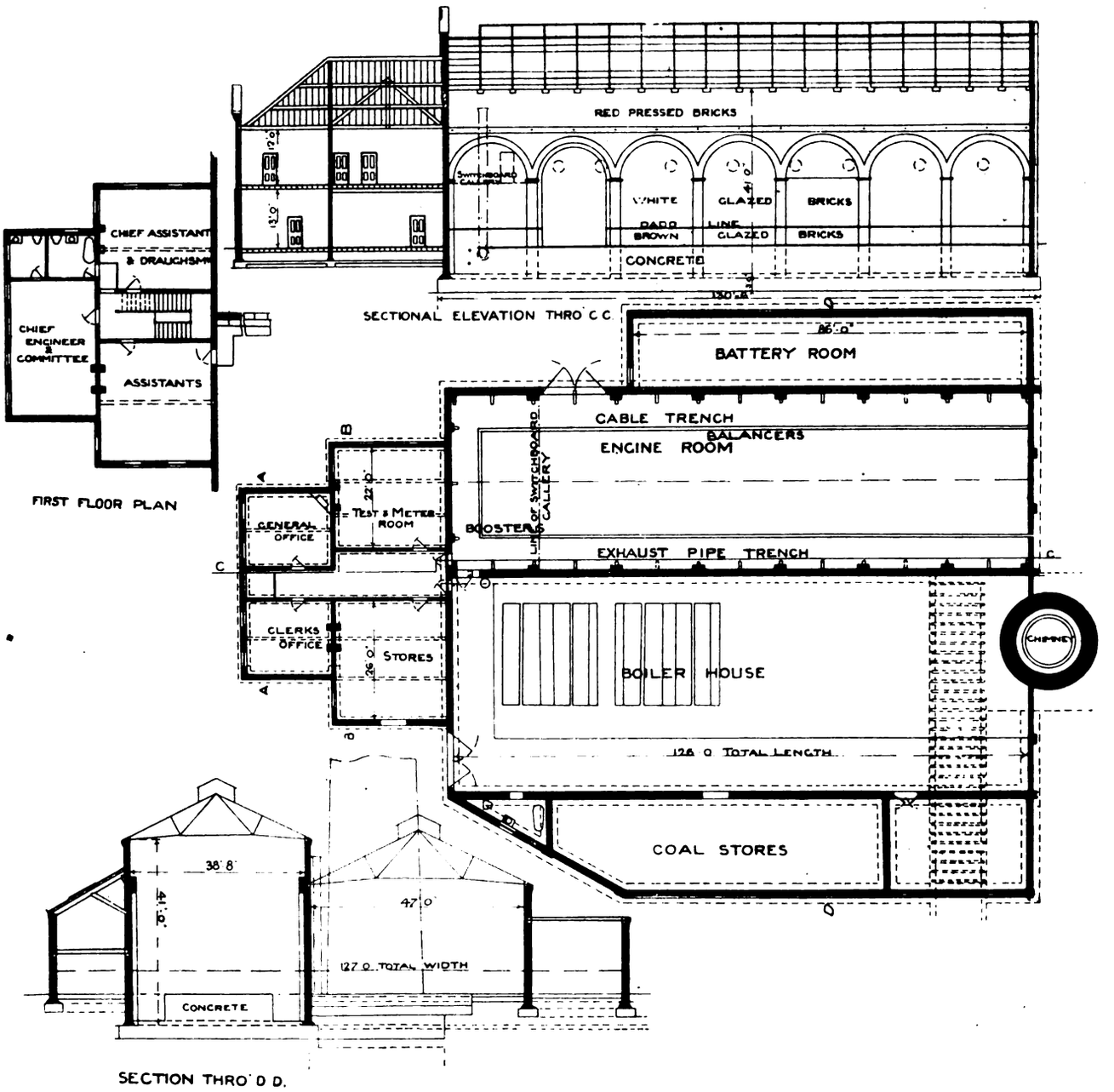

FIG , 4, AND 5.—General Plans and Elevations of the Wigan Electricity Works.

obtained to borrow £85,000, and the work was put in hand. The foundation-stone of the buildings was laid on Jan. 4, 1900, and the works commenced to supply on Dec. 17 of last year. In order, however, to get together a certain number of consumers, a small temporary plant was put down, which supplied some 2,000 8-c.p. lamps on the two-wire system. This plant was put to work by Mr. Bishop in December, 1899, and it has done much to enable the larger works to start with a respectable load. These lamps were changed over from the two to a three wire system as soon as the permanent works were completed.

Position of Works.

The site selected for the electric light and power works boasts a large number of advantages, as will be seen from the block plan (Fig. 1). The site in question is practically surrounded by water, as the Leeds and Liverpool Canal forms a boundary on the one side, while the stream which passes under the canal is a boundary on the other. The other boundary is a small leet of water, which comes, we believe, from a neighbouring mill and discharges into the canal. Having the canal so close to the works will enable all the coal required to be brought on it from collieries in the near neighbourhood, and in this way the cost of transit, which in the Lancashire district forms a considerable proportion of the total cost, will be kept down. As will be seen from the block plan, a small dock has been constructed from the canal, in which the barges will be able to lie while being unloaded. Another advantage of the position of the works is that there is ample supply of water for condensing purposes. These Mr. H. Collings Bishop has taken advantage of in the design of his station, which will start condensing very shortly. The canal water, when softened by a process afterwards to be described, will also be used for the boiler feed. The engine and boiler house at present erected will contain a good deal more machinery than is now required for the electric lighting in the town and for the tramways already authorised, but even after these buildings have been filled up there is ample space behind for the extension of the engine and boiler house in a straight line. In fact, the capacity of the site is ample for the probable needs of Wigan in the

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future, when all the trams are electrical and current for both power and light is distributed from the central station. The Corporation have also acquired, or are acquiring, the land on the other side of the river, which, if the Bill now before Parliament is passed, will be used for a main car depôt in connection with the electric tramways.

Buildings.

The designs for the buildings and for the offices which are the nearest to the entrance to the site were all prepared by Mr. Collings Bishop, and the arrangement is such as to be exceedingly convenient. The position of the various offices is to be seen in the illustrations (Figs. 2 to 5). The foundations for these buildings had to be carefully prepared, as the subsoil is water-logged, and provides none too firm a bed on which to place moving machinery. It will be seen from the illustration of the shaft that its foundation was prepared by driving 18ft. piles down into a hard substratum of sand and clay. On the top of these piles was placed the concrete bed on which the shaft was built. The bottom of the piles is some 31ft. below the actual ground line. Over the rest of the site on which the main buildings had to be erected, a continuous bed of concrete 3ft. thick was laid, and on this the walls were built. The engine foundations consist of an additional depth of 10ft. of concrete above this bed. The space between these engine foundations and the various walls makes the most convenient passage in which the mains and also the exhaust pipes can be carried. These exhaust pipes come between the engine foundations and the boiler-house wall, whereas the connecting cables between the various machines and the switch-

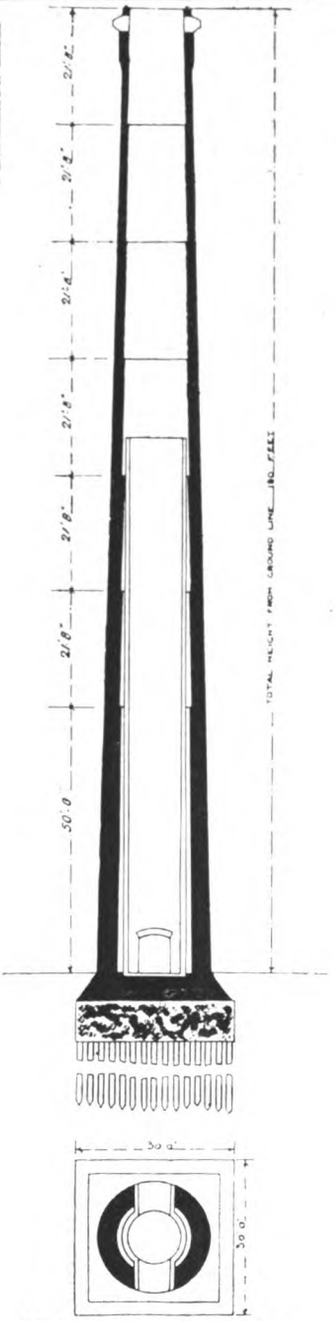
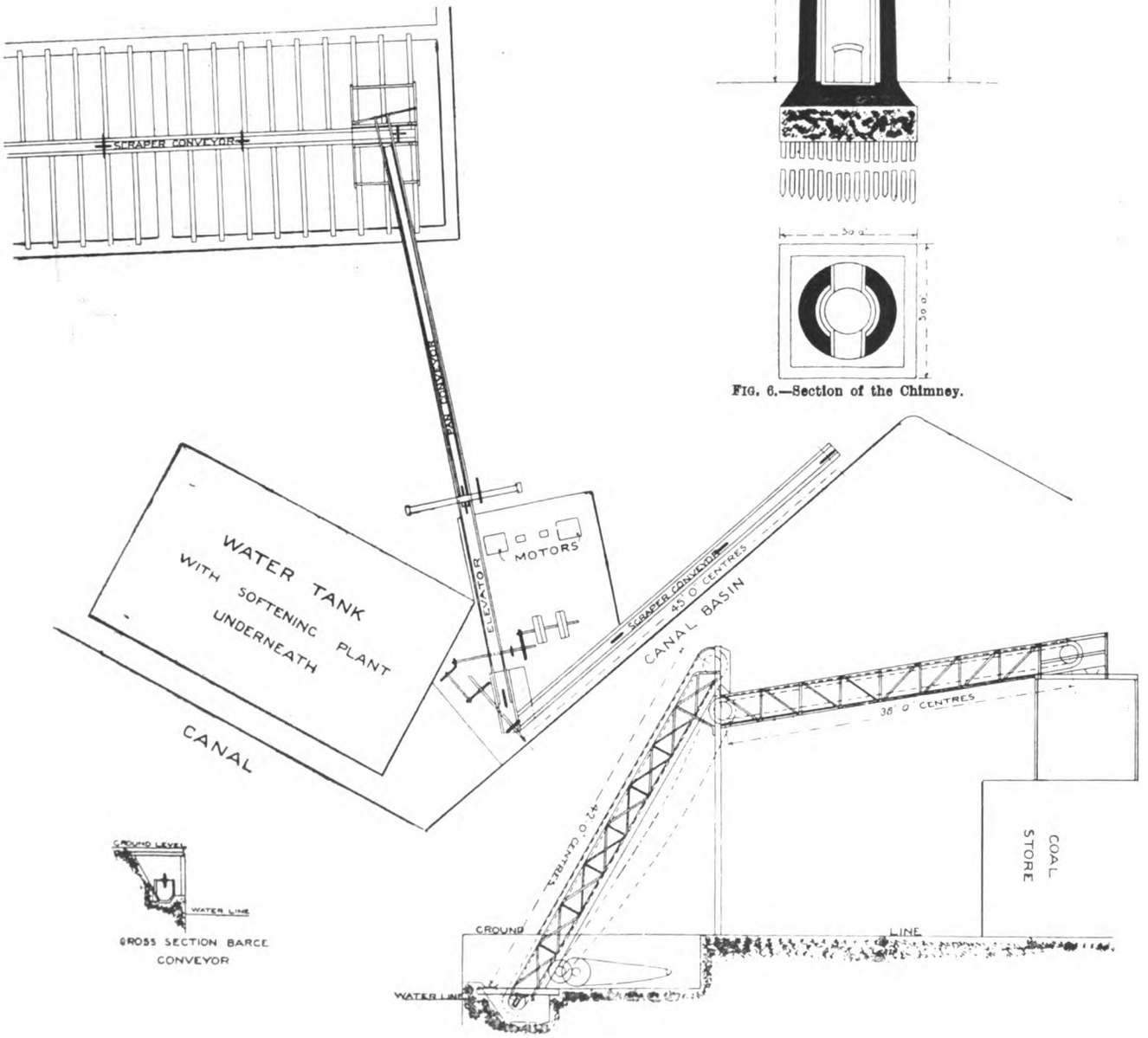


Fig. 6.—Section of the Chimney.



Figs. 7 and 8.—Plans and Elevation of the Coal-Conveying Apparatus between the Canal and Coal Store.

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board are carried in the space between the engine foundations and the wall against which the accumulator-room is built. Owing to the offices being not quite completed when we there, we are unable to give a full view of the buildings from which the architectural design could be seen. The general effect, however, is good, and the arrangements leave nothing to be desired. Another attempt of the engineer in the building line is the car-shed now being used on the tramways on the Markland Mill Bridge route. This building is only a temporary one, but the whole of the roof principals were actually made by a blacksmith employed by the Corporation under Mr. Bishop's supervision. The car-shed was also erected by Corporation labour.

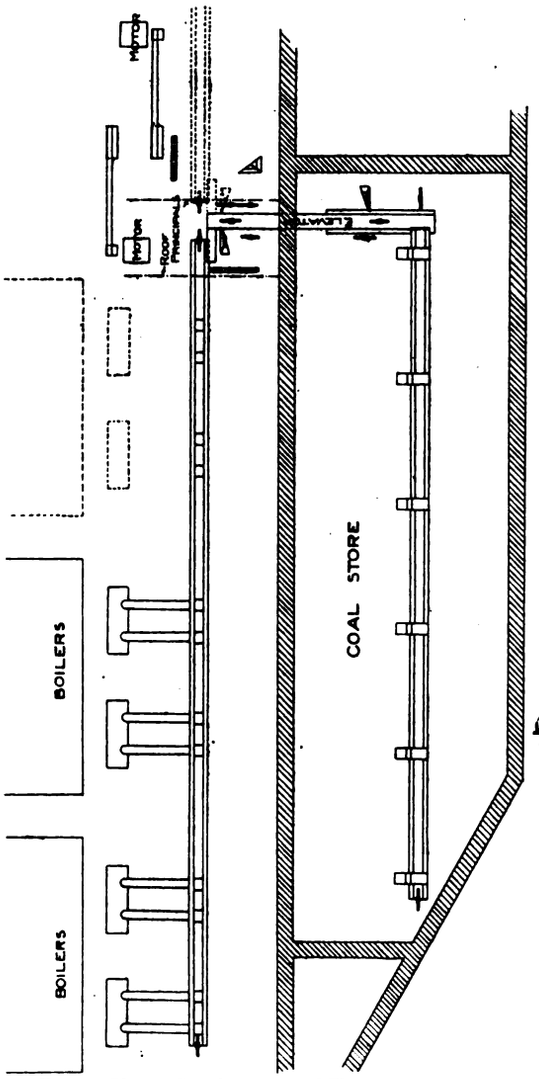


FIG. 9.—Plan o Coa Conveyor and Elevator to feed the Boilers from the Coal Store.

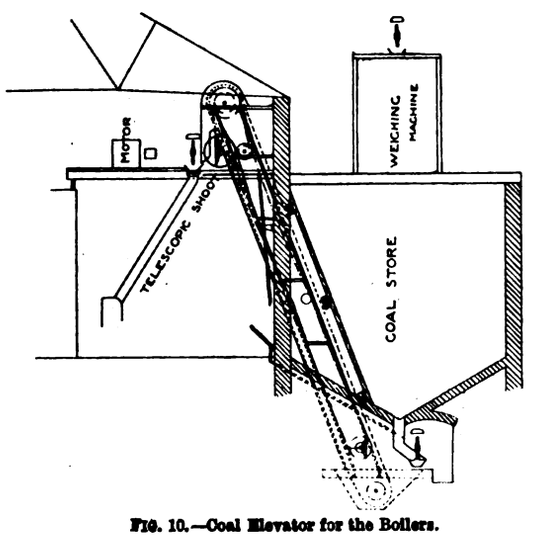
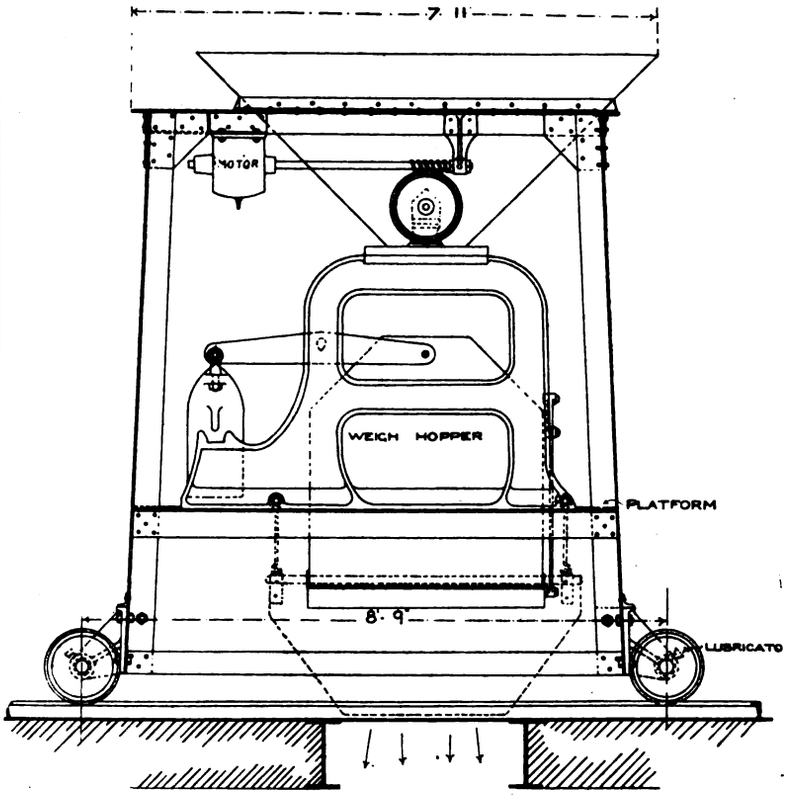
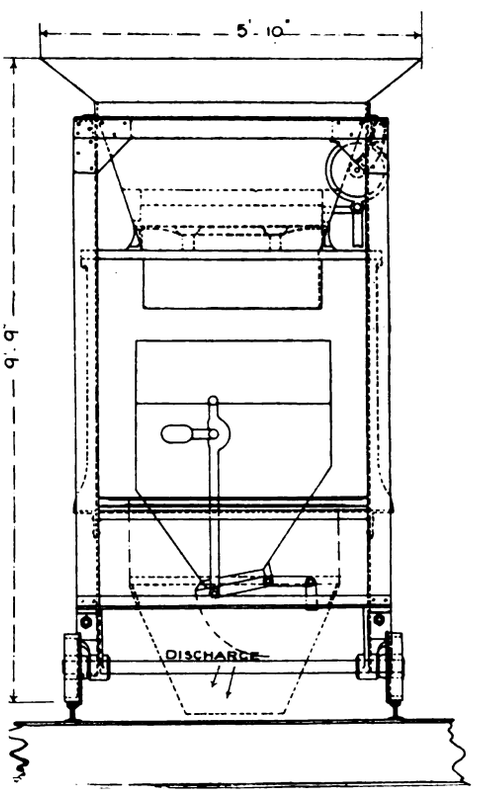


FIG. 10.—Coal Elevator for the Boilers.

COAL-HANDLING PLANT.

Before proceeding to describe the boilers, a few words concerning the means of getting the coal from the canal into the mechanical stokers of the boilers will be of interest. The machinery for this is being supplied by the Chain Belt Engineering Company, of Derby. It may be divided into two heads—first of all, the apparatus required to get the coal from the barges into the coal store and weighing it in transit; and, next, the apparatus required to get the coal out of the coal store into the various hoppers of the mechanical stokers of the boilers. In Figs. 7 and 8 illustrations are given of the conveyors and elevators, and also the weighing machine for the first operation. It will be seen that the coal can be shovelled by hand into the Dodge





FIGS. 11 AND 12.—Elevations of the Coal Weighing Machine.

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conveyor, which is about 50ft. long, and is placed alongside the dock into which the coal barges will be brought. This conveyor is below the level of the barge, and any number of men can shovel the coal into it at any portion of its length. This conveyor delivers into an elevator

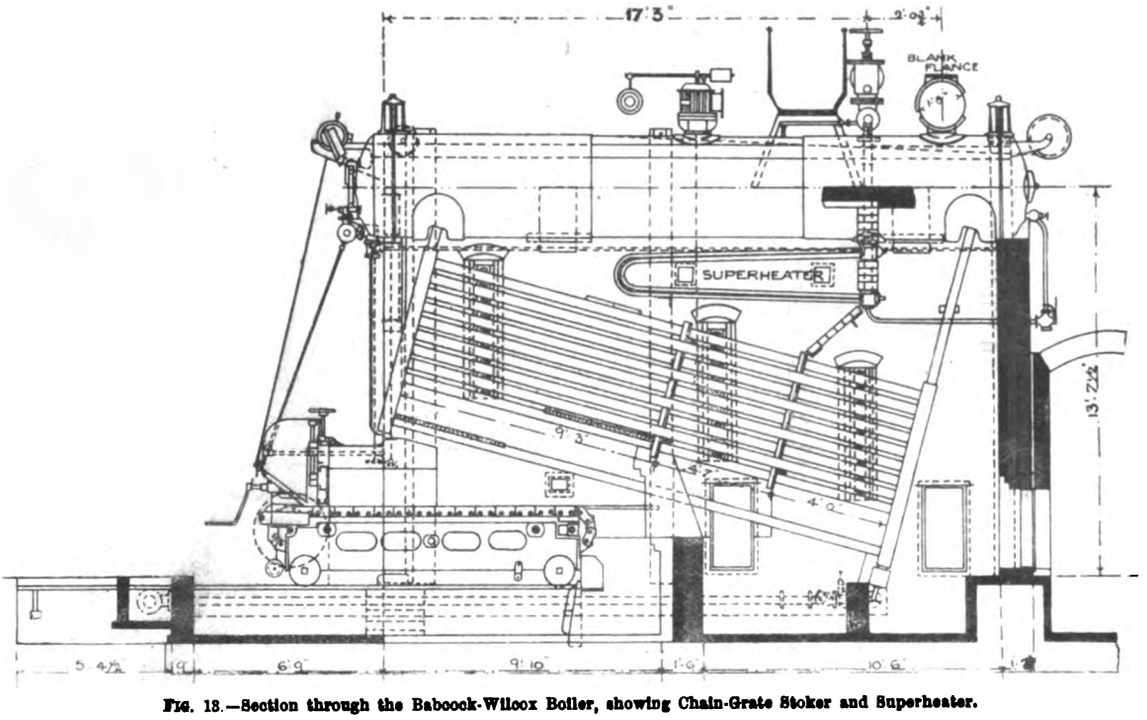

FIG. 13.—Section through the Babcock-Wilcox Boiler, showing Chain-Grate Stoker and Superheater.

of 43ft. centres, which in turn delivers into an endless pan conveyor 36ft. centres running across the roadway. The pan conveyor delivers into a Dodge conveyor 84ft. long, which runs over the coal store at a considerable height. Underneath this conveyor a weighing machine runs, of half-ton capacity. This can be fixed at any open-

store. For taking the coal from the store to the boiler hoppers the plant is arranged as illustrated in Figs. 9 and 10. A Dodge conveyor, 54ft. long, runs underneath the store, and the coal falls by gravity into this conveyor through regulating doors which are worked from the stokehole. This conveyor delivers into an elevator 37ft. high, which in turn delivers the coal into a conveyor 74ft. long, running directly over the hoppers on the boiler fronts and delivering automatically into any of these hoppers, the supply being regulated by doors worked from the stokehole. There is thus no manual labour required for supplying the boilers

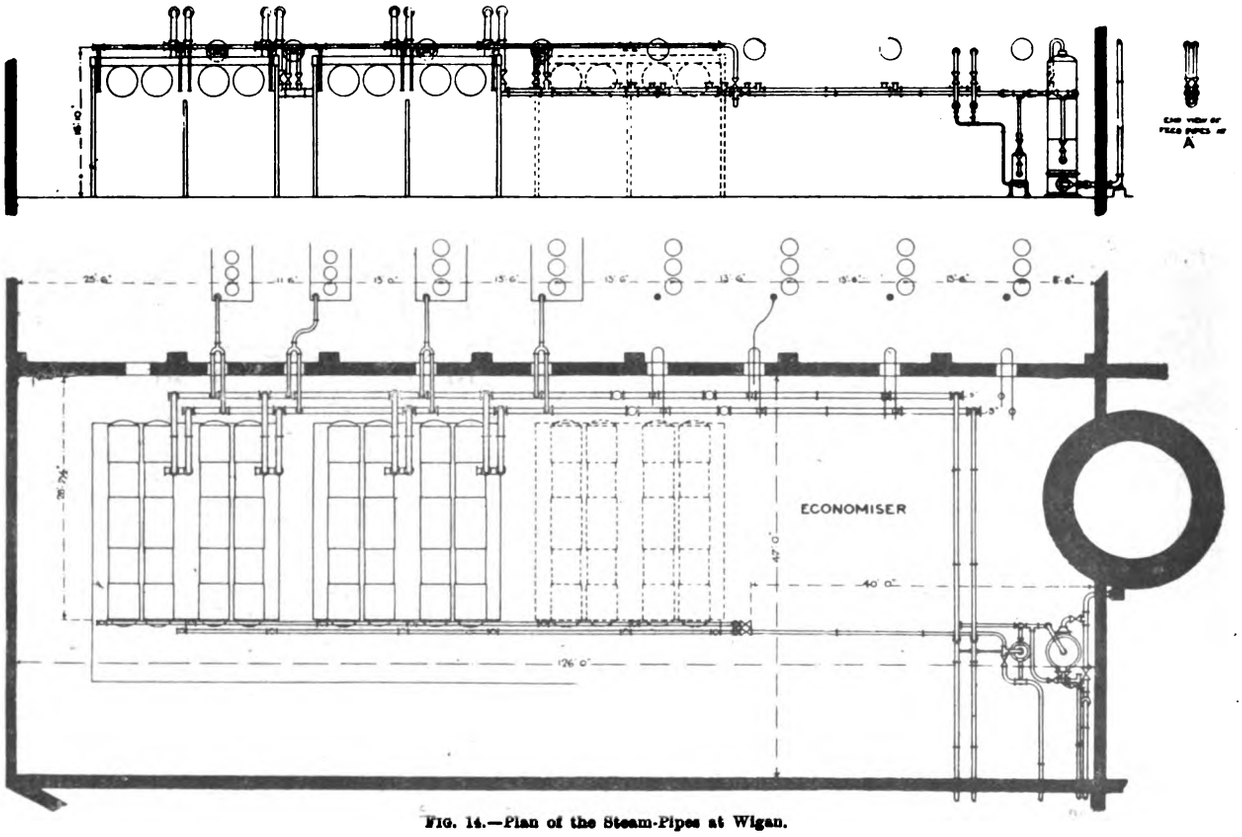

FIG. 14.—Plan of the Steam-Pipes at Wigan.

ing in the roof of the coal store, and is automatically filled by the conveyor above it. The weighing machine itself is quite automatic, and will weigh the coal in half-ton lots and register same without any attention from the men in charge. There is thus no handling of the material from the time it leaves the barge until it is received into the coal with coal out of the store. The capacity of the plant is about 20 tons per hour, running at a moderate speed, and it is all driven by electric motors, which are placed in the positions indicated in the drawings. The weighing machine, which is of the Avery type, is illustrated in Figs. 11 and 12. The apparatus for withdrawing the

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coal from the store is so arranged, as can be seen, that any part of the store can be drawn on, and this will enable, if need be, the kind of coal used to be varied, as the coal from different collieries can be placed in different parts of the store.

THE BOILERS.

These are of the Babcock-Wilcox type, and four of them are fixed under the first contract. Each of these has a total heating surface of 3,140 square feet, and is fitted with steam superheaters and with chain grate stokers. A sectional elevation of the boiler with this stoker and superheater is shown in Fig. 15. From this it will be seen that the coal from the hopper falls on to the travelling endless chain grate, the depth of the fire being regulated by the height of the firedoor. The feed of the coal is so slow that the quantity of gas evolved from the fresh fuel coming under the front end of the arch, has time to complete its combustion by the radiated heat from the further end of the arch before coming into contact with the boiler surface. Thus the fuel is coked, and is gradually consumed as it travels the length of the grate, falling over at the back end into the clinker pit. The speed of travel of the grate is regulated by a ratchet and pawl attachment on the driving worm, which latter gears into a wormwheel, on the shaft of which are drums which revolve the grate. The depth of the fire, as above mentioned, can also be regulated at will, and thus the machine can be in a moment adjusted to any kind of fuel at any rate of combustion. These stokers are driven from a countershaft fixed to the girders running back of the boiler-house wall, which in turn is driven by means of an electric moto of the G.E.C type. The stoker is so arranged that it can be worked by hand by means of a crank placed on the end of the wormshaft if the motive power breaks down, or it can be worked as a stationary grate, as the firedoor, which is made in halves, can be opened just the same as the fire-

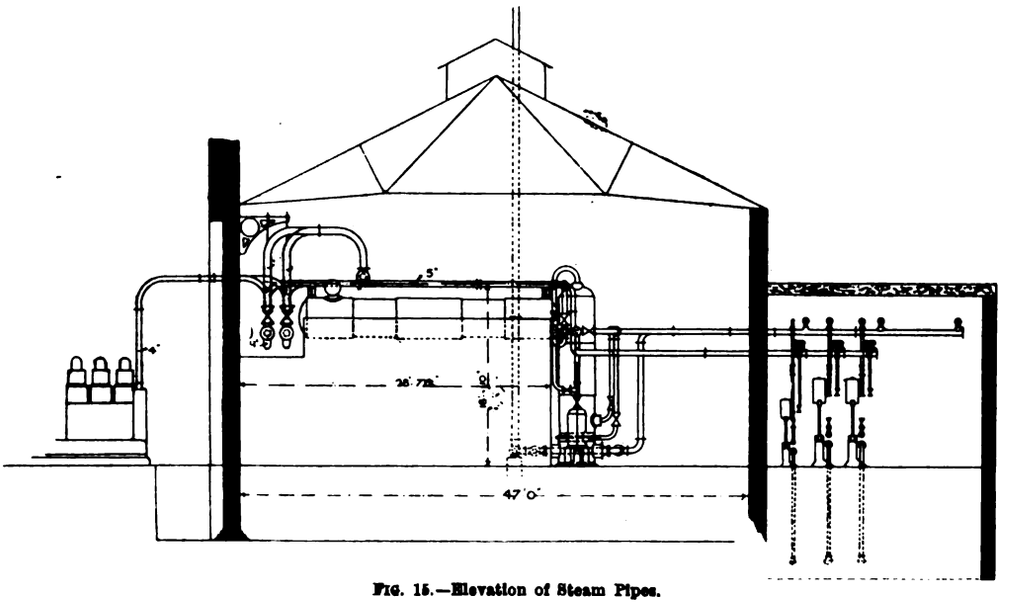

FIG. 15.—Elevation of Steam Pipes.

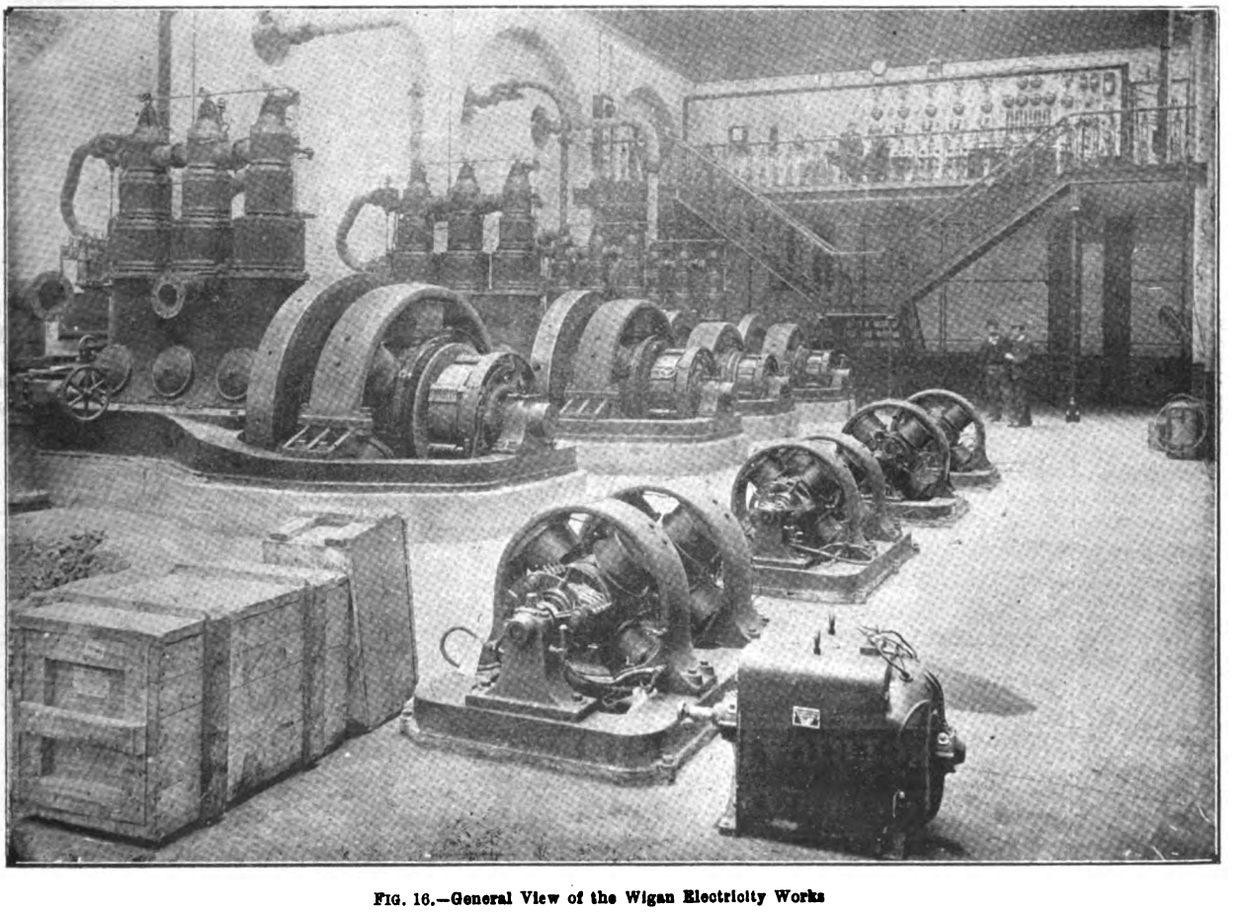

FIG. 16.—General View of the Wigan Electricity Works

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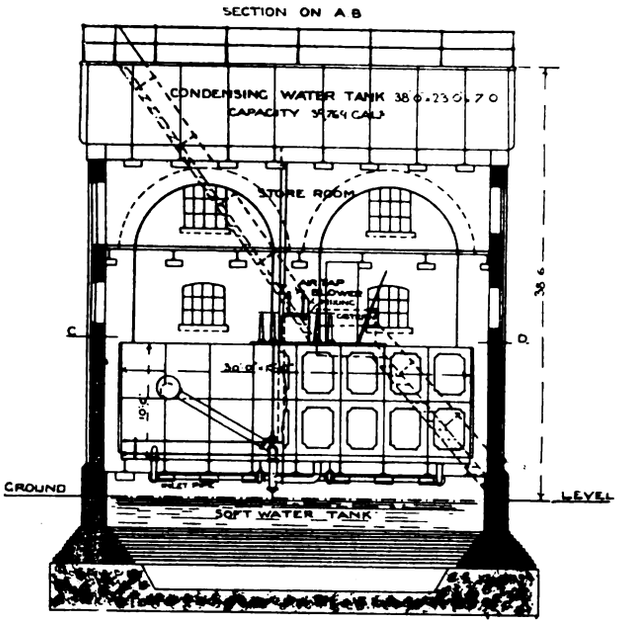
doors of an ordinary hand-firing furnace. The ashes from the grate fall down an inclined shoot into a passage constructed beneath the boiler-room floor. The openings of each of the shoots is closed by means of a door. Along the passage a small truck runs on rails, and the ashes are



FIGS. 17 AND 18.—Plan and Elevation of the Water Power and Water oftening Plant.

raked down into this truck after the doors closing the shoots have been opened.

STEAM-PIPES.

The general arrangement of these steam-pipes can be seen from the drawing of the station given in Fig. 14. The two steam-mains are placed over the main flue between the boilers and the chimney, and there is space left behind these pipes and the wall for a man to walk along the line in order to actuate the various valves. On each boiler is placed the usual non-return stop valve. The connection from this provides two flanges on to which the bends connecting the boilers to either of the duplicate steam-mains is made. The stop valves on these bends are placed at the junction of the bends with each of the main steam-pipes for means of working. The connections between these main pipes and the various engines are made in much the same way, there being an independent rising pipe from each steam-main. A valve is provided in each of these rising pipes, and they are afterwards connected together by a Y, from which a single pipe goes on to the engines. It will be seen from the drawing, and also from the photograph of the station (Figs. 15 and 16), that there are no steam-mains in the engine-room, the only pipes which occur overhead being the single connections from the steam-mains in the boiler-house to the various engines. Although only four boilers are at present fixed, the mains are run the full length of the boiler-house in order to connect up to the feed pumps and the condensing water pumps, which are placed in a room which is a continuation of the coal store.

THE BOILER FEED.

As mentioned in the introductory remarks above, the Corporation are able to use either canal water or town water for boiler feeding purpose. In either case the water is passed through the water-softener, which is placed under the large iron tank forming the reservoir for the condensing water. This water-softening plant was supplied by Messrs. Mather and Platt, and is of their standard type; it is capable of treating 6,000 gallons of water per hour. It consists of one large iron tank divided up by a wrought-iron division into two compartments, each 15ft. by 15ft. by 10ft. deep. The tanks are worked alternately—*i.e.*, the processes of filling, softening, and clarifying are carried on in one compartment, whilst softened and clarified water is being drawn off from the other. The softened water is run into a brick reserve tank, from whence it is taken to the boilers. Figs. 17 and 18 give illustrations of this water-softening plant, and the position of the various valves required in working the same. The mixing tank for the lime-and-soda solution is seen in the middle of the platform over the tanks. Steam is used to inject this solution into the water to be softened, and the whole is then stirred by forcing air through it. After the whole is mixed together, the sediment is allowed to deposit on the bottom of the tank. The withdrawal tube, seen in the illustration, for drawing off the water is arranged with floats, so that the softened water is always taken from the surface. In this way there are no stirring-up currents caused by the withdrawal, such as would disturb the deposit at the bottom of the tank. The water from the town mains in its usual condition has a hardness of about 12deg. on the Clark scale. After treament in this water-softener the hardness is reduced to about 4deg. at a cost for chemicals of about ½d. per 1,000 gallons. This water-softening apparatus supplied by Messrs. Mather and Platt works on the Archbutt-Deeley process.

The softened water from the storage tank underneath the water-softener then flows through a brick conduit to an open trench in the pump-room, into which the pump suctions dip. The feed pumps employed are of the Weir type,

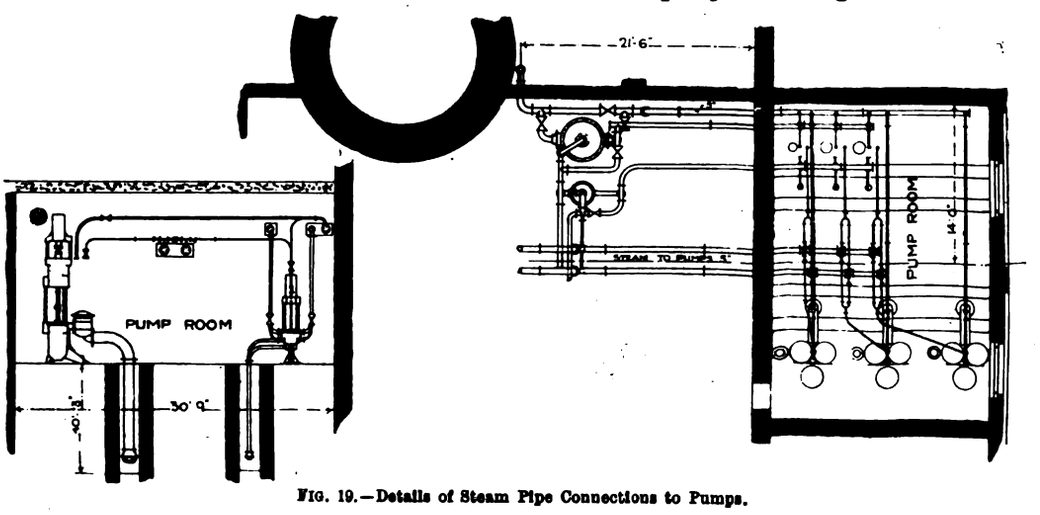


FIG. 19.—Details of Steam Pipe Connections to Pumps.

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which are now so frequently met with in all power stations. From these pumps, which can be seen in Fig. 19, the water is passed to the boilers in various ways. Thus it may either go through a live-steam heater or an exhaust-steam heater, supplied by Messrs. Isaac Storey and Son, and thence to the boilers, or it may go to the Green's economisers. The connections on the feed pipes are so arranged that they are completely in duplicate. The duplicate ranges of pipes have also cross connections in places, so that in the event of a breakdown, in each independent service of feed the pipes can be so cross-connected that one complete system is still available.

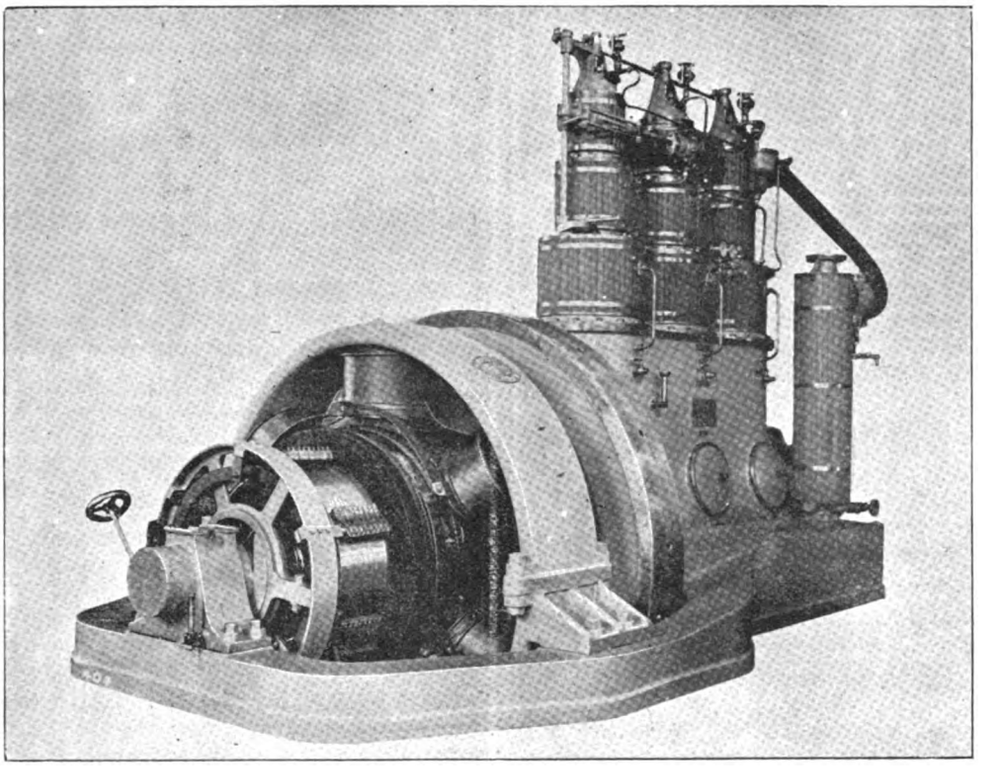

FIG 20.—End View of the Willans and Byng Hawkins Steam Dynamo.

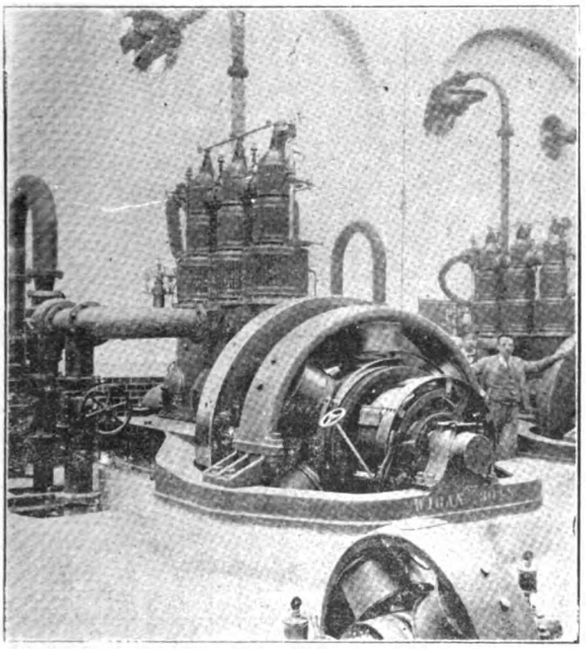

FIG. 21.—View of one of the 210-kw. Sets, showing the Exhaust Pipe Connections to the Condensers.

The economiser, which was supplied by Messrs. Green and Son, of Manchester, is arranged in three separate sections. There are some 512 pipes altogether fixed, but the three sections enable any one-third of these to be used quite independently of the remaining two-thirds. This is a decided advantage, as one section of the economiser can be closed for cleaning or any other purpose while the other two sections are at work. Each economiser is arranged in two parts, with expansion pipes between them, to facilitate examination in cleaning. There are, of course, three independent dampers to admit the furnace gases into the economisers from the main flue.

ENGINES AND DYNAMOS.

The generating plant now fixed consists of four engines made by Messrs. Willans and Robinson, while the dynamos were supplied by the General Electric Company. The two large engines are of the Willans 3-I type, with three lines of cylinders and three cranks at right angles. Each of these engines is capable of developing 336 h.p. when running at a speed of 350 revolutions per minute with 160lb. of steam at the stop valve. The two smaller engines indicate 240 h.p. at 38 revolutions. The above are at ordinary full load, as the engines will give an overload of 10 per cent. The governors are of the automatic expansion type, specially designed to enable the engines to respond quickly to the changes of load due to the tramways. The centrifugal governors actuate a relay which quickly moves the levers varying the cut-off in each line of cylinders.

The dynamos of the General Electric Company's six-pole type were all manufactured in their Manchester workshops. The duty of the larger dynamos is 420 amperes at any voltage from 460 to 500 on lighting load, and 500 to 550 volts, 300 amperes, on traction load. The smaller sets on lighting load are made for 460 to 500 volts, 300 amperes, and on traction load 500 to 550 volts, 215 amperes. These dynamos can be overloaded 10 per cent. on lighting load and 25 per cent. on traction load. The machines are, of course, over-compounded for traction work, the compounding being cut out for lighting service. The magnet frames of the generators are divided on the horizontal diameter, and the larger sets especially have very light fields and yokes, much resembling the American type. The pole-pieces and field coils are of cylindrical shape. The armatures are of the flywheel type, of large diameter, with slotted cores. The carbon brushes can be retained in a fixed position, and run sparklessly from no load to 25 per cent. overload.

From the illustrations (Figs. 20 and 21) a good idea of the general arrangement of the parts of these dynamos can be obtained, while the fullest details of construction are given in the section (Fig. 22) kindly furnished to us by the makers. From this section it will be seen that the armature cores are well ventilated. This is proved by the temperature measurements taken after a six hours' run at

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full load. With an air temperature of 73deg. F., the engine end of one of the large dynamo armatures was found to have a temperature of 117deg. F., while at the commutator end the temperature of the armature was only 106deg. F. These readings give rises of 44deg. F. and 33deg. F. respectively. The smaller armatures get rather warmer, but here again the maximum rise was only 67deg. F., while on the field coils the maximum rise was 50deg. F. The efficiencies obtained from these engines and dynamos on trial will be seen from the two diagrams (Figs 23 and 24). The steam consumption per kilowatt-hour in the larger sets at 155lb. steam pressure at the engine stop valve was 27·8lb. at full load, 28lb. at three-quarter load, and 32·12lb. at half load, and in the case of the smaller sets, with 152lb. steam pressure, 29·7lb. per kilowatt-hour. The weight of the complete armature of a large generator is 3½ tons.

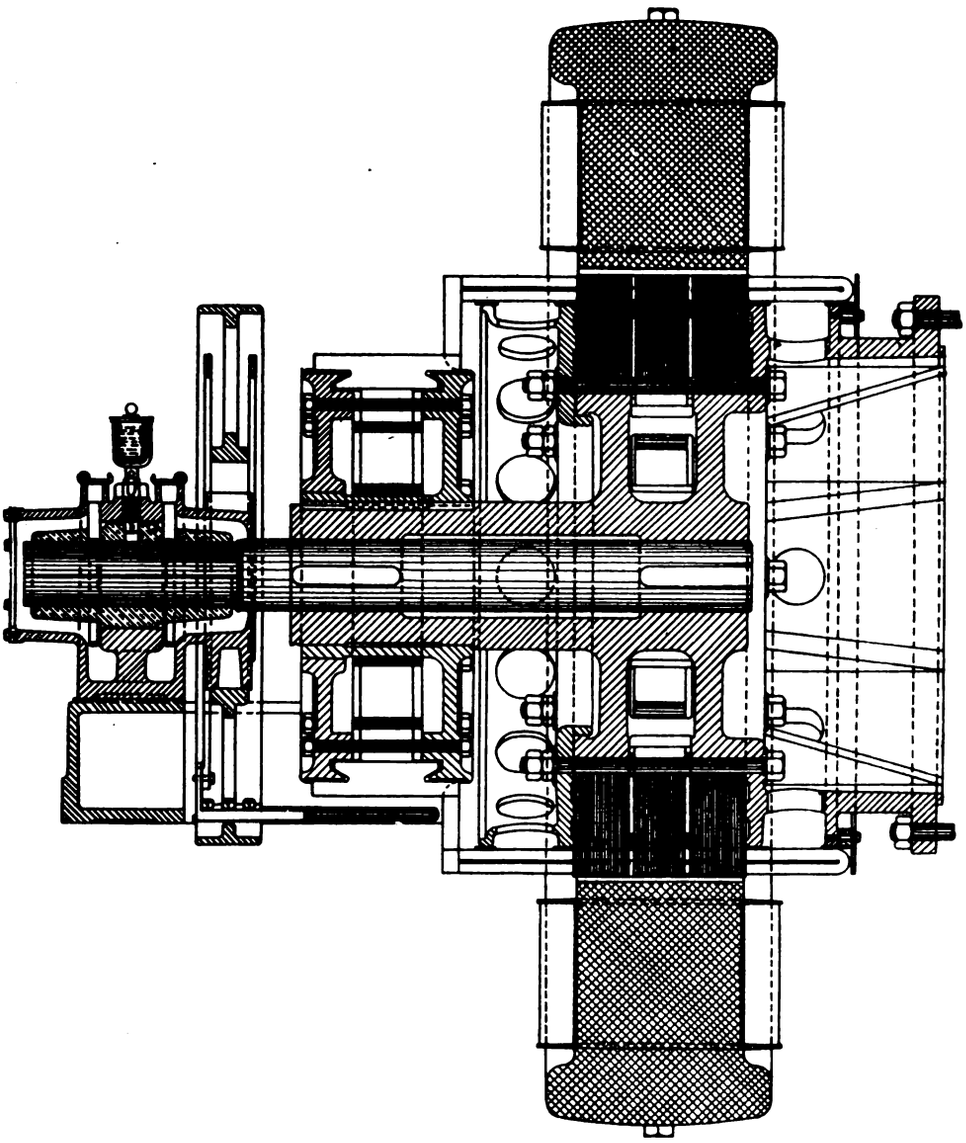

FIG 22.—Section of the Byng Hawkins 6-pole Direct-Current Dynamo.

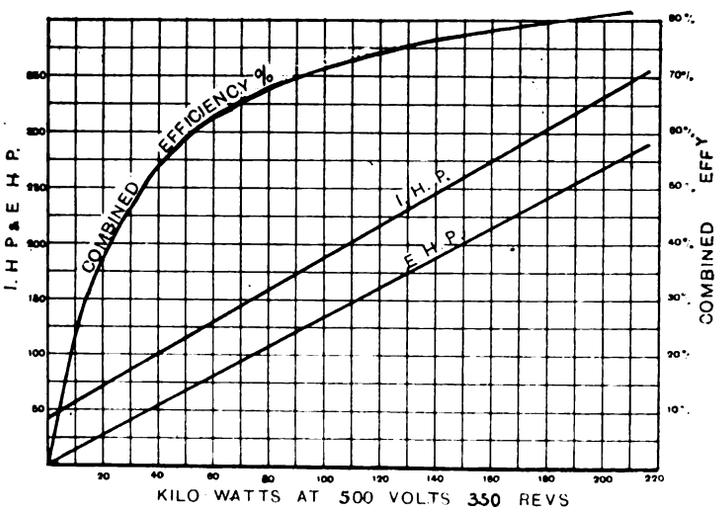

FIG 23.—Efficiency Curves of the 210-kw. Steam Dynamo.

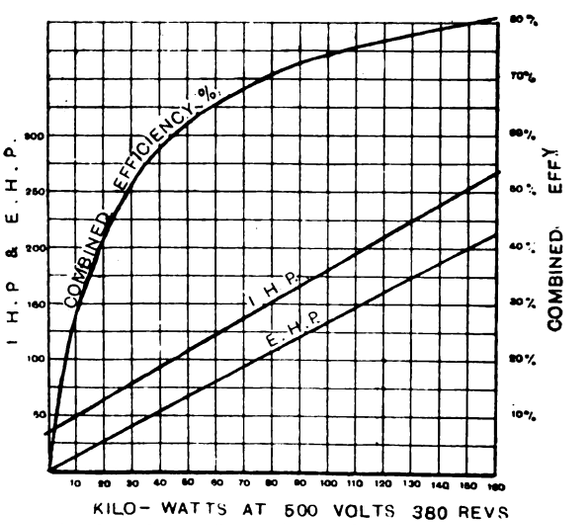

FIG. 24.—Efficiency Curves of the 150-kw. Steam Dynamo.

THE CONDENSING PLANT.

The arrangement of the condensing plant at Wigan contains several most interesting features. The Korting type of ejector condenser is employed, and Messrs. Korting Bros. also supplied and erected the whole of the

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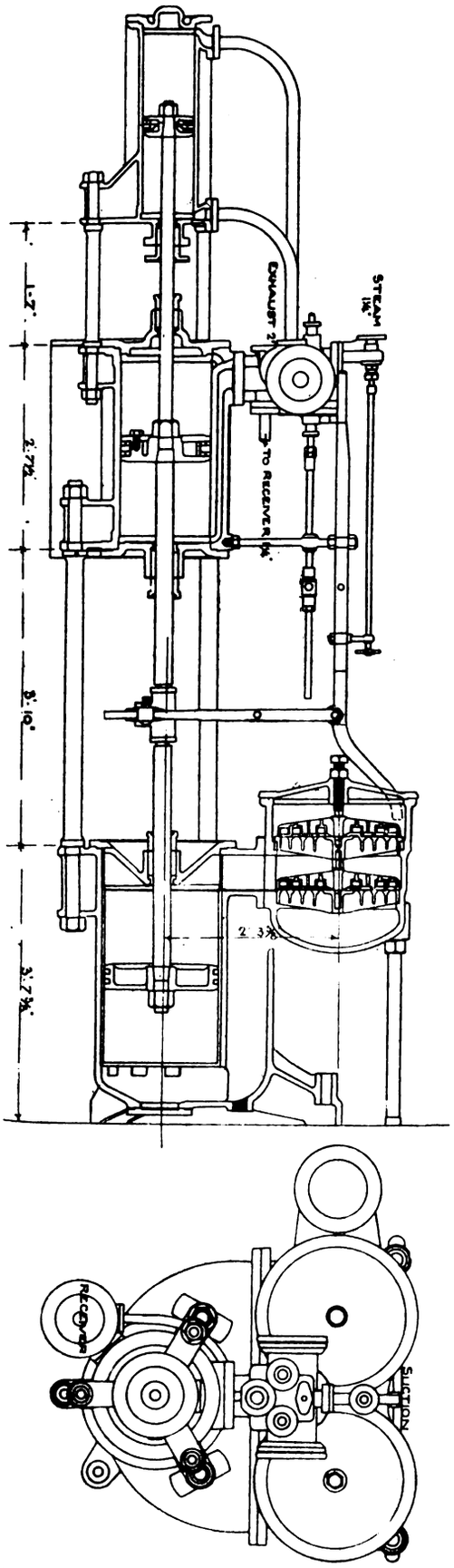
pipe work in connection with the condensing plant. The water used for the ejector condensers comes from the canal. It is drawn from the canal by means of three circulating pumps supplied by Messrs. J. and G. Weir,



FIGS. 25 AND 26.—Plan and Elevation of the J. and G. Weir Pumps for Lifting the Condensing Water.

each of which is capable of forcing up into the large tank 60,000 gallons of water per hour. This is done by 25 double strokes per minute of the pump. The head against which these pumps have to work is some 40ft. Figs. 25 and 26 show respectively the elevation and plan of these pumps, which are, we believe, the largest the firm has yet made. They had not been put to work when we were at Wigan, but were practically ready for starting. The arrangement of the pipes and pumps is shown in Fig. 27, while in the next illustration (Fig. 28) can be seen the arrangement of the pipes as fixed to each engine. The photograph (Fig. 21) also shows the exhaust pipes and ejector condenser as connected to one of the largest engines. Besides being able to condense in this way, an atmospheric exhaust has been provided by Mr. Collings Bishop. The arrangement of this exhaust can be seen from the illustration. The two smaller condensers fixed to the Willans 3-H engine are of Messrs. Korting Bros.' No. 25 size, and require 15,400 gallons of water per hour. The larger pair of condensers for the 210-kw. steam dynamo is of the No. 30 size, passing 22,000 gallons per hour. Two more condensers of this size are also on order for the other two steam dynamos which are shortly to be erected in the station. A vacuum equal to 24in. of mercury is guaranteed for all the condensers, and this the makers have undertaken to obtain when the smaller plants are giving 5,000lb. of steam per hour to the condensers and the larger sets 7,000lb. It is provided in this guarantee that the supply water shall be at a temperature of 70deg. F. All the condensers are discharged into a common pipe which carries the water into a sump, from which a drain is taken to the canal. The water-pipes have been put in of such a size as to allow for more engines to be connected without altering the existing arrangements or inconveniencing the present plant.

ACCUMULATORS.

The battery was manufactured by the Electrical Power Storage Company, Limited, and consists of 280 cells in wood lead-lined boxes, each cell containing 15 plates erected on single-tier stands, and is capable of discharging at 75 amperes for 10 hours, or 150 amperes for four hours, or 300 amperes for one hour, the final E.M.F. at the end of any of these discharges not to be less than 525 volts. The first half of this battery was erected some months ago in a temporary battery-room, but it has now been taken to the permanent electric lighting station, and the remaining half of the battery erected with it. There are two floor levels in the accumulator-room. The upper floor, which is only partially boarded over, is carried on iron girders, and is reached by a staircase from the ground floor. The cables to these accumulators are all of the rubber-covered type, and are laid in wooden casing which is filled up with bitumen. This gives a secure protection against the fumes from the acid. The charging of the battery is effected on somewhat novel lines. The procedure is as follows: The battery is put across the 'bus bars, and the number of cells reduced until charging takes place. The cells so cut out of circuit are charged independently by a small motor-driven dynamo. The battery regulating switch can be seen in Fig. 29.

The arrangement of the subsidiary electrical apparatus in the station is decidedly novel. This is so because Mr. Bishop has elected to use only two wire feeders throughout, and to distribute his balancing machines in various parts of the network. The third wire of the system is, however, brought back into the station, and two of these balancing machines are fixed in the main engine-room. Another point of novelty in central-station work is that there is no provision made on the switchboard for supplying different voltages to different feeders. Thus there is only a pair of lighting 'bus bars—*i.e.*, one positive bar and one negative bar. In order, then, to be able to run at a common voltage in the station for both long and short feeders, provision is made for inserting boosters in the feeders which go to the more distant parts of the town. The balancing machines, one of which can be seen in Fig. 29, are of the General Electric Company's standard four-pole type, with a single field magnet and a double-wound armature. Each side is capable of transferring to the opposite side of the three-wire system 50 amperes at 230 volts. It will thus be seen that each of the balancers can compensate for 100 amperes out-of-balance current in the system. The machines run at a speed of 1,100 revolutions per minute. Seven of these balancers, which are exceedingly neat and compact machines, have been supplied by

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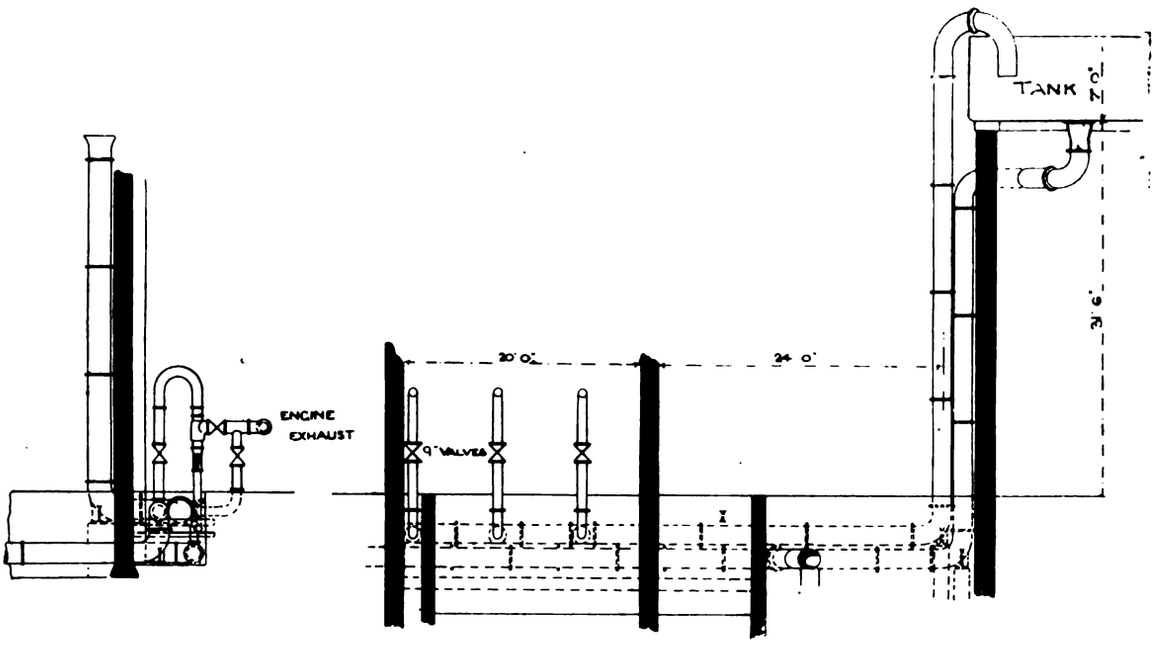
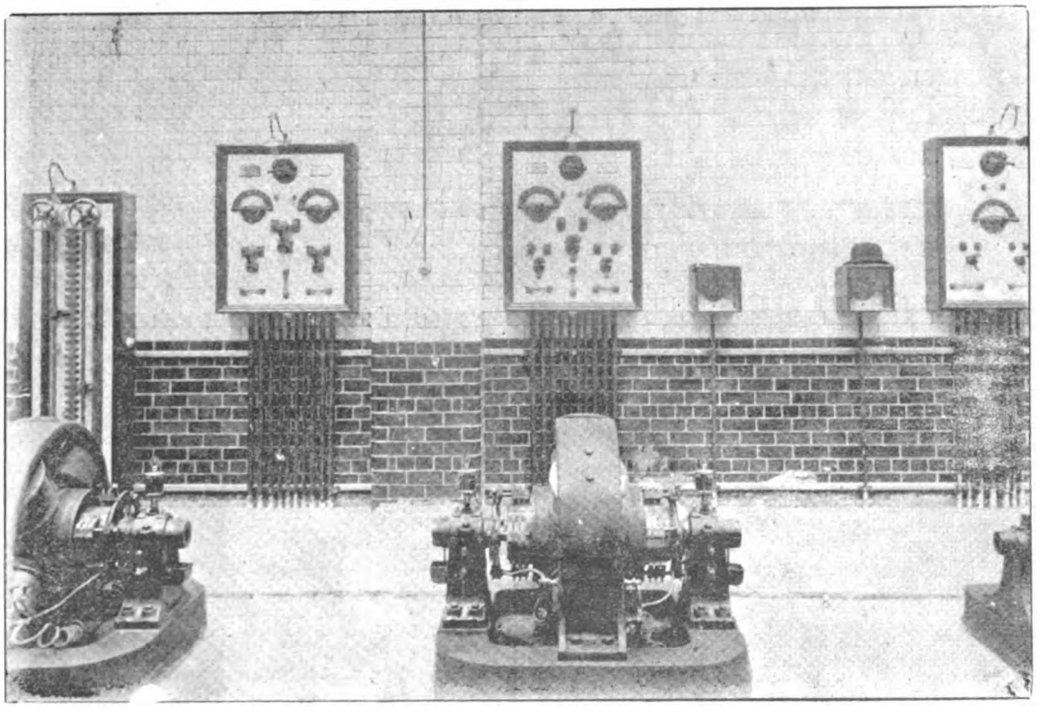
the contractors. Two of these are fixed in the central station, while the other five are placed in sub-stations constructed in various parts of the town. The boosters are naturally placed in the engine-room, and space has been found for them under the switchboard gallery. Three of these boosters are now erected; they each consist of a standard four-pole motor coupled to a four-pole dynamo. The dynamo is capable of passing a current of 500 volts and of adding 20 volts to the E.M.F. The dynamo armature is duplex wound—that is to say, there are two distinct windings in parallel. This construction does much to enable the machine to run smoothly in spite of heavy currents being passed through its armature while the field is only a little excited. The field magnets of this booster are wound with a heavy conductor, through which the current to the feeder passes. In this way the E.M.F. added is practically proportional to the current in the feeder, and al.. .. the drop in the feeder. The regulation of the boosting is arranged for by inserting a low-resistance shunt across the terminals of the field winding. The switch gear for introducing the booster dynamo into a feeder circuit is a most ingenious one, and was designed for the purpose by the General Electric Company. It is so arranged that a series of resistances across the field-magnet winding that the armature is cut into the feeder circuit when it is generating only about two volts. The resistance is then increased until the required boosting voltage for the current going through the booster is obtained. The machine is then practically automatic, but it can be further regulated by altering the resistance in the shunt in the driving motor. This motor is supplied at 460 volts from the lighting 'bus bars, and its normal speed is 900 revolutions per minute. On trial it was found that this 10-kw. motor-driven booster had a combined efficiency of 74 per cent.



FIGS. 27 AND 28.—Sectional Elevations of the Circulating Water Pipes for the Condensers.

The other two motor-generators seen in the foreground



W showing one of the Balancers with Switch Gear at the back and also the Accumulator Switch Gear.

of Fig. 16 are used to charge the end cells of the battery of accumulators, which cannot be charged at the 'bus bar voltage. The construction of these motor-generators is similar to that of the motor-driven boosters described above. In this case, however, the dynamos are designed to give 100 amperes at 100 volts, at a speed of about 1,050 revolutions per minute.

(Continued on page 164.)

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TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

The adjourned general meeting of the Tramways and Light Railways Association was held at Norfolk House, Norfolk-street, W.C., on Friday last. In the unavoidable absence of Sir C Rivers Wilson (the president) through indisposition, Mr. Atherley Jones, M.P., was elected to the chair.

The SECRETARY (Mr. Norman E. Thompson) read the notice convening the meeting.

In opening the proceedings the CHAIRMAN said: This is the first meeting of the Tramways and Light Railways Association. It is called in the main for business purposes, but perhaps I shall not be regarded as unduly intruding upon your time if I say a few words with regard to the purposes of this association. It was formed some 18 months ago, and I need hardly say that its main, and almost its sole, object is to develop throughout this country means of transit, and chiefly through the aid of electricity. I think probably every gentleman in this room will concur with me when I say that the development of tramway locomotion in this country, undoubtedly considerable as it has been, has not been commensurate with what might reasonably have been expected, and is certainly not to be compared with what has been done in other countries. The progress in this country has been lamentably short of what we might have hoped for. I need only state that if you take the development of tramways in the United States of America, some very few years ago—about the year 1890—there were not more than 150 miles of electrical tramways, whereas at the present time, within a period of 10 years, that has developed to something like 20,000 miles. Unfortunately, there has been no corresponding development over here, for during that same period, instead of developing by thousands of miles, as the industry has in the United States, only some 175 miles have been added. Altogether there are not more than 1,200 miles of tramways in this country. One of the most urgent matters which has recently engaged the attention of the Legislature is that of enabling the humbler classes of the community to dwell some distance from the centres at which they work, and that can better be attained by facilities of cheap locomotion than probably by any other method that the Legislature can take advantage of. As I have said, this association is mainly concerned in development by electric traction, and it hardly needs very much argument to convince even the least informed man of the enormous advantages of electric traction over horse traction, or even steam traction. It is obvious, in the first place, that it is a great saving as regards wear and tear, and it does away also with a large amount of physical suffering to horses. That alone ought to commend it to rational beings. But it has another advantage. Whereas horse traction costs something like 9d. to 1s. per car mile, electric traction is found to cost not more than 5d. to 8d. per car mile, and, of course, it is obvious that probably that cost may be materially decreased in the future. I may proceed now to deal with the specific objects of this meeting. What I have said provides, I hope, a sufficient justification for the establishment of this society. There are 200 members, derived not merely from those who are profitably associated with the tram industry, but from those connected with the great corporations of this country. We have to make it apparent to municipalities that there is no intention and no desire on the part of this association to do anything to interfere with their just rights. At the same time, this association is alive, and it is a fact that one of the greatest hindrances in tramway development is the existence of restrictions, partly legislative and partly administrative. We hope, however, by proper objection in conjunction with corporations to remedy, if not altogether remove, these state of things. There are two Acts of Parliament dealing with the subject, the old Tramways Act of 1870 and the Light Railways Act, and they are not always very wisely used by those who have authority to put them in force. We have been in communication with the Board of Trade with the idea of getting the former Act abandoned. The decision is unfavourable at present, but we do hope that at any rate some reasonable modifications may be made in both. We know that corporations have done a good deal, and are still doing a good deal, in the way of tramway expansion, but at the same time in some cases objections have been raised partly through jealousy and partly in consequence of the rival interests of adjoining local authorities. Sometimes the power of veto which under the statutes are given to municipalities, has been unjustly and unwisely used. This is also the opinion of many leading men who are concerned in these matters, and of the London County Council. As I have said, we do not want to interfere with the just rights of municipalities, but we do think that absolute right of veto which they exercise under the Tramways Act, and by practice under the Light Railways Act, might be materially modified, and it is the intention of this society to secure some modification of the objectionable clauses in those Acts. Another matter of importance is as to the power of compulsory purchase. We feel that there might possibly be some modification of the law in that respect which, without operating unfairly upon municipalities, might give proper compensation to those persons who have invested their funds in the tramway industry. The matter is engaging the attention of this body. There is one other topic of interest. The idea was conceived by the managers of tramway undertakings to form a society with the same objects as but apart from ours. Representations, however, have been made to them that divided counsels at this developing stage of the tramway industry are inadvisable, and that therefore it would be better for them to constitute a unit of this society, so that their action might be a consolidated action with us on all matters of moment. This was agreed to, leaving these gentlemen the right to take private counsel together. What I have said, I think, constitutes a fair statement of what the purposes, objects, and proceedings of this society are and have hitherto been. It only remains to say that it is a matter of gratification to the gentlemen associated with this body that we have received a communication recently from the Union Nationale de Tramways accepting the invitation of this society to come over here and take counsel with us in 1902, and, I hope, to enjoy the traditional English hospitality.

On the motion of the CHAIRMAN, a resolution was adopted in silence expressing deep sorrow at the death of her Majesty the Queen, and sympathy with the Royal Family.

The CHAIRMAN then said there was not much revenue attached to the society, nor was much necessary. What money was required was readily found. He might say, however, that there was a substantial balance at the bank.

The following gentlemen were afterwards elected members of the council for 1901: Messrs. A. Baker, R E. Crompton, W. L. Madgen, E. F. Vesey Knox, R. H. Scotter, and C. R. Bellamy.

A vote of thanks to the chairman closed the proceedings.

APPOINTMENTS VACANT.

Assistant Mains Engineer, Manchester Corporation, £200 per annum, Feb. 5.

Mechanical and Electrical Engineer, Darjeeling Tea Estate. Full particulars in our advertisement columns.

Traveller, must have complete knowledge of vulcanite electrical articles. Full particulars in our advertisement columns.

Mechanicians (two), lathe and bench work, in the Manchester district. Full particulars in our advertisement columns.

Traffic Assistant, electric lighting and tramways department, East Ham Urban District Council, £150 per annum, Feb. 14.

Outdoor Assistants, East Ham District Council, £150 per annum, Feb. 10. Full particulars in our advertisement columns.

Switchmen (several), in direct-current and three-phase substation, 30s. per week. Full particulars in our advertisement columns.

Assistant Electrical Engineers, Devonport Corporation, £130 per annum, Feb. 7. An assistant electrical engineer is also required by Feb. 7. Full details in our advertisement columns.

The Light Railway Commissioners are about to make an order empowering the construction of the light railway from Cricklewood to Edgware in the terms of the draft submitted.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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FRICTION POSSIBLE AND PROBABLE.

It is extremely difficult at this moment to write upon any topic except the one uppermost in the hearts of the citizens of the Empire, but the business of the world moves on, and claims the attention even of those whose hearts are stricken the most. Soon the storm and stress of another session of Parliament will have to deal with questions of great importance to the electrical industry. It is necessary, therefore, to discuss once more a special point of the conflicting interests between private enterprise and municipal action. We have always held that certain operations must be of the nature of monopolies if the public is to be served properly and *economically*. Many people will wonder if economy is possible under a monopoly. It is not if humanity is absolutely lost to truth and honesty; but although the world is bad enough, it is not utterly bad. One of the worst signs of the times is the increased tendency to believe men's actions to be bad before they have been shown to be so—in fact, never to credit innocence, but always to assume guilt. The work of a corporation may be done honestly and economically quite as much so as that of a company or an individual. In our estimation, monopolists are not necessarily thieves or rogues. It is not necessary to set out a list of operations which should be monopolies; it is enough to suggest that the distribution of water is of this kind, also of electrical energy. The Legislature, greatly assisted by the divergence of opinion within the electrical profession, has decided otherwise. In various instances competing companies are to be found exploiting the same area; in other instances combined authorities are trying to obtain powers so that they may compete against a company already supplying a part—greater or less—of the area proposed to be exploited. Power stations which could supply in bulk are not to be supported, because the authority or authorities desire to equip works of their own. All is chaos, and the end is like to be confusion. Why does every new comer in a district proceed to incontinently damn all that has been done in that district over five or ten years ago? Of course, much is obsolete. The industry could not be progressive were it not so, and there is no method known to humans to prevent such a state of things. What sayeth history? Less than twenty years ago men who believed in electric lighting did all they could to induce authorities to adopt that method of lighting. When the doubtful member of an authority urged that the "industry was in its infancy," every possible argument was urged to prove the contrary. If one of those members lives, and is in power to speak at the present time, what a fine text he has, and the moral he might preach, though wrong, is supported by the thoughtless actions and speeches of the present-day promoter. Every authority that took action is to be commended, not condemned, for at the time of installation installing something better than what they had had previously. If since any installation was made great advances have taken place, one advantage rests with those who have

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waited; and if similar progress is made in the near future, those who argue so glibly for the scrap-heap must not be surprised to find men far from eager in support of views put forward and apparatus offered. Perhaps the most important problem for solution at the present moment is that of a power company authorised to sell in bulk throughout a given area, and various authorities within that area combining to obtain an order to equip a station. If such an order is obtained, there will arise conflicting interests within this area which will be a continued source of trouble for all parties. We may put the case briefly, trying to fathom the original ideas of the promoters of the power scheme. They saw a district which was open to a supply of electricity with several authorities which might ultimately adopt electric lighting and purchase in bulk. A combination of authorities to equip a common station was hardly contemplated, and if carried out will probably make all the difference between success and failure. There ought to be some way out of the difficult position, and we think the way is not indistinct if both parties are desirous of avoiding troubles. The combined authorities no doubt have an estimate of the probable cost to them per unit at the 'bus bars. Will the power company supply at that estimated price at the 'bus bars, or will it pay them so to do? The reply to such questions seems to provide a basis for the solution of the difficulty. Of course, there might be a sliding-scale agreement to alter the price with the introduction of improved apparatus or the lowering or raising cost of materials.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICAL DANGERS.

SIR,—I have read your comments on the Cardiff transformer sub-stations, which are apparently based on some report submitted by the present electrical engineer to his committee. As anyone would conclude from reading the paragraph that there are many sub-stations in Cardiff in a decidedly dangerous condition, I should be glad if you will kindly find space in your next issue for the following:

There are in Cardiff just 14 sub-stations. Of these, two are idle—*i.e.*, contain neither switch gear or transformers. Of the remaining 12, six or seven are fitted with modern, safe, simple, high-pressure switch fuses for the mains and the transformer feeds, made by the British Insulated Wire Company. All the high-pressure metal is entirely enclosed in cast-iron cases, with slate covers through holes in which the porclain switch fuses are pushed into place. There is no bare high-pressure metal in anyone of these sub-stations. Three of the remainder have somewhat different gear. Mostly there are switch fuses of the Brush Company's latest protected type, and main switches enclosed in cast-iron cases all mounted on slate bases on iron framework. All high-pressure cables are concentric with the outer earthed, or are lead-cased twin cables right up to the transformers, and it is practically an impossibility for anyone to inadvertently get a shock in these sub-stations. Of the remaining two or three stations, one contains but one transformer fed by one concentric cable, terminating in the case of the transformer itself; the last one or two admittedly contain some temporary gear, but at a safe distance from the entrance.

Whether this justifies the sweeping assertions attributed to the present engineer, I leave to the common-sense of your readers and yourselves. Personally, I prefer to think that that gentleman relied more for his facts upon some of his staff than by personal inspection of the lot. It should also be borne in mind that the question of changing over to the low-pressure direct-current system has been under consideration by the Cardiff Corporation for a long time, and is now definitely decided upon, and which has necessarily checked spending capital freely upon sub stations and other alternating plant.—Yours, etc., N. APPELBEE.

[N.B.—We think it a pity that any personalities should be introduced in this question, especially as Mr. Appelbee agrees that alterations to the alternate-current plant in the sub-stations were not made in view of the possibilities of a complete change over to a low-tension system. In any case, it was the duty of the present engineer to report dangers which existed in these sub-stations. ED. *E. E.*]

FORTHCOMING EVENTS.

FRIDAY, FEB. 1.

North-East Coast Institution of Engineers and Shipbuilders. At 7.30 p.m., general meeting at Newcastle-on-Tyne.

Sanitary Institute.—At 7 p.m., "Mechanical Physics; Laws of Motion, Hydraulics," etc., by Mr. E. J. Steegmann.

MONDAY, FEB. 4.

Royal Institution of Great Britain.—At 5 p.m., general monthly meeting.

Sanitary Institute.—At 7 p.m., "Natural Forces; Light, Heat, Electricity; Chemistry," by Mr. E. J. Steegmann.

Society of Engineers.—Ordinary meeting.

TUESDAY, FEB. 5.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, lecture on "Works Management," by Mr. A. H. Barker.

WEDNESDAY, FEB. 6.

Royal Institution of Great Britain.—At 3 p.m., Prof. J. A. Ewing on "Practical Mechanics."

Sanitary Institute.—At 7 p.m., "The Atmosphere; Pressure and Composition; Air; Combustion and Respiration," by Mr. E. J. Steegmann, M.B.

Institution of Electrical Engineers (Students' Section).—Ordinary meeting. Paper on "Systems of Distribution and Economy in Mains," by Mr. J. T. Irwin.

THURSDAY, FEB. 7.

Rontgen Society.—At 8 p.m., ordinary meeting. "Experiences of X Ray Work during the Siege of Ladysmith" (with lantern slide illustrations), by Lieut. and Quartermaster F. Bruce.

FRIDAY, FEB. 8.

Royal Institution of Great Britain.—At 9 p.m., discourse on "History and Progress of Aerial Locomotion," by Prof. G. H. Bryan.

Sanitary Institute.—At 7 p.m., "Meteorology," by Mr. W. Marriott.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, paper on "Electric Power Supply in the Metropolis," by Mr. Louis F. Awde.

Institution of Mechanical Engineers.—Extra meeting at 8 p.m., adjourned discussion on "Power—Gas and Large Gas-Engines for Central Stations," by Mr. Herbert A. Humphrey.

Physical Society.—At 5 p.m., Burlington House, annual general meeting; address by the President. Council meeting at 4.30 p.m.

SATURDAY, FEB. 9.

Institution of Electrical Engineers (Students' Section).—Visit to the generating station and depôt of the Central London Railway, Shepherd's Bush.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. "Diatomite," by Mr. R. B. Stewart.

Events Postponed.

INSTITUTION OF CIVIL ENGINEERS.—All meetings until further notice.—Birmingham (Students') Section, dinner arranged for Jan. 31 last.

INSTITUTION OF ELECTRICAL ENGINEERS.—Visit to the Willesden generating station from Feb. 2 till Feb. 16.—Manchester Section, meeting on Jan. 29 last.

GENERAL ELECTRIC COMPANY.—Annual dinner from Feb. 2 till March 2.

SOCIETY OF ARTS.—All meetings for next week.

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WIGAN ELECTRICITY WORKS.

(Concluded from page 160.)

SWITCHBOARD.

The switchboard at Wigan was manufactured by Messrs. Dorman and Smith, of Manchester, to the general design of the electrical engineer, Mr. H. Collings Bishop. A general view of the lighting and traction board can be seen in the photograph (Fig. 30). The lighting switchboard runs the full length of the switch gallery, while the traction feeder board stands at right angles to it in the distance. Both of these boards are made up of white Sicilian marble slabs mounted on steel framework, and surrounded by cast-iron moulding. Commencing with the lighting switchboard, the first five panels contain the provision for the dynamos so that they can be connected to either the lighting or traction 'bus bars. The diagrammatic reproduction of one of these panels is given in Fig. 31. It will be seen from this that when the machine is supplying the lighting circuits, there is a single-pole fuse on each conductor. On the other hand, when it is connected to the traction 'bus bars these fuses are out of circuit, and the supply is given through the automatic cut-out at the top of the panel. The throw-over switch in the middle of the panel, which has three contacts at the top and three at the bottom, is required in order to cut in the series winding of the generator when it is working on the tramway circuits. The dynamos then work as over-compounded machines, whereas with the switch in the other direction the dynamos supply the lighting currents with only the shunt coils in connection. The next panel contains a single set of plug bars by which the various feeders are directly connected on to the 'bus bars. The ammeters near these 'bus bars indicate the currents which go out to the various feeders. As mentioned elsewhere, there is only a single pair of 'bus bars for the lighting circuits on this board, so that the machines are always running at a common voltage. The excess voltage required to overcome the drop in the long feeders is obtained by boosters described above. The seventh panel of the board contains the arrangements by which the battery can be connected either on to the lighting or the traction 'bus bars. The cell regulator switches are not mounted on the main board, but are placed on the wall of the engine-room against which the battery-room is constructed. The eighth panel is used for paralleling the various generators, and is provided with a number of multiple point voltmeter switches, so that the machines can be brought to exactly the same voltage before they are switched on to the lighting or traction 'bus bars. The last section of the board contains the recording instruments required by the Board of Trade, in order to see that their regulations with respect to the fall of voltage on the earth return is not exceeded, and also that more than the given proportion of the main current is not returned to the station by earth. The traction board at present consists of three panels only, each containing a maximum current circuit breaker, an ammeter, a main switch, a lightning arrester with

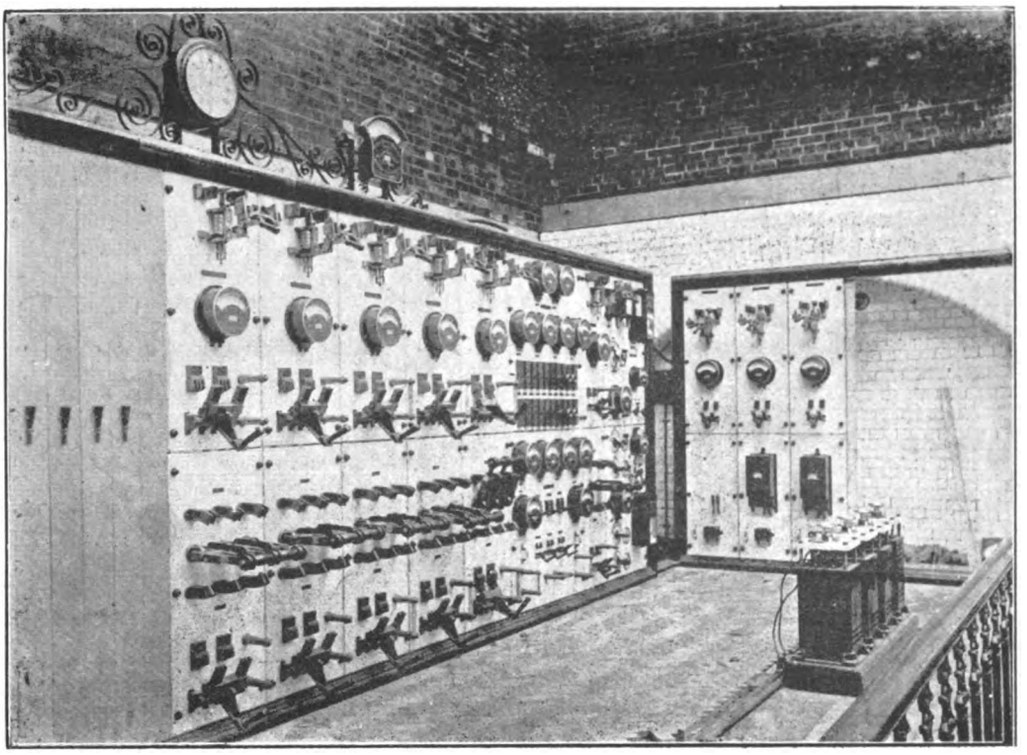

FIG. 30.—The Wigan Main Switchboard, Made by Messrs. Dorman and Smith.

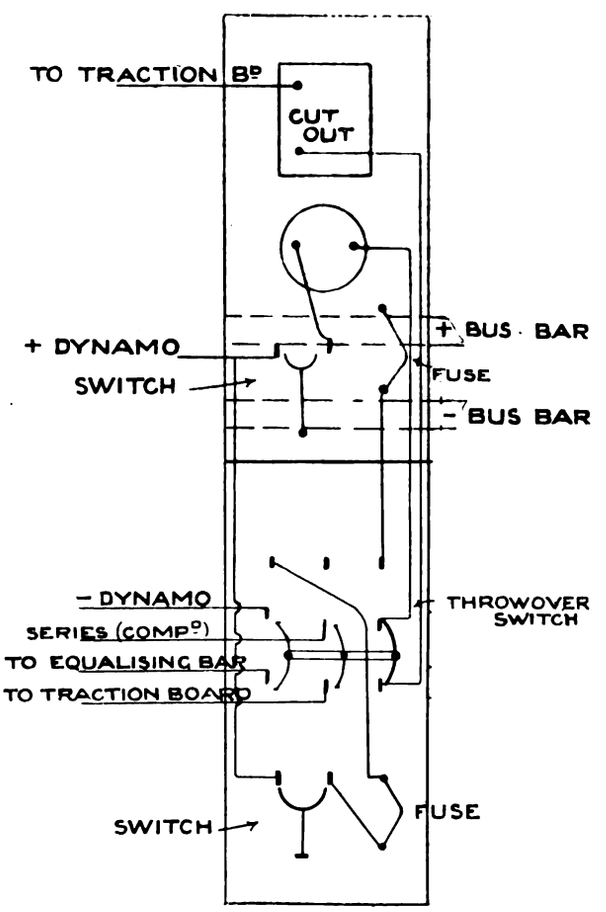

FIG. 31. Diagrammatic View of Switch Generator Panel with Connections.

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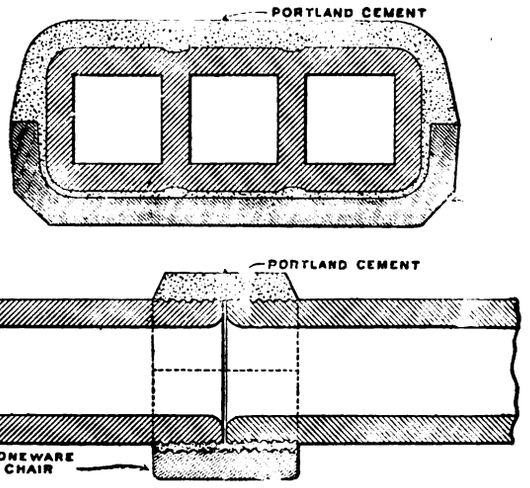
choking coil, and a recording wattmeter. The shunt regulation for the machines is not placed on the board, but is arranged in the front of the same, as can be seen in the illustration. A table is being constructed along the front of the switchboard so that the attendant taking the records can watch the instrument while he is entering up the figures which require to be taken at frequent intervals. The independent switchboards for controlling the balancers are also placed elsewhere in the station, and in the sub-stations where individual balancers are provided in various parts of the system. These switchboards are seen in the illustration (Fig. 29). Underneath the switch gallery and near the booster regulating switches there is a main fuse board, of which all the feeders are connected as they come into



FIGS. 32 AND 33.—Sections of a Typical Doulton Conduit, showing Joint ng.

the station. This was not completed when we visited the station, and it seemed to us that more protection would be required to prevent the blowing of one fuse, causing an arc which would spread to the various other circuits going out from the fuseboard. Arrangements might also be advantageously made for more quickly replacing fuses in case of a short-circuit lasting only for an instant.

MAINS.

All the cables, both for the feeders and distributors, which were used at Wigan were supplied by Messrs. W. T. Glover and Co., of Manchester. Five feeders are at present laid, each consisting of a concentric cable with a $\frac{1}{2}$in. section of copper in each conductor. The tramway feeders, of which three are now put down, consist of single cables, each ·3 of a square inch sectional area. The three-wire distributing system for the lighting and power circuits consists of three conductors with sectional areas respec-

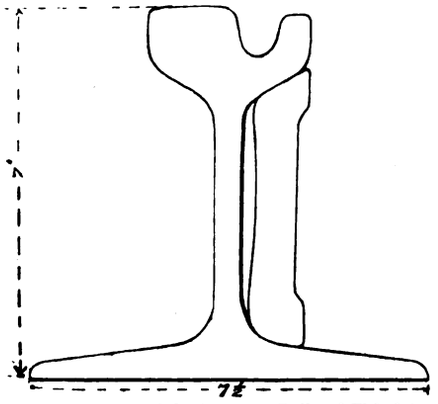


FIG. 34.—Section of the Tramway Rail and Fishplate.

tively of ·2, ·1, and ·2 square inch. The whole of these feeders for both lighting and traction, and also the distributors, are drawn into earthenware conduits of the Doulton type. Typical sections of these conduits and also a view showing how the cement joints are made between adjacent lengths are given in Figs. 32 and 33. From various points on the system three-core pilot wires are brought back to the station, so that observations can be made on voltmeters there of the actual pressure on practically any part of the distributing system. These three-core pilot cables are also protected in the same way by being drawn into earthenware conduits. It is found, however, that an

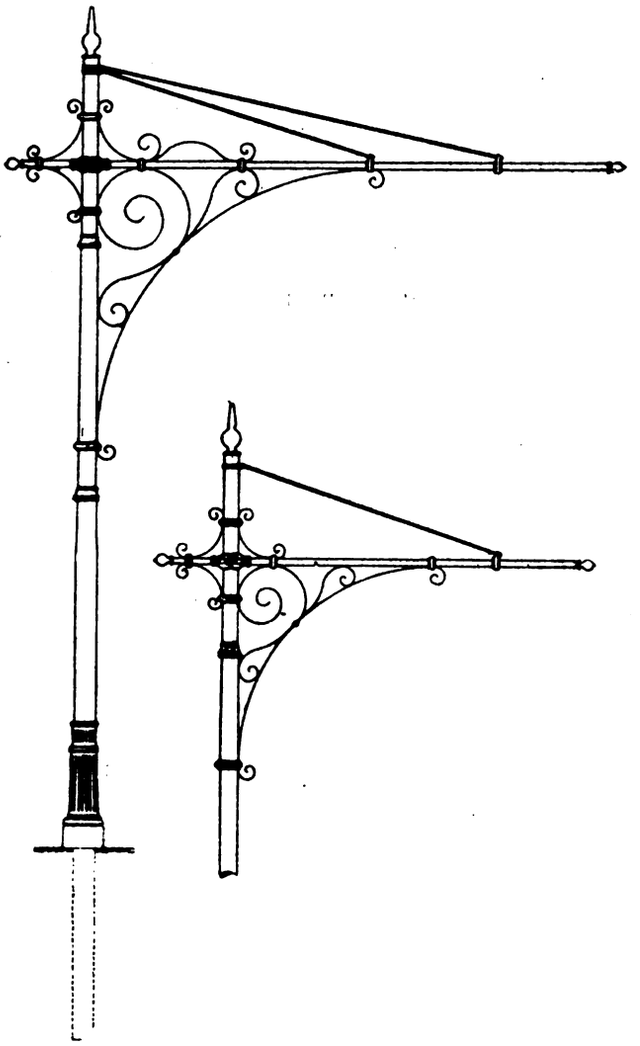


FIG. 35.—The Wigan Tramway Poles.

exception will have to be made to this procedure in extending the mains for the tramways and for lighting

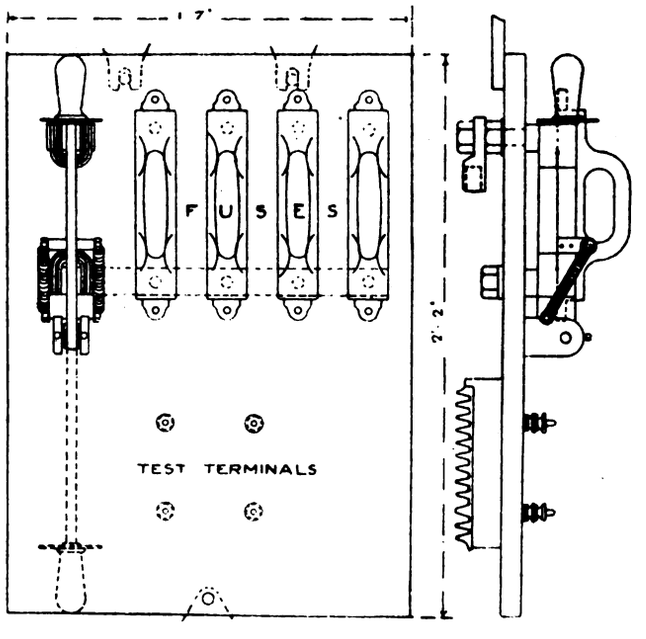


FIG. 36.—Details o the Blackwell Switch Gear in the Section Pillars.

along the Markland Mill Bridge-road. The level of the canal, which is close to this road, is almost the same as the roadway, and, in consequence of this and of the surface water which collects, it is found impossible to keep the water out

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of the drawing-in boxes and of the conduit. In consequence it has been decided to lay new mains in this part of Wigan, on the solid system in troughs filled with bitumen. The various cast-iron junction boxes required for connecting up these mains both to the feeders and to the consumers' terminals were supplied by Messrs. Pickaley, Sims, and Co., of the Bedford Foundry, Leigh. The designs, however, were prepared by the borough electrical engineer. These boxes include the connecting boxes for consumers, the house service boxes, the joint-boxes for concentric cable. The same firm also supplied the various frames and covers for the sub-stations and for the street pits containing the junction boxes. The frames and covers for the drawing boxes were also in the contract.

Scale of Charges.

The scale of charges for light and power which are being made by the Wigan Corporation are such as to give all consumers an advantage from using their lights or their motors regularly. The electrical energy sold for lighting is invoiced on the Brighton system, the charge being 7d. per unit for the first hour per day average use of the maximum output demanded. Any energy consumed above this quantity is charged at 2d. per unit. The motors are also supplied on a sliding scale, which is as follows: For an average use at full load of under one hour per day, 2d. per unit. Where the average use per day is between one hour and five hours, the charge is 1¾d., whereas the charge is still further reduced to 1d. per unit if the average use per day comes out between 8 hours and 12 hours. The last stage in the scale provides that any consumer using his motors night and day throughout the year will only be charged ¾d. per unit. Mr. Collings Bishop has already obtained a consumer who requires an 80-h.p. motor to run continuously in this way. The motor is required to drive the refrigerating machinery and accessories in a cold-air store, and even at this low price the transaction should be profitable to the Corporation, and especially to the consumer. Some 6,000 8-c.p. lamps are now connected to the mains, and many more are applied for. The new Technical College being built by the Corporation will require 3,000 8-c.p. lamps, as well as many motors.

The Tramway System.

The establishment of a complete system of electric trams throughout Wigan was hampered by the fact that a tramway company is already in possession of certain routes. This company runs services with steam trams over lines which are the property of the Corporation. The lease under which the company works the line has still about 14 years to run. We believe that a proposal had been made to buy back the lease from the company, but that the price asked for the same was too high to make the purchase financially feasible. The Corporation would have the steam tramcars on their hands if they purchased the lease, and these, of course, would not be worth much in view of the fact that they would be entirely displaced by electric cars.

The Corporation, however, in 1898 obtained an Act of Parliament enabling them to construct the present line, which runs to Markland Mill Bridge, and also the route in Wigan-lane, which it is expected will be completed in April next. Powers were also obtained to extend the first-named route, and the overhead work on this extension has also been completed. Powers are now being sought by the Corporation to construct other lines outside the borough boundary to Standish, Scoles, and Frogland. When these are completed there will be nine miles of route, along which will be laid single lines, with frequent turn-outs to enable the cars to pass. The gauge of these lines is 3ft. 6in., and they will be interconnected. In the Market-place it will either be necessary to run another line of rails beside those leased by the steam tramway company or else to obtain running rights over the loop line of the company. The laying of the track for these electric trams has been carried out by the borough engineer, Mr. W. Bolton. The rails and fishplates were supplied by the Barrow Hematite Steel Company, and have the section which is shown in the accompanying illustration (Fig. 34). Messrs. Askham Bros. and Wilson furnished the points, which are of their patent automatic type. The crossings and drain rails also were supplied by the firm, and are of best crucible cast steel; also the joint-plates for supporting the joints of the rails, and the tie-bars and fish-bolts, were in

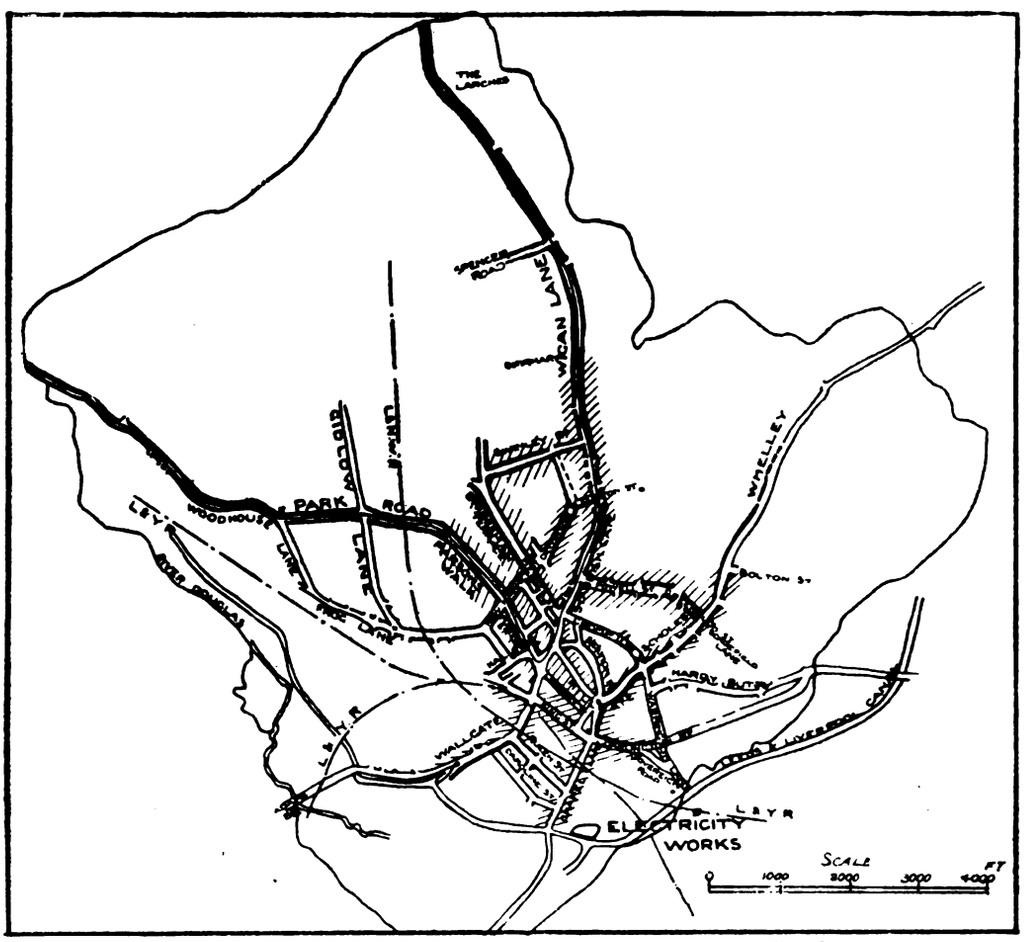

Fig. 31.—Map of Wigan. The hatched lines round the streets denote distributing mains and the full lines down the streets are tramways.

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the firm's contract. Mr. Bolton has paved the space between the rails and a strip each side of the same with granite setts.

The overhead equipment for these lines has been carried out by Mr. Collings Bishop, who has bought the supplies from various firms and erected the materials with his own staff. In every case the conductors are supported by side poles with overhanging brackets. Messrs. Robert Blackwell and Co. supplied the steel poles with their bases and bracket arms (Fig. 35), the junction boxes at which the trolley wire is divided up into sections, the bonds for the track, and also the trucks on which the tramcars are carried. The poles are three-section tubular steel poles of two sizes, one capable of standing a strain of 700lb., and the other a strain of 1,000lb. The fittings are of the "Blackwell" standard type. The truck is of the Peckham extra long cantilever extension type, as in use on a great many other lines in the country. The bonds are of the well-known crown flexible type.

The bracket arm hangers, of which some 500 or 600 were required, were supplied by Messrs. Bergtheil and Young. The bracket arm hangers in question are the ordinary "J.P." type of hanger, with galvanised body made of malleable iron, with a $\frac{5}{8}$in. steel insulated bolt suitable for bracket arms of $2\frac{3}{8}$in. diameter each. The bolts in question are the ordinary type of the well-known moulded mica insulation, and are interchangeable throughout, being capable of being slipped in or out at any time. The insulation is a homogeneous mass of insulating material, which is pressed on to the steel bolt by heavy hydraulic pressure, while the insulating material is in a plastic state. This insulating medium is of an extremely solid and mechanical nature, and due to these qualities is much in favour for this class of work. It can be submitted to heavy blows, not chipping sufficiently to in any way injure the insulating qualities.

Attached to the bolt in question are the ordinary type of 24in. and 18in. ears. The firm also supplied the trolley wire, which is of 000 gauge, and the various insulators required for it.

Messrs. Dick, Kerr, and Co. supplied the 12 tramcars complete with motors and controllers. The whole of these motors, the controllers and accessories, as well as the cars themselves, were manufactured in England in the works of the English Electrical Manufacturing Company, Limited, with which firm Messrs. Dick, Kerr, and Co. are so closely associated. The cars are provided with hand brakes, and an additional safeguard is obtained by moving back the controller past the off position, in which case the motors are short circuited on themselves: they then act as electric brakes. These controllers are provided with the solenoid blow-out for preventing arcing at the contacts.

The first section of this tramway system was opened on the 25th inst., and we learn that it is being very well patronised. Owing to its comparatively short length—$1\frac{1}{2}$ miles—two cars can provide for the regular service, while a third car is required at busy times. The number of passengers carried seems likely to exceed in 20,000 the first week.

In conclusion, we have to congratulate the Corporation of Wigan on their electric undertaking, and to thank their electrical engineer for his kindness in placing drawings and information at our disposal.

ELECTRIC LIGHT IN NORTH LONDON.

The third of the series of statutory meetings in connection with the East Middlesex Electricity Bill was held at Tottenham on Friday evening. The meeting was called for the purpose of procuring the ratepayers' consent to the Council's action in combining with the District Councils of Enfield, Edmonton, Southgate, and Wood Green to obtain powers to generate and supply electricity. The North Metropolitan Electrical Power Distribution Company, which has already received an Act to enable it to supply electricity in bulk to the districts named, is offering stern opposition to the joint board of the local councils.

At Friday night's meeting Mr. Wm. Jubb, J.P., chairman of the Tottenham District Council, presided, and was supported by a number of the councillors, and also by Mr. R. Hammond and Mr. W. C. C. Hawtayne, the experts retained by the Councils. The Chairman put the case for the local authority, and proposed the usual resolution confirming the Council's action. Several other gentlemen having given their views,

Mr. HAMMOND, in the course of an instructive speech, said he was the first man in Europe to introduce electricity into a private house. He lighted his house throughout with that illuminant 20 years ago, and found it to be such a benefit that he became an apostle to electricity. He knew of no authority which did not enter into such an undertaking without fear and trembling. In the United Kingdom there were two places that actually supplied electricity for lighting and for power at an average price below 3d. per unit. The power in those places was supplied by the local authority. No company had yet supplied electricity at such a price. In five districts electricity was supplied at a charge of between 3d. and $3\frac{1}{2}$d. per unit. They were all supplied by local authorities. Of 12 that charged between $3\frac{1}{2}$d. and 4d. per unit, 10 were local authorities and two companies; 30 charged between 4d. and $4\frac{1}{2}$d. per unit, 24 of which were local authorities and six companies; 20 charged between $4\frac{1}{2}$d. and 5d., 15 being local authorities and five companies. Between 5d. and 6d. per unit there were 14 authorities and 17 companies, and above 6d. two authorities and 11 companies. All these were Board of Trade returns.

Mr. HAWTAYNE made a speech, in which he said that he had, after carefully examining the district, presented a scheme that involved an outlay of £345,000, although application had been made by the Councils for £400,000.

The meeting was a very lively one, and a threat was made to eject a ratepayer who protested against the experts being allowed to speak. After several speeches had been given in opposition—including one by the Chairman of the Tottenham Ratepayers' Association, Mr. W. E. Windsor—the Council's action was confirmed by a majority equivalent to 2 to 1. A poll was demanded.

Mr. George Spicer, J.P., a very prominent resident of Enfield, presided at Tuesday's meeting of Enfield ratepayers, which the principal councillors attended.

Mr. SPICER, in his opening speech, spoke on the various advantages derived from the use of electric light.

Mr. C. C. HAWTAYNE produced produced several diagrams and statistics showing the cost of the land and buildings, plant, and distribution, and generally compared the undertaking of the supply of electrical energy by municipalities and private companies. He proved conclusively that the local authorities could supply energy far cheaper to the consumer than the companies could.

Mr. ROBERT HAMMOND, in the course of his remarks, said that that was one of the first joint schemes for the supply of electrical energy that had existed. The Bill would be brought before a parliamentary committee, and if he was called before that committee he would be prepared to say that in principle the Bill was right. What he proposed was this: to lay down a central works, to get a suitable site, to lay down the works for the generation of electricity, and to carry it by high pressure to every one of the districts. The Joint Board were anxious to show that their scheme was a commercial one, and that they were not proposing to get a revenue through electricity at an absurdly high price. The price quoted by the opposing company was utterly absurd. The true business principle was not to go and put a price on where a loss would be sustained. His house was the first in Europe which was lighted from top to bottom with electric light. The fittings for electric light were just as cheap as gas fittings. There were 130 local authorities in this country with electric light works in operation. Many had gone in for it with the very greatest fear, and not in one single case had an authority regretted the undertaking. In the present case the prospects were excellent. There would be no sinking fund during the first three years, the interest charges would be light, and the revenue would begin to come in from almost the day the works were opened.

In answer to a ratepayer, Mr. Hammond said that he had given no guarantee that it would be a paying concern.

Mr. ADCOCK moved the following resolution: "That, having heard the experts on the scheme by the proposed Joint Board, this meeting is of opinion that it is to the interest of the parishioners and owners that the scheme should be proceeded with, and, therefore, recommend the owners and ratepayers to vote in favour thereof at the ensuing poll." This was seconded and carried by a majority of four votes.

The following are the estimates of the schemes: (1) purchase of site, buildings, plant, etc., £122,740; (2) distribution, including free wiring, £199,260; (3) contingencies, including also fees and services of experts, parliamentary and legal expenses, £23,000—total, £345,000.

LIGHT RAILWAYS.

The Commissioners on Wednesday concluded an enquiry at Crewe into an application by the Crewe Town Council for an order to construct light railways within that borough. The

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London and North-Western Railway Company and the Cheshire County Council opposed the scheme. The former said the scheme was unnecessary, and would entail a loss; the latter opposed on account of the roads being too narrow. Mr. Hopkinson, engineer, Manchester, gave evidence in its favour, and said it was proposed to borrow £100,000 for the construction of about eight miles of railway. The Commissioners reserved their decision.

The Commissioners have issued a draft order sanctioning the construction of light railways by the Middlesex County Council in 12 parishes in the county of Middlesex, including Finchley, Hornsey, Hendon, Tottenham, Wood Green, and Willesden, at an estimated cost of £450,000.

It is reported in the local Press as a persistent rumour that the North-Eastern Railway Company are likely to become in time the promoters or owners of the Bridlington-Flamborough light railway.

A Bill to be introduced into Parliament in the ensuing session by the Cork, Blackrock, and Passage Railway Company, which, amongst other matters, contains provisions for making certain alterations affecting the public in the Cork, Blackrock, and Passage Railway Act, 1896, in connection with the construction at Passage West and Glenbrook of the extension railway from Passage West to Crosshaven, will come before the Council on Feb. 12.

Deputations from the Rhondda and Pontypridd District Councils attended a meeting of the Parliamentary Committee of the Glamorgan County Council last week. As a result, it is understood that the two bodies have come to an understanding whereby the opposition of the county authority to the light railway proposals will be withdrawn.

A private company has been granted powers by the Light Railway Commissioners to construct a line from Porth to Tonypandy, but the Rhondda Council consider that this will interfere with their comprehensive scheme for constructing a tramway of their own all the way from Hafod to Treherbert. Both the Glamorgan County Council and the Rhondda District Council will appear before the Board of Trade in opposition to the private company's scheme.

It is stated that the whole of the share capital of £51,000 for the purposes of the construction, completion, and equipment of the Vale of Rheidol light railway has been applied for and allotted. We understand that a contract has been entered into for the completion of the line in good time for the season of 1902.

The Isle of Thanet Light Railway Company have concluded arrangements with the London, Chatham, and Dover Railway for the rebuilding of Broadstairs Bridge in accordance with the plans and specifications of the Council.

At the last meeting of the Gwyrfai District Council at Carnarvon, the question of the proposed light railways from Carnarvon to Dinas Dinlle and Ebenezer came up for consideration. A resolution was come to, after much discussion, to the effect that the Council should take no steps to oppose the application to the Board of Trade, as they had every confidence that Mr. Peterson would carry out his promise with regard not only to electric lighting but also the water supply and the railways.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

347. Describe the connections of a switchboard and an effective type of synchroniser for three-phase generators supplying motor circuits. Is there any method of starting up the motors as a whole from the generating station?—H. W.

348. How would you arrange connections so that an ordinary double-pole throw-over switch can put two dynamos in series or in parallel? When the switch is on the top contacts the machines to be in parallel, and when on the bottom in series.—S. W. C.

ANSWERS.

Question No. 341.—Give the formulæ for the construction of a choking coil required to give a definite voltage with a given current and periodicity.

Best Answer to No. 341 (*awarded* 10*s.*).—In order to answer this question fully it will be necessary to consider three more or less distinct types of choking coil: those having a completely closed magnetic circuit of laminated iron (Fig. 1); those having a magnetic circuit composed principally of iron, but including an air-gap of definite area and length (Fig. 2); and, lastly, those having adjustable

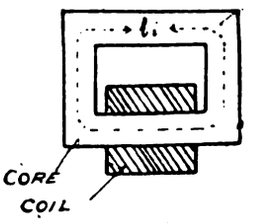

FIG. 1

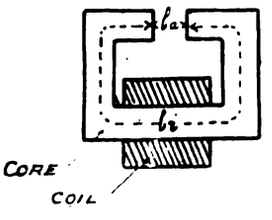

FIG. 2.

magnetic circuits variable from a complete or partial iron circuit into a complete or partial air circuit by withdrawing an iron core (Figs. 3 and 4). The closed magnetic circuit

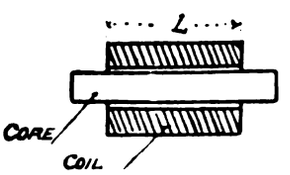

FIG. 3.

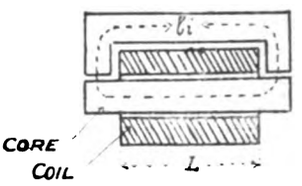

FIG. 4.

type is seldom used in practice, since the physical relation of the permeability of iron to its hysteretic loss at a given density is such that the power factor cannot be reduced below about ·5—*i.e.*, about 50 per cent. of the current through the coil × the volts across the coil are absorbed in the coil itself. The type shown in Fig. 2 would usually be used where no adjustment of the choked voltage is necessary, whilst, if a fair range of adjustment (say, 2 : 1 or 3 : 1) is required, Fig. 3 would be used, and for a still larger range Fig. 4 would be found most suitable.

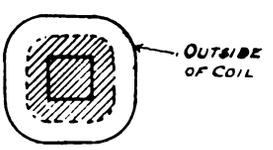

FIG. 5.

When the type to be used has been decided upon, the next point is to obtain the best size of iron core—*i.e.*, the size of core for which the combined price of copper and iron (with a reasonable temperature rise) shall be a minimum, except in a few special cases in which efficiency is of more importance than price. No general rule of a simple nature can be given for obtaining this size, so that it must be approximated to by a trial and error process, as described below. This, however, will be found to give little trouble, since considerable variation is permissible without greatly influencing the total cost.

Let C = the given current passing through the coil ($\sqrt{M}$S value);
V = the given volts to be measured across the terminals of the coil when the current, C, is passing;
$\sim$ = the given periodicity;
T = the number of turns in the coil;
S = the net section of iron in the core, in square inches;
B = the permissible flux density (maximum value) in the core—this depends on the quality of the iron and the readiness with which the core can cool itself, and should lie between 40,000 and 60,000 C.G.S. lines per square inch at ordinary periodicities;

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N = average total flux which must pass through every turn of the coil in order that the volts, V, may be read at the terminals; = B × S.

Having assumed tentative values for the section of core, S, and the induction density, B (and therefore N), two independent expressions for the number of turns, T, are available, one depending on the number of volts, V, and the total flux, N, and the other depending on the current, A, and the reluctance of the magnetic circuit. The process of designing a choking coil consists practically in so adjusting the different variables that the two values of T obtained from these two expressions shall be alike.

The first expression is merely the ordinary transformer formula:

$$T = \frac{V \times 10^8}{4{\cdot}44 \times N \times \sim},$$

whilst the second varies with the type of choking coil under consideration as follows:

1. For the complete iron circuit type (Fig. 1)—

$$T = \frac{l_i \times X}{\sqrt{2} \times C},$$

where l_i = the mean length of the iron circuit, in inches;
X = the ampere-turns per inch of iron at the density, B, and is obtained from a permeability curve of the particular quality of iron used.

2. For the partial iron, partial air-circuit type, shown in Fig. 2—

$$T = \frac{(l_i \times X) + (\cdot 3132 \times \frac{N}{a} \times l_a}{\sqrt{2} \times C},$$

where l = mean length of the iron part of the circuit, in inches;
X = ampere-turns per inch of iron;
a = effective area of the air-gap, in square inches (taken at right angles to the direction of the flux);
l_a = length of air-gap from iron to iron, in inches.

3. For the movable straight-core type (Fig. 3), two extreme cases occur—

(*a*) When the iron core is placed centrally within the coil,

$$T = \frac{N \times \cdot 175}{C \times \sqrt{D}}.$$

(*b*) When the iron core is entirely withdrawn,

$$T = \frac{N_1}{C_1}\left(\frac{\cdot 222 \times L}{A} + \frac{\cdot 125}{\sqrt{A}}\right),$$

where N = the flux corresponding to the maximum volts, V, which the coil is to choke with current, C, passing;
N_1 = the flux corresponding to the minimum volts, V_1, which the coil is to choke with current, C_1, passing;
A = the area in square inches of one end face of the coil taken to the centre of the winding space (= the shaded area in Fig. 5).
D = the total superficial area in square inches of those parts of the iron core which project beyond the coil at both ends, including top, bottom, side and end faces so far as they project beyond the coil. (*Note.*—If the core ends are flush with the ends of the coil D = 2 S practically);
L = length of coil, in inches.

In the formula (*b*) the first term within the bracket is proportional to the magnetic reluctance of that part of the magnetic circuit lying *within* the coil, whilst the second term is proportional to the external reluctance. A little consideration will show that, in order to obtain a large range of voltage, the winding should be arranged in a long and shallow coil, and with the central iron core of small section and projecting beyond the coil to a considerable distance (say as much as one-quarter the length of the coil) at each end.

This formula is based on a paper by Mr. Evershed, which has been found to give quite satisfactory results in practice.

4. For the special case of (3) shown in Fig. 4, the two formulæ would be:

(*a*) When the central core is in the coil, thus forming a complete iron circuit,

$$T = \frac{l_i \times X}{\sqrt{2} \times C}$$

X being the number of ampere-turns per 1in. of iron corresponding to the maximum flux, N.

(*b*) When the central core is completely withdrawn, but the outer core left in position,

$$T = \frac{N_1 \times L \times \cdot 222}{C_1 \times A}$$

In conclusion, it must be remembered that when a choking coil is introduced into a circuit the net remaining voltage available in the circuit cannot be got by simply subtracting the voltage measured across the coil from the supply voltage, for phase shifting is present, and the correct result can only be obtained by a vectorial sum. Thus, if the rest of the circuit is non-inductive (such as an incandescent lamp load would be), the net remaining voltage across the lamps is given by $\sqrt{E^2 - V^2}$, where E is the total supply voltage and V is the voltage across the choking coil. If, however, the load is not non-inductive, but has a power factor = cos ϕ less than 1, the summation is best made by means of such a diagram as Fig. 6. The line O H represents the current in phase.

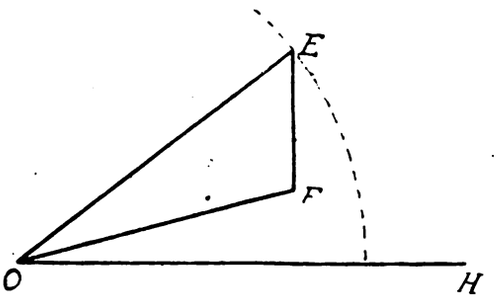

FIG. 6.

Draw the line O F at the angle ϕ to line O H, and of such a length as to represent to any scale the required remaining voltage with the choking coil in circuit. Then draw an arc of a circle with centre, O, and radius equal to the total supply voltage to the same scale. Draw a line from F at right angles to line O H. This will cut the semicircle of some point, E. Then, neglecting volts lost in the resistance of the coil, F E is the required voltage which must exist across the choking coil terminals in order to reduce a supply voltage, O E, down to an available voltage, O F.—Q.

Answer to No. 341 (*awarded* 5*s.*). — The following formulæ may be employed in designing a choking coil:

Let n = frequency;
τ = number of turns in the coil;
F = total magnetic flux, in C.G.S. lines;
e = effective back voltage of coil;
C = effective current, in amperes;
A = net iron cross-section of core, in square centimetres;
l = mean length of magnetic circuit;
μ = permeability of core at induction adopted.

Then
$$e = \frac{2\pi n \tau F}{\sqrt{2} \times 10^8} = \frac{4{\cdot}44\, n \tau F}{10^8} \quad . \quad . \quad . \quad \text{(i.)}$$

and if the magnetic circuit is entirely in iron

$$F = \frac{\cdot 4\sqrt{2}\,\mu\pi\tau C A}{l} = \frac{1{\cdot}78\,\mu\tau C A}{l} \quad . \quad \text{(ii.)}$$

Hence, substituting in (i.) for F,

$$e = \frac{7{\cdot}9\,\mu\tau^2 n C A}{10^8 l}.$$

Thus for a core of assumed dimensions the requisite number of turns is given by

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$$\tau = \sqrt{\frac{10^8 \, e}{7 \cdot 9 \, \mu \, n \, C \, A}}.$$

The gauge of the wire may now be determined such that the $C^2 R$ loss is kept within a prescribed limit. The resistance, R, is found by the product of τ and the mean length per turn into the resistance per unit length. The last is conveniently found from tables for any proposed gauge. Or we may put

$$\text{Diameter of wire} = \left\{\frac{4 \, l' \, \tau \, \sigma}{\pi \, R}\right\}^{\frac{1}{2}},$$

where R is the limiting value of the total resistance, l' the mean length per turn, and σ the specific resistance. The gauge chosen must permit of the τ turns being passed through the hole in the core, and must afford sufficient cooling surface to prevent overheating. The heat produced per second is the sum of $C^2 R$ watts, hysteresis, and eddy-current watts. At an induction of 5,000 to 6,000 lines, which is suitable, the last two sources of heat amount together to about ·014 watt per pound per cycle—*i.e.*, iron watts = ·014 × *n* × weight of core in pounds. Allowing a temperature rise of 60deg. to 70deg. C., the surface should give 20 to 30 square centimetres per watt spent in heating.

If the magnetic circuit of the coil be interrupted by air-gaps, the calculation of F becomes modified. Such air-gaps of variable length are often introduced to permit of F, and consequently *e*, being regulated. Let the core be of uniform section. Then if *d* be the length of the air-gap,

$$4 \sqrt{2} \, \pi \, \tau \, C = F \left(\frac{l}{\mu \, A} + \frac{2 \, d}{A}\right)$$

$$1 \cdot 78 \, \tau \, C = \frac{F}{A} \left(\frac{l}{\mu} + 2 \, d\right)$$

and substituting in (i.) we obtain

$$e = \frac{7 \cdot 9 \, n \, \tau^2 \, C \, A}{10^8 \left(\frac{l}{\mu} + 2 \, d\right)}$$

$$\tau = \sqrt{\frac{10^8 \, e \left(\frac{l}{\mu} + 2 \, d\right)}{7 \cdot 9 \, n \, C \, A}}$$

In general, a slightly less number of turns would suffice, owing to the lines in the air-gaps fringing out.

In the case of a coil wound upon a straight core, such as a bundle of wires, the lines returning from pole to pole through air, the winding is facilitated, but many more turns are required than for a closed iron circuit. The poles now exert a demagnetising effect, and the calculations, based on the assumption that the core is an elongated ellipsoid, at best only give approximate values. Let

l = length of core, in centimetres;

$d = 2 \sqrt{\frac{A}{\pi}}$ = diameter of core, in centimetres;

$t = \frac{\tau}{l}$ = turns per centimetre length of core.

Then it may be shown that

$$\cdot 4 \, \sqrt{2} \, \pi \, t \, C = \frac{F}{A} \left(\frac{1}{\mu} + \frac{N}{4 \, \pi}\right),$$

where

$$N = 4 \, \pi \, \frac{d^2}{l^2} \left(\log_e \frac{2 \, l}{d} - 1\right).$$

The following table gives values of N for various ratios of length to diameter:

$\frac{l}{d}$	N	$\frac{N}{4 \pi}$
6	·041	·00326
7	·0335	·00266
8	.0275	.0021
9	·0235	·00187
10	·02	·00159

Hence

$$F = \frac{\cdot 4 \, \sqrt{2} \, \pi \, \tau \, C \, A}{l \left(\frac{1}{\mu} + \frac{N}{4 \, \pi}\right)} = \frac{1 \cdot 78 \, \tau \, C \, A}{l \left(\frac{1}{\mu} + \frac{N}{4 \pi}\right)}$$

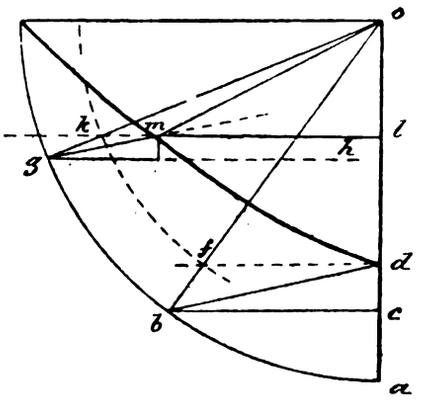
and from (i.)

$$e = \frac{7 \cdot 9 \, n \, \tau^2 \, C \, A}{10^8 \, l \left(\frac{1}{\mu} + \frac{N}{4 \, \pi}\right)}$$

$$\tau = \sqrt{\frac{10^8 \, e \, l \left(\frac{1}{\mu} + \frac{N}{4 \, \pi}\right)}{7 \cdot 9 \, n \, C \, A}}.$$

In the above expressions for *e* the inductive back E.M.F. only has been taken into account, the C R drop due to the ohmic resistance being regarded as negligibly small in comparison with it. This, in practice, is usually permissible, as for the sake of avoiding loss of energy R is small. It may, however, be taken into account by setting lines at right angles representing to scale *e* as obtained from (i.) and C R; the hypothenuse of the triangle is then the true back E.M.F. of the coil (see Answer No. 336).

It should be noted that this term "true back E.M.F." of the coil only indicates that if placed across mains having that voltage, a current of C amperes passes through. If placed in series with even a non-inductive resistance, R', across mains having a voltage E ($> e$), the current is not given by $\frac{E - e}{R'}$ or $\frac{E - e}{R + R'}$. The actual current, and other conditions, with a resistance of any inductance in series, may be found graphically by the following method (a poor thing, but mine own).



Let *o a* represent the voltage between the mains. Angle *a o b* is drawn having its tangent equal to $\frac{e}{C \, (R + R')}$ *b c* perpendicular to *o a*, and *b d* making tan *c b d* = $\frac{C \, R}{e}$ Then the length *o d* divided by R gives the current passing through an inductionless resistance, R. Drawing any radius *o g*, making *d f* parallel to *b c*, and *g h*, *k l* parallel to the same (*g k* = *b f*), the angle *h g m* is set off, and *o m* drawn to the intersection of *g m* and *k l*. Here *o l* represents C R, *g m* the back E M F. of the coil, *o m* the voltage on the inductive resistance. The lag of current from the mains behind the voltage is *a o g*, the lag in the resistance *l o m*. If other points corresponding to *m* be set out, a curve giving the current for any inductance possessed by R is obtained. This indicates the reduction of the coils' choking effect as the resistance in series with it becomes more inductive.—ZIPHERN.

LEGAL INTELLIGENCE.

CENTRAL LONDON RAILWAY.

Claim for Damages.

Mr. J. W. Penfold sat as arbitrator on Tuesday at the Surveyors' Institution in respect to a claim against the Central London Railway Company for injury done to 2, Lancaster gate, W., alleged to have been caused by the railway works. The claimants were Lord Herschell and Mr. A. W. M Baillie acting as executors under the will of the late Mrs. Mary Cunliffe, and the damages claimed amounted to something like £1,600.

Mr. C. A. Cripps, K C., and Mr. Israel Davis appeared for the claimants; whilst the company was represented by Mr. G. M. Freeman, K C., and Mr. Daldy.

Mr. Cripps stated that certain cracks appeared in the walls of the house, and there was a serious subsidence. The inference was that these circumstances were due to the construction of the Central London Railway.

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A large body of evidence was given, one witness stating that the value of the property had gone down from £6,000 to £4,500.

The hearing was adjourned till Feb. 8 next.

Another claim for damages against the Central London Railway was disposed of on Wednesday before Mr. Under-Sheriff Burchell and a special jury at the London Sheriff's Court. The claim was for £4,200 in respect of damage to 20, Stratford-place, Oxford-street, of which the plaintiff, Dr. W. Laidlaw Purvis, has a perpetual lease from the City Corporation, due, as alleged, to the construction of the Central London Railway, the ground having subsided, thereby causing cracks to appear in the outer walls.

Expert evidence was called to prove that it would cost £2,294 to carry out the necessary repairs. Dr. Purvis also claimed £1,000 for inconvenience, damages to his practice as a consulting physician, consequent on his having to take other premises for a time, and for other incidental expenses.

The defendants offered to pay £1,120.

The jury, however, awarded the plaintiff £1,500, and judgment was entered accordingly.

ACTION BY ELECTRICAL ENGINEERS.

In the Westminster County Court on Friday, before his Honour Judge Lumley Smith, the case of Sharp *v.* the Gaiety Bars and Restaurant Company was disposed of. It was a remitted action from the High Court, in which the plaintiffs, a firm of electrical engineers carrying on business at Sloane-street, S.W., sued the defendant company to recover the sum of £30. 15s. 6d. in respect of work done in connection with the electric lamps.

Evidence was given that the work was carried out satisfactorily in every way, and if the lamps did not work properly it must have been in consequence of improper treatment.

His Honour held there was nothing to show that the plaintiffs' work was faulty, and in these circumstances judgment would be for the plaintiffs for the amount claimed, with costs.

"TUBE" SMOKE NUISANCE.

At the West London Police Court on Tuesday there were two summonses against the London Central Railway Company in respect of an alleged nuisance caused by the issuing of black smoke from the shafts of the electrical generating station at Wood-lane, Shepherd's Bush.

Mr. Rose, after hearing evidence, said he was satisfied that the best appliances were used, but not that the best kind of coal was used on some occasions. It was not a case, however, for the maximum penalty, and it would be sufficient to impose a fine of £5 on each summons, with two guineas cost. The payment of the money stood over pending the application for a special case.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN RAILWAY.

On Friday last the ordinary half-yearly general meeting of this Company was held at the Cannon-street Hotel, Colonel John J. Mellor (deputy chairman) presiding.

The Secretary (Mr. G. H. Whissell) having read the notice convening the meeting,

The Chairman referred to the irreparable loss they had sustained in the death of their illustrious and beloved sovereign. He felt that he was only giving utterance to their wishes and feelings when he ventured to express in their name the profound and heartfelt sympathy they all felt for every member of the Royal Family in the bereavement they had sustained. The Chairman then explained the absence of the chairman of the Company (Mr. John Bell). Mr. Bell for some time past had been out of health, and he had been advised by his medical adviser to take three months' leave of absence and go on a sea voyage. Having expressed the sorrow which, he was sure, they would all feel at this indisposition of Mr. Bell, the Chairman said the report and accounts showed very clearly that the unsatisfactory result of the working of the half-year was due to two circumstances—viz.: (1) the opening of the tube railway between Shepherd's Bush and the City at a 2d. fare for the maximum distance of 6½ miles, which had depleted their receipts; and (2) the high price of coal and other material, but especially of coal, which had very largely increased the cost of working. In the half-year they had had a reduction in the number of passengers carried of 2,966,842, distributed over the three classes, the whole of the reduction being attributable to the competition of the tube line, and this loss in passengers represented £26,246 in money. He might remind them that the Metropolitan Railway was the pioneer of underground lines, and its London portions were constructed under conditions involving enormous outlay in the purchase of property and in compensation for damage, which the tube lines, being permitted to tunnel under the roads, were free from. By certain changes in the working of the line, they hoped, pending the advent of electrical traction on the Circle, to mitigate as far as possible the result of this new competition. There were two other directions in which they might look for encouragement. First, they had a steadily developing traffic on what he might call their country lines, and in the past half-year they had had increases under every head of traffic except passengers, making a total increase of £13,929, which reduced their loss in receipts to a net figure of £12,317. This showed a healthy growth, and was very encouraging. As showing the progress of the traffic of the undertaking in past years, the Chairman referred to the fact that between 1894 and 1898, a period of five years, the gross receipts increased by the sum of £100,000 a year without any special circumstances to account for it beyond the ordinary natural growth of the traffic. Another direction to which they might look hopefully was the advent of electrical traction on the Circle lines. They now felt confident that the time was not far distant when this difficult work might be commenced and accomplished, and they believed the shareholders would have no cause to regret the delay that had taken place in the application of electrical working to the system. They believed the cost of installing electrical traction on the railway would be much less than they at first anticipated. They were told by the experts that it was possible to overcome all the obstacles to success, and that when the change was made the railway would be a first class electrical line, working at a less cost and with increased carrying capacity. The tunnels were large, giving plenty of air space: they had numerous openings along the line which could not fail to improve the ventilation; and, further, they were near the surface, so that they would have no need to employ the costly and not always convenient machinery of lifts for getting to and from the trains, a mode of access which was undoubtedly attended at times with some undesirable drawbacks. There could be little doubt that if they had commenced their undertaking with an up-to-date installation of 1900, they would be regretting it in 1901. The Chairman then dealt with the increase of £13,313 in expenditure, £10,737 of which was in locomotive power, nearly the whole due to the increased price of coal. To sum up the result of the half year, they had £33,532 less available for dividend than in the corresponding period. The amount which they carried forward—£20,633—was £2,293 more than in the corresponding period. Turning to the Bills deposited in Parliament affecting this Company, the Chairman said that in a Bill deposited by the Great Central Railway Company powers were applied for to construct a short railway at Neasden, and to make a junction with this railway. They should certainly have to oppose the granting of these powers, and there were other sections in the Bill relating to a proposed junction with the Midland and South-Western Junction Railway, which they considered were prejudicial to their interests, and he was a little surprised that the Great Central Company should bring these questions again before Parliament, and attempt to alter the arrangements that had been settled by previous Parliamentary Committees. He then moved that the report and accounts be adopted.

Mr. Francis Pavy seconded.

Mr. Newby asked for information as to the cost of the new electric traction as compared with the present. Seeing that electric traction was as yet in its infancy, and having regard to the great strides it was making, he considered it was certainly not wise to adopt the system just now.

Mr. Plumber asked for an assurance that the adoption of electric traction would not interfere with the interchange of traffic on the northern lines.

Mr. Sloper considered, with regard to the competitive traffic they had to meet, that as time rolled on the traffic over the Metropolitan Railway would be greater than ever it had been. He confided in the ability of the present management to pull the Company round to its old position, and he urged the importance of an amalgamation with the District Railway being brought about in view of the saving of expense which would thereby be effected.

Replying to these and other remarks, the **Chairman** said Mr. Newby's views on the question of electric traction had become obsolete. Clearly the time had come when any railway system underground, in tunnels or tubes, must make use of electric traction. When they had abolished the locomotive from their tunnels, when they had the electric motors on their trains, and all the disagreeable consequences of burning coal in their tunnels done away with, they would have in their large and spacious tunnels an underground system infinitely superior to anything which the tubes could offer. They would have an accession of traffic from that very reason, which would far more than compensate them for the very moderate outlay which they would be called upon to undertake in installing electric traction. With regard to the question of cost, it would certainly be nothing like so much as they had at first anticipated. The cost of working with electric traction, and the greater rapidity with which they would move their trains, would in themselves mean a very considerable saving to the Company. On the receipt of the report from Sir Wm. Preece and other experts no unnecessary delay would occur in introducing the new system.

The report and accounts were unanimously adopted. The dividends recommended were declared, and the retiring directors re-elected.

The meeting was then made special to deal with the question of raising additional capital—viz, £450,000—to pay off the debit to capital account for widenings and improving the railway, and also approving of the Harrow and Uxbridge Railway Bill.

The **Chairman** stated that the directors proposed to raise the £450,000 by the issue of a new 3½ per cent. preference stock, which they would allot at par to the stockholders in proportion to their holdings of ordinary stock.

The necessary resolutions were carried unanimously.

At a Warncliffe meeting held immediately afterwards a resolution was passed approving of the Company's omnibus Bill, in which they asked for an extension of time for carrying out certain works at Aylesbury, and for the purchase of properties under the 1896 Act, and also for the carrying out of the works for electrical traction and ventilation purposes, under the Act of 1898.

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The **Chairman** then explained that it was not proposed to submit the Bill relating to the sale of the undertakings of the East and West Junction Railway, the Evesham, Redditch, and Stratford-upon-Avon Railway, and the Stratford-upon-Avon, Towcester, and Midland Junction Railway to certain northern companies and to the Metropolitan Company, or any one or more of such companies jointly. The reason for this was that the northern companies had decided not to submit the Bill to their shareholders.

The proceedings then closed.

EASTERN TELEGRAPH.

The ordinary meeting of this Company was held on Monday at Winchester House, E.C., Sir John Wolfe Barry presiding.

A resolution expressing to the Royal Family the meeting's profound grief at the loss they have sustained having been passed,

The **Chairman**, in moving the adoption of the report, pointed out that the traffic had been increased by the military operations in China and South Africa. The tariff to the latter place was reduced from 4s. to 3s. 6d. per word for ordinary telegrams on the 1st inst., and the rate would go down to 3s. in 1902, and 2s. 6d. in 1903, supposing always that the standard revenues were maintained. This was in accordance with the arrangements made between the Company, the British Government, and the Governments of Cape Colony and Natal, and others interested. The Australian tariff on ordinary telegrams was reduced to 3s. 6d. per word on the 1st inst. so far as telegrams were exchanged between South and Western Australia and Tasmania, and since then the Government of New South Wales had accepted the agreement, and they would be entitled to similar reductions on Feb. 1. With regard to the tariff to India, the difficulties which had been raised had not entirely been overcome. However, at the request of the Indian Government, the directors assented last year to reduce the tariff between Europe and India to 2s. 6d. per word, with the eventual reduction, under certain conditions, to 2s. per word. Turning to the accounts, the gross revenue showed a considerable increase, not entirely due to increased traffic, but largely to a rearrangement of the proportion payable to the Company under the Cape joint-purse agreement. However, apart from this, they might be very well satisfied with the traffic of the year.

The report and accounts were adopted.

DIRECT UNITED STATES CABLE.

The forty-seventh ordinary meeting of this Company was held at Winchester House, E.C., on Tuesday.

Mr. E. M. Underdown, the chairman, said that the revenue for the six months ended 31st ult., after deducting out-payments, amounted to £50,534, while the working and other expenses, including income tax, but excluding the cost of cable repairs, absorbed £20,827, leaving a balance of £29,707 as net profit, making, with £3,761 brought forward, a total of £33,468, which had been appropriated in the payment of two interim dividends of 3s. each to Sept. 30 and 31st ult., and in setting aside £10,000 to the reserve fund, leaving £5,255 to be carried forward. The revenue showed a reduction of £6,266 as compared with that for the corresponding period of 1899, and they might take it that this had been occasioned principally, if not wholly, by the construction of other cables across the Atlantic.

NORTH METROPOLITAN TRAMWAYS.

In the report for the half-year ended 31st ult. reference is made to a statement which has already appeared in a previous issue—viz, that the London County Council at its meeting on Nov. 20 passed a resolution instructing the Highways Committee to ascertain from the Company at what price they would surrender the lease now held from the Council, and a letter dated Dec. 1 last to that effect was received from the Council, to which the directors replied that the matter had received their consideration, and they were not prepared to name a price for the surrender of the lease of the Council's (northern) tramways. With reference to the negotiations with the West Ham Corporation and the Urban District Council of Leyton, mentioned in previous reports, the directors state that they have nothing further to report except that the negotiations are still proceeding.

LIVERPOOL OVERHEAD RAILWAY.

Directors: Sir William Bower Forwood, Bromborough Hall, Cheshire (chairman); Richard Hobson, Esq., The Marfords, Bromborough, Cheshire (deputy-chairman); James Barrow, Esq., 7, Beach-lawn, Waterloo; John Brancker, Esq., Green Bank, Wavertree; Harold Brocklebank, Esq., 20, Birketh-street, Liverpool; Sir Edward Lawrence, The Grange, St. Michael's Hamlet; George H. Robertson, Esq., Plas Newydd, Llangollen. Engineer and manager: S. B. Cottrell, Esq., M.I.C.E., 31, James street, Liverpool. Secretary: William H. Alexander, Esq., C.A., 24, North John-street, Liverpool.

Report of the directors (with abstract of accounts) to be submitted to the twenty-fifth half-yearly general meeting to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Feb. 12, 1901, at 3 p.m.:

In presenting the half-yearly statement of capital and revenue accounts to Dec. 31, 1900, the directors have to report that the gross revenue receipts amount to £43,964. 10s. 8d., and the working expenses to £29,187. 9s. 4d. The number of passengers carried during the last two years is as follows:

	Half-year ending June 30, 1899.	Half-year ending Dec. 31, 1899.	Half-year ending June 30, 1900.	Half-year ending Dec. 31, 1900.
First class	594,669	676,768	635,449	716,095
Second class	2,445,572	2,941,392	2,477,025	3,369 833
Workmen (special return tickets)	1,435,038	1,596,797	1,575,388	1,569,571
Total	4,475,279	5,214,957	4,687,862	5,655,499

The tramway line to Great Crosby, completing the Waterloo-with-Seaforth and Great Crosby extension, was opened on Sept. 1, and the traffic has proved satisfactory. There has, however, been a decrease in the railway traffic of the Company, as compared with the corresponding period of last year, when the receipts were considerably augmented in consequence of the departure of troops for South Africa.

REVENUE ACCOUNT.

Receipts from passenger traffic amount to	£42,901	5	1
Miscellaneous receipts and interest	1,063	5	7
	43,964	10	8
Less working expenses	29,187	9	4
	14,777	1	4
Deduct interest on mortgage debentures	3,400	0	0
	11,377	1	4
Add balance brought forward, June 30, 1900	4,452	12	0
Leaving available for dividend	£15,829	13	4

Out of this balance your directors recommend the declaration of dividends at the following rates (less income tax), payable on and after Feb. 15 next: 5 per cent. per annum on preference shares, £3,000; and 3½ per cent. per annum on the ordinary shares, £8,750, leaving a balance of £4,079. 13s. 4d. to be carried forward to next half-year. The directors retiring by rotation at this meeting are Sir Edward Lawrence and Mr. George H. Robertson, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. J. S. Harmood Banner, who is also eligible for re-election.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Maintenance of way, works, and stations	4,480	6	0
Locomotive power	8,104	16	10
Repairs and renewals of carriages	317	13	9
Traffic expenses	10,658	19	10
General charges	2,381	12	5
Law charges	103	6	5
Compensation	62	6	0
Rents, rates, and taxes	2,995	5	4
Government duty	78	2	9
	29,187	9	4
Balance carried to net revenue account	14,312	0	8
	£43,499	10	0

Receipts.	£	s.	d.
Passenger traffic	42,901	5	1
Parcels, etc.	47	15	4
Rents	537	9	7
Transfer fees	13	0	0
	£43,499	10	0

GREAT NORTHERN AND CITY RAILWAY.

The report (for which we are indebted to the *Financial News*) for the half-year ended Dec. 31 states that two additional shields have been erected and are now working at Drayton Park, where 460 lineal yards of tunnel have been driven. At Essex-road the station tunnels have both been driven to their full length, and the construction of the connecting passage is being proceeded with. At Regent's Canal the up and down line tunnels have been driven for distances which together amount to nearly two miles, and through communication is established with Essex-road. Two additional shields to drive southwards will shortly be erected at Old-street, where a shaft has been sunk, and the up-line station tunnel has been commenced. At Finsbury-pavement a shaft has been sunk to its full depth, and the connecting passage is in course of construction. Tenders have been invited for the supply of electrical plant, and, generally, the progress made with the works is satisfactory.

WATERLOO AND CITY RAILWAY.

The report for the last half-year gives the gross receipts as £15 481. After paying the London and South-Western Company £6 589 in respect of working expenses, £8,892 remains available for a dividend at the rate of 3 per cent. per annum on the Company's ordinary and borrowed capital. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 2,038,400, showing an increase of 268,669 over the number carried in the corresponding period of 1899. The season-ticket holders on Dec 31 last numbered 883, as against 776 at the end of December, 1899.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bournemouth.—The Town Council invite tenders for 42 electric cars. Tenders by March 2. Details in our advertisement columns.

Mortlake.—The Barnes Urban District Council invite tenders for wiring their electricity works at Mortlake. Tenders by Feb. 11.

Edinburgh.—The Corporation invite tenders for engine and dynamo. Tenders by Feb. 9. Details in our advertisement columns.

Brighton.—The Council invite tenders for the overhead trolley construction and equipment on the whole of the tramway routes. Tenders by Feb. 14.

Aberdeen.—The Electric Lighting Committee invite tenders for surface condensers, air and circulating pumps. Tenders by Feb. 8. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of 100 car equipments and spare parts for same. Tenders by Feb. 22. Details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of storage battery for their electricity works. Tenders by Feb. 11. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for four electric motorcars for the pier electrical tramway. Tenders by Feb. 6. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the electric lighting installation at the public baths, Portobello. Tenders by Feb. 6. Details in our advertisement columns.

Aberdeen.—The Tramway Committee invite tenders for the electrical equipment of their bathing station route. Tenders by Feb. 13. Details in our advertisement columns.

Great Yarmouth.—The Town Council invite tenders for the supply of 800 tons, or thereabouts, of steel girder tramway rails of from 80lb. to 90lb. per yard. Tenders by Feb. 6.

Wigan.—The Electric Light and Tramways Committee invite tenders for dynamos, Korting condensers, switchboards, etc. Tenders by Feb. 2. Full details in our advertisement columns.

Bradford.—The Tramways Committee of the Corporation invite tenders for the complete electrical overhead equipment of over five miles of tramway. Tenders by Feb. 2. Details in our advertisement columns.

Beckenham.—The Council invite tenders for boilers, steam alternator and combined engine dynamo and motor, pipework, batteries, and switchboard. Tenders by Feb. 25. Details in our advertisement columns.

Hull.—The Works Committee of the Corporation invite tenders for the supply of one multipolar generator, to be coupled direct to a Bellis high-speed engine. Tenders by Feb. 8. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of boilers, with mountings, gangway, feed and drain pipes, etc., complete. Tenders by Feb. 15. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for the supply and installation of the complete motor and electrical plant of the central station of the town electrical works. Tenders by April 1. Details in our advertisement columns.

Long Eaton.—The Urban District Council invite tenders for producers, gas-engines, dynamos, switchboard, feeder and distribution cables, and conversion of street lamps. Tenders by Feb. 18. Details in our advertisement columns.

Stockton-on-Tees.—Tenders are invited for electric light installations at the town hall and borough hall. Specifications, etc., may be seen at the office of Mr. M. H. Sykes, borough engineer, Town Hall. Tenders by Feb. 4.

Shoreditch.—The Borough Council invite tenders for erection of a generating station in Whiston-street, adjoining the Haggerston basin of the Regent's Canal. Specifications, etc., can be obtained at the Town Hall, Old-street, E.C. Tenders by Feb. 13.

Stirling.—The Town Council invite tenders for engines and dynamos (first extension), two sets each of about 350 h.p., and Lancashire boilers (first extension), 28ft. long and 8ft. diameter. Tenders by Feb. 15. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for coal conveyor and elevators and coal-discharging plant, including hoist, automatic weighing machine, tower, and bridge over roadway. Tenders by Feb. 21. Details in our advertisement columns.

Croydon.—The Town Council invite tenders for the supply, delivery and erection of two dry-back boilers at their electric light station. Specifications, etc., may be obtained at the Borough Electrical Engineer's Office, Factory-lane, Croydon. Tenders by Feb. 16.

Wallasey.—The Urban District Council invite tenders for the erection and completion of car-sheds, stores, workshops, and dwellings at their tramway depôt, Seaview-road, Liscard, Wallasey. Tenders by Feb. 21. Details in our advertisement columns.

Eastbourne.—The Electric Light Committee invite tenders for the erection and completion of a proposed electric lighting station, with administration block. Plans, etc., may be seen at the Borough Engineer's Office, Town Hall, Eastbourne. Tenders by Feb. 4.

Manchester.—The Tramways Committee invite tenders for the supply of (*a*) car trucks and (*b*) plant, tools, and materials for overhead electrical equipment. Tenders by Feb. 5. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for three miles of 2in. pipes. Specifications, etc., may be had on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders to be addressed to Sir James Marwick, town clerk, City Chambers, Glasgow, by Feb. 12.

Bromley (Middlesex).—Tenders are invited for sundry work in connection with the installation of electric light at the Poplar and Stepney Sick Asylum. Specifications, etc., may be obtained and plans inspected at the office of Mr. Robert Foskett, clerk to the managers, Bromley. Tenders by Feb. 12.

Wallasey.—The Urban District Council invite tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. Tenders by Feb. 21. Details in our advertisement columns.

Bournemouth.—The Corporation invite tenders for the supply of three steam dynamos and two steam-driven surface condensers, and other works in connection therewith. Specifications, etc., may be obtained of Mr. F. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by March 2.

Luton.—The Town Council invite tenders for wiring for electric lighting purposes the Council-chamber, town hall, free library, corn exchange, and baths. Sketches of designs and full details of the proposed works to be given. Further information can be obtained of the Borough Engineer. Tenders by March 4.

Islington.—The Electric Lighting Committee invite tenders for the erection of a water-tower, tanks, and sundry additions to the central electric lighting station, Eden grove, Holloway, N. Plans, etc., may be seen at the office of Mr. A. Hessell Tiltman, F.R.I.B.A., 51, Russell-square, W.C. Tenders by Feb. 12.

Wimbledon.—The Urban District Council invite tenders for the supply and erection of steam and exhaust pipes, etc., and the moving of two boilers, feed pumps, feed-water heater, and storage tank, an independent surface-condensing plant, and two water-tube boilers. Tenders by Feb. 18. Details in our advertisement columns.

Ballinasloe (Ireland).—Tenders are invited for supplying and erecting the necessary plant and fittings for an electric light installation in the new hospital block of the district lunatic asylum, Ballinasloe. Specification, etc., can be seen at the office of Mr. J. F. Fuller, F.S.A., 179, Great Brunswick-street, Dublin. Tenders by Feb. 9.

Southampton.—The Corporation invite tenders for the supply and the erection of the works included under the following contract: Contract No. 10—(Section A) car bodies and trucks; (Section B) motors and equipments. Specification, etc., may be obtained at the offices of the Borough Engineer, Southampton. Tenders by Feb. 11.

Wolverhampton.—The Tramways Committee invite tenders for the supply and erection of a 10-ton electric travelling crane at the new car depôt, Cleveland-road, to operate on a 500 volt direct-current circuit. Specifications, etc., can be obtained from Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Feb. 11.

Poplar.—The Guardians invite tenders for the provision and construction of the necessary brickwork flues, and settings, etc., for two Lancashire boilers (28ft. by 6ft. 6in.), and an economiser about to be erected at the new buildings in course of construction adjoining the union buildings in High street, Poplar. Tenders by Feb. 6. Details in our advertisement columns.

Southwark.—The Electric Light Committee invite tenders for the supply and erection of the following plant for their electric light station at Penrose-street, Walworth-road, S.E.: (Section A) One 400-kw. high-speed engine and dynamo and accessories; (B) two water-tube boilers, fitted with mechanical stokers, and extension to the steam and water mains. Tenders by Feb. 18. Details in our advertisement columns.

Huelva (Spain).—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's ambassador at Madrid, stating that tenders are invited by the Spanish Government not later than Feb. 21 for the establishment of a telephone system in the city of Huelva. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Glasgow.—The Corporation invite tenders for the supply of the following material: (1) 1,000, 2,000, or 3,000 tons steel straight track rails, 100, 200, or 300 tons steel curved rails, 50, 100, or 150 tons steel fishplates; (2) 50 tons steel tiebars. The rails and fishplates will be a separate contract from the tiebars. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield street, Glasgow. Tenders by Feb. 22.

Valletta (Malta).—Tenders will be received at the office of the Receiver-General and Director of Contracts, Valletta, until 11 a.m. on Feb. 15 for supply of 75,000 arc lamp carbons. Tenderers in England not having a representative in Malta are to deposit with the Crown Agents the sum of £50 as surety. The tenderer whose tender will be accepted may be compelled to carry out the obligations arising from his tender, notwithstanding that he may not have signed the contract. Particulars, specifications, etc., may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

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RESULTS OF TENDERS

Sutton (Surrey).—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, have secured the contract for the supply of storage batteries required for the electric lighting of Sutton.

Farnworth.—The contract for tramcars has been placed by the District Council with the British Westinghouse Company, Limited, at £5 028, and the contract for feed pumps, steam pipes, superheaters, etc., at Middleton, with Haigh and Co., Oldham, at £3,080.

Gateshead.—The Gateshead Electric and Mechanical Supply Company, Limited, have secured the contract for the electric lighting of the extensive premises of Messrs. Snowball, Son, and Co., Limited, Gateshead. There will be 500 incandescents and several arc lamps.

Brighton.—The tender of the Union Cable Company, 23, College-hill, Cannon-street, E.C., to supply, deliver, and maintain such quantities of cable, of the several sizes and descriptions specified in the amended specification annexed to such tender, as may be ordered of them by the electrical engineer during the year ending Dec. 31, 1901, at a total of £13,952, has been accepted, subject to the sureties proposed by the contractors for the due performance of the contract being approved by the committee. The above appeared in our last issue, but the price was stated at £11,986.

Kendal. — The following tenders have been received for electrical plant. Contract No. 1:

Bergtheil and Young, Economic boilers, Reavell engines, £3,970; Browett and Lindley engines, £4,170; Peache engines (three-crank), £4 225.

Johnson and Phillips, Fraser boilers, Reavell engines, own dynamos, £4,600.

Geipel and Lange, Fraser dry-back boilers, Reavell engines, Lancashire Dynamo and Motor Company's dynamos, £4,717; with Economic boilers, £4,738.

Crompton and Co., Lindsay Burnett boilers, Allen compound engines, own multipolar dynamos, £4,758; Lindsay Burnett boilers, Willans compound engines, own multipolar dynamos, £4 870

Johnson and Phillips, Fraser boilers, Willans engines, own dynamos £4 760. (Accepted together with balancing dynamos and necessary alterations to switchboard entailed thereby, making a total of £4,975.)

General Electric Company, Economic boilers, Willans engines, own multipolar dynamos, £5,154; Economic boilers, Willans engines, own multipolar dynamos, £5 374.

Clayton Engineering Company, Economic boilers, own engines and dynamos, £5 285.

Electrical Construction Company, Economic boilers, Peache engines, own dynamos, £5,434.

Sunderland Forge Company, Economic boilers, Peache engines, own dynamos, £5,490.

Siemens Bros., Economic boilers, Alley and Maclellan engines, own dynamos, £5,580; Economic boilers, Browett-Lindley engines, own dynamos, £5,640; with Peache engines, £5 690.

T. Parker, Economic boilers, Willans engines, own dynamos, £5,706; with Browett-Lindley engines, £5,768; with Peache engines, £5,798.

Boilers, pipes, etc.

Anderton and Sons	£2,594

Battery alone.

E.P.S. Company	638
Hart Accumulator Company	649

Contract No. 2.—Cables, meters, etc., with cast-iron service boxes.

Western Electric Company, Venner meters	£2,909	7	11
British Insulated Wire Company, Vulcan meters (accepted)	2,965	3	6
British Insulated Wire Company, Venner meters	3 068	19	10
St. Helens Cable Company, Venner meters	3 398	1	4
Johnson and Phillips, own meters	3 356	7	11
St. Helens Cable Company, Ferranti meters	3,417	18	10
Siemens Bros., Venner meters	3 533	5	10
Henley's Cable Company, Venner meters	3,751	19	9
Glover and Co.	3,588	5	0

With cast-iron service boxes instead of wiped joint, and only meters to specification included.

Pemberton (Lancs.).—The Urban District Council have received the following tenders for the supply of electric lighting plant:

Building engine-house, boiler-house, tall chimney, etc.

T. and H. Houghton, Warrington road, New-town, Wigan (accepted)	£3,694
A. Bywater, Pemberton Sawmills, near Wigan	4,288
W. Winnard, Wallgate, Wigan	4 286
D. A. Ablett, Sovereign-road Sawmills, Wigan	3,914
J. Johnson and Son, Caroline-street, Wigan	4,325
A. Wigan, Rose Bridge, Ince, Wigan	3,870
W. France, Newtown, Wigan	4,390
J. Wilson and Co., Caroline-street, Wigan	3,585

Boilers.

Babcock and Wilcox, Limited	£3,107
A. Anderton and Sons*	3,566
Yates and Thom†	2,987
Tinkers, Limited, Hyde, Manchester (accepted)‡	2,246
Stirling Boiler Company	2,497
J. Musgrave and Sons	3,400

* Superheaters, £200 net. † Extra for pipes, ‖ £332. ‡ This amount does not include mechanical stokers.

Engines and dynamos.

British Westinghouse Company, Bellis £2,402 (condenser £933), Browett £2,290 (condenser £730), Willans £2,720 (except steam and water pipes).

T. Parker, Limited, £3,792.

Johnson and Phillips, £3,230.

Bergtheil and Young, Willans £3 235, Bellis £2,995.

Bruce Peebles and Co., Willans £3 526, Bellis £3,214, Browett £3,160, Allen £3,436 (except steam and water pipes).

Jackson and Co., £3,399

Siemens Bros. and Co., £4,031, Bellis £4,101, Willans £4,411.

Brush Electrical Engineering Company, £3,856.

Electric Construction Company, Willans £3,890, Bellis £3 584, Browett £3,536, Allen £3,569 (add £100 for contingencies), Reavell £3,617.

W. H. Allen, Son, and Co., £3,735.

Ashton, Frost, and Co., £3 250.

Johnson-Lundell Electric Traction Company, Browett £3,810, Willans £3,950, Bellis £3,650.

Crompton and Co., £3,384 (if Willans engine, £320 extra).

Sunderland Forge Company, £3,370.

Walker and Hodgetts, Browett £3 342.

Scott and Mountain, Limited, £3,520, alternative £3,165.

Laurence, Scott, and Co., Willans £2,610 (condenser, &c., £1,365), Bellis £2,298, Browett £2,232, Allen £2,175.

Parsons and Co., Newcastle, £4,764.

British Schuckert Company, £2,074 (condenser £695, cooler £234).

Lancashire Dynamo, etc., Company, Willans £2,361, Bellis £2,062, Browett £1,965 (condenser £407, cooling-tower £440).

Lister Electric Light Company, £5,050.

Warrington and District Power Company, £3,844.

Mather and Platt, Salford Ironworks, Salford, Bellis £3,150 (accepted).

Clayton Engineering Company, £3,142.

B. Thomas, £3,004, alternative £2,957.

Battery.

Electric Power and Storage Company	£2,537
Chloride Electrical Syndicate Company	2 624
Chloride Electrical Syndicate Company	2,499
Ashmore, Benson, Pease, and Co.	1 550
D.P. Battery Company	1 943
Hart Accumulator Company	2 352
Eclipse Brass and Copper Company and British Power, Traction, and Lighting Company	869
Tudor Accumulator Company, 16, Victoria-street, Westminster (accepted)	1 927
Marquand Accumulator Company	2,000

Switchboard.

Johnson and Phillips	560
Siemens Bros. and Co., Limited	605
Dorman and Smith, Ordsal Station Electrical Works, Salford (accepted)	435
Brook, Hirst, and Co.	579
Williamson and Joseph	380
Electric Construction Company	750
Edison and Swan United Company	668
Crompton and Co.	555
Heaton and Smith	775
General Electric Company, Limited	575
General Electric Company, Limited (alternative)	615
Cox-Walkers	538
E. Dewhurst	475
Hodges and Todd, Limited	586
E. F. Moy and Co., Limited	814
Cowans, Limited	426
B. Thomas	490

Crane.

Morris and Bastert, Limited	169
J. Spencer and Co.	172
Chatteris Engineering Works Company	194
Carrick and Ritchie, Waverley Engineering Works, Edinburgh (accepted)	161
J. Booth and Brothers, Limited	225
J. Carrick and Sons	182
T. Larmuth and Co.	210
B. Thomas	185

Conductors.

Henley's Telegraph Works Company	7 823
Johnson and Phillips	7,926
Johnson and Phillips (alternative)	6,905
Johnson and Phillips (alternative)	7 831
Johnson and Phillips (alternative)	6 810
British Insulated Wire Company, Limited, Prescot, St. Helens (accepted)	7 013
Siemens Bros. and Co., Limited	8 693
Callender's Cable and Construction Company	8 391
St. Helens Cable Company	10 612
Glover and Co.	9 570
Western Electric Company	7 306
Dennis and Co.	7 957

Telegraphs in China.—The manager of the Eastern Extension, Australasia, and China Telegraph Company Limited, states that the company has constructed land lines between Taku, Tientsin, and Pekin, and opened them for traffic. These land lines are under the complete control of the companies, and are worked in direct connection with the cables laid by them last autumn between Shanghai, Chefoo, and Taku. The existing tariff to Tientsin and Pekin of 5s. 6d. per word remains unaltered.—*Financial Times.*

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BUSINESS NOTES.

TRACTION.

North Shields.—The opening of the electric tramways between North Shields and Whitley is expected shortly.

Wallasey.—The District Council have decided to advertise for a tramways manager at a salary of £250 per annum.

Middlesbrough.—The work of paving the route of the tramway extension to the ferry will be commenced on March 1.

Halifax.—The route of the tramways now covers 16½ miles, as against 11 miles for the corresponding period last year.

Stirling.—The Police Commissioners have confirmed their resolution to purchase the undertaking of the tramways company.

Baker-street and Waterloo Railway.—This Company have purchased the site and buildings of the Indigent Blind Schools in St. George's-circus, S.E., for £140,000.

Bournemouth.—The Borough Council have confirmed the Bill for the construction of tramways with and without the borough. The loan of £200,000 has been sanctioned.

Brighton.—The Corporation have decided to purchase for £25 000 the whole of the premises known as Longhurst's Brewery in connection with the tramways scheme.

Waterloo and City Railway Co.—The directors have resolved to recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended Dec. 31 last.

Liverpool Overhead Railway Co.—The ordinary half-yearly meeting of this Company will be held at the Law Association Rooms, Cook-street, Liverpool, on Tuesday, Feb. 12.

Wicklow.—The County Council have approved the Bray and Enniskerry tramways scheme, subject to the draft Order in Council being amended to the satisfaction of the Council.

Central London Railway.—The following dividends will be paid: ordinary shares, 2½ per cent. per annum; preferred shares, 4 per cent. per annum; deferred shares, 1 per cent. per annum.

Salford.—The Corporation have arrived at an interim agreement with the Manchester Corporation with regard to the working of the tramways by horse traction until such time as the electric system is complete.

Dublin.—The County Council on Friday last approved the proposed extension of the tramways from the terminus at Clonskeagh to the Scalp and Enniskerry and from Bray to Enniskerry, subject to certain conditions.

Wimbledon.—On the Tramways Committee's recommendation the Urban District Council have decided to consider what steps should be taken with a view of constituting the Council the tramway authority for the district.

Institute of British Carriage Manufacturers.—At the nineteenth annual meeting of this institute last week, Mr. Alexander Naughty, J.P., of Dingwall, N.B., was elected president for the ensuing year.

Camberwell.—The Borough Council have been recommended by the Finance Committee to assent to the doubling of the tramline from Camberwell to Vauxhall and to contribute £5,000 towards the cost of widening the roadway.

Cape Electric Tramways.—Holders of share warrants to bearer can obtain payment of dividend due to them by presenting coupon No. 8 at the offices of the Company, 55 and 56, Bishopsgate-street Within, E.C., on and after 1st inst.

Dublin United Tramways.—We notice that for the first time horse car receipts have dropped out of the traffic return of this Company. The mileage now being worked by electric traction is 45 miles as against 38 miles electrically, and six miles by horses for the corresponding period last year.

Huddersfield.—The portions of the Corporation tramway system which have been converted to electric traction were formally inspected by the Board of Trade officials on Wednesday. With the exception of a slight hitch on the Outlane section, the inspection was of a satisfactory character.

Hampstead.—At a public meeting held last week, under the presidency of the Earl of Mansfield, it was decided to present a memorial to the Borough Council urging them to take immediate measures for opposing the Extension Bill of the Hampstead, Euston, and Charing Cross Railway Company.

Paris.—The employés of the Metropolitan Electric Railway have gone on strike. The men are claiming 10 per cent. bonus for work during the late exhibition, the abolition of suspension as a punishment, and regular increase of pay at stated intervals, whatever the employés' merits may be. The company are holding out.

Leicester.—At last week's meeting the Town Council were invited to adopt the recommendation of the Tramways Committee for the acquisition of the undertaking of the tramways company, the substitution of electric traction for horse power, the reconstruction, equipment, and extension of existing lines, and the establishment of an electric power station.

East Molesey.—The District Council have decided to oppose the Bill of the London United Tramways Company unless provision is made therein for widening the Thames, Mole, and Ember bridges, for providing the space of 9ft. 6in. between rail and kerb throughout the system and for payment of the same contribution for repair of roads as is given to other districts.

Sunderland.—The Tramways Committee received a deputation of East End traders last week on the subject of extending the tramways to the East End of the borough. The engineer was instructed to prepare a report on the matter. It was decided to run a trial car over the whole of the new routes next week, and it is hoped that they will all be opened within three weeks.

Ealing.—It is reported that the questions at issue between the District Council and the London United Tramways in regard to the construction of the authorised electric tramway in Ealing have been virtually settled on terms which adequately conserve the interests of the ratepayers, and it is probable that before many days have passed construction work will be commenced.

Great Eastern Railway Co.—At the ordinary meeting of the Company on Tuesday, the Chairman stated that the Board had decided to abandon the high-level scheme and construct low-level tube lines, starting at Ilford and running under the existing rails to Liverpool-street, whence the line would proceed to Walthamstow, and so form a continuous service between those three points, with intermediate stations wherever they might be regarded as necessary.

Barnes.—At a special meeting of the District Council it was decided to oppose the London United Tramway Company's Bill so far as it relates to the proposed line between Upper Richmond-road, Putney, and the Broadway, Hammersmith, on the ground that the line of route is not satisfactory. The continuation of a line from Putney to Richmond, through Barnes and Mortlake, was approved in principle, but the objection was to the proposed terms of purchase. It was resolved that the Surrey County Council should be asked to assist in the opposition.

Cardiff.—At the Tramway Committee's meeting last Friday a letter was read from the Board of Trade, stating that, in view of the limited headway given by one of the overhead bridges of the town, they were not prepared to sanction the double decked type of car for the electrical tramway. The engineer is to report on what can be done to lower the road surface under the Bute-road Bridge. On Thursday week a deputation, composed of residents of Cathedral-road, waited upon the Works Committee with a view of inducing that body to expedite the work of laying down the track for the electric tramways in that road.

North-East London Railway Bill.—This Bill has passed the Examiners of Standing Order Proofs. The proposed line, if sanctioned, will run from the City to Walthamstow, passing through the densely crowded districts of Shoreditch, Kingsland, and Hackney to Walthamstow, with a branch line to the growing working class district of Tottenham. The same promoters are also responsible for the Piccadilly and City Railway, which will continue the same line from the Mansion House, along Fleet-street and the Strand to Piccadilly-circus, there forming a connection with the authorised Brompton and Piccadilly line.

Wandsworth.—The General Purposes Committee recommended the Borough Council in their last report to consent to the short length of tramway in the borough, subject to a double line being constructed, and to the necessary widening to secure a width of 9ft. 6in. between the outer rail and the kerb on each side of the proposed tramway being carried out by the London County Council, and that the Council be informed that, in the opinion of the Borough Council, a tramway was not required along the proposed route, and that a better route would be along the valley of the Falcon Brook to Balham Station by a new road, or along the Trinity-road from Upper Tooting-road to the Council house.

Leeds.—The formal Board of Trade inspection of the Beeston and Elland-road section of the tramways took place on Thursday last week. The Tramways Committee have decided to lay tramlines from the junction of Upper Accommodation-road with York-road to Easy-road. It is the intention ultimately to continue the line through East-street into Marsh-lane. The tramway men have rejected the proposal of the Tramways Committee to pay the rent and rates and the caretaker's salary of their recently-established club on the ground that the conditions prohibiting the sale of intoxicating liquors, and that three trustees should be appointed with absolute right of veto in the management, are unreasonable.

Rochdale.—Last week a conference of local authorities interested in the taking over of the Bury, Rochdale, and Oldham tramway undertaking was held. It was resolved that a joint arrangement be, if possible, come to with the tramways company, or a joint arbitration held, to determine the terms of the acquisition of the company's undertaking, a share of the purchase money and costs of the necessary proceedings to be allocated to each authority, and that in view of the varying periods of expiration of the powers of the tramway company, the various local authorities be requested to consider the question of the desirability or otherwise of acquiring the undertaking of the company before such respective periods of expiration.

Hull.—A deputation of tradesmen and property owners waited upon the Works Committee last Friday to urge the introduction of the tramways and electric lighting into the old town between the Whitefriargate Bridge and the pier. The Chairman of the committee said the North-Eastern Railway Company would not allow the Corporation to carry the electric current over the bridge, but he promised to consider the matter and try to find out what the cost of a temporary arrangement would be to carry the trams over the route named. The Tramways Sub-Committee are to report upon the matter. At a meeting of the Sessions Court the Corporation's omnibus Bill in Parliament embodying the further extension of the tramways was approved.

Proposed Watford and District Tramways.—A Bill to incorporate a new tramway company in Hertfordshire by the name of the Watford and District Tramways Company for the purpose of the purpose of constructing tramways through Watford, Rickmansworth, and Bushey will be introduced in the ensuing session of Parliament. The aggregate length of the proposed system will

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be just over 8¾ miles, and it is proposed to work the tramways by electricity generated from a station erected at Bushey. The capital of the company is to be £125 000, of which £55,000 may be raised by the issue of preference shares. It is sought upon this capital power to create and issue debenture stock to an extent not exceeding one-third of the capital raised. Mr. John Fell, Mr. Samuel Hunter, and Mr. W. J. Kershaw are mentioned as the promoters of the Bill.

Manchester.—At the meeting of the Electricity Committee yesterday week a letter was read from Prof. Kennedy stating that it would be a calamity to the city if the Bloom-street power station were not ready to take up its load by September or October next. It was explained that at the Dickinson-street station two special Ferranti generators had been laid down, which will supply the current necessary for working the three tramway routes which it is hoped will be opened in spring—viz, the Cheetham Hill-road, Bury New-road, and Rochdale-road routes. The committee passed a strong resolution with the object of spurring on those engaged in the works at Bloom-street, which will supply traction, light, and power. When in full running the Bloom-street station will add 14,000 h.p. to the 11,000 h.p. possessed at Dickinson-street, bringing up the total horse-power to 25,000. No further delay is to take place in connection with the equipment of the high-tension generating station at Stuart-street.

Newcastle.—Last week the members of the Tramways Committee paid a visit of inspection to Walker in regard to the proposed routes in the extension of the tramways from Newcastle to Byker. The idea is to commence at the top of Byker-hill tramway terminus, and proceed by Union-road and Welbeck-road as far as Wigham, Richardson, and Co.'s works, and to come back by a loop line running from the railway station to Church street, and again joining the line at Welbeck-road. The Walker Urban Council wish to have a line to join the proposed line on Shields-road, at Walker-gate, and be carried on to what is known as the Willows, and then to Church-street. The committee did not come to any unanimous decision, but the opinion seemed to be that such a line as proposed by Walker Council was unnecessary because there was practically no population at that particular part, and that it would be carrying tramways for some considerable distance through what is only a country road. The car-sheds at Byker-hill are rapidly progressing.

Darlington.—Last Monday the General Purposes Committee passed a resolution recommending that a committee be appointed with authority to enter into a contract, subject to satisfactory terms being agreed upon, to purchase the whole of the property of the Imperial Tramway Company Limited, in Darlington, including the order of the Light Railway Commissioners when confirmed by the Board of Trade. Messrs. Kennedy and Jenkin have prepared a report of estimate of cost and the returns which might be expected in connection with the proposed electric tramways. It estimates that the cost of buying up the present tramways would be £6,500. The net capital cost of laying down 6½ miles of tramways and the necessary plant would be £87,000 for a single line and £109,000 for a double line. The report points out that for receipts to balance expenditure there would have to be earned 8·23d. for the single line and 8·65d. for the double line per car mile. At 1d. per mile per passenger there would have to be carried the whole population of 45,000 every three days in order to earn sufficient income, which is very much more than could be expected. Probably there would be traffic equivalent to carrying the whole population in 5½ days, which would mean three millions of passengers per annum. If the service of five minute cars were reduced except on the main line there would have to be earned 10·4d. per car mile for single line and 11·3d. per car mile for the double lines, which was quite a reasonable figure. It is added that in general it might be said that it appears that the tramways could be constructed and worked so as to pay their way. It is proposed to call a public meeting on the subject.

LIGHTING AND GENERAL.

British Insulated Wire Co.—The directors have declared a dividend of 6 per cent.

Lowestoft.—Feb. 12 has been fixed as the date for the switching on of the current at the Town Council's station.

British Electric Transformer Manufacturing Co.—The directors have declared an interim dividend of 10 per cent. per annum

New Zealand Electric Light and Traction Co.—The directors have declared a dividend of 60 per cent. for the year 1900.

Westminster Electric Supply Co.—The directors recommend a dividend for the half-year ended 31st ult. at the rate of 11 per cent.

Thanet.—The Isle of Thanet Light Railway Company have assured the local authorities that electric lighting cables would be laid in the main streets before the summer.

Electrical Engineers Volunteers.—Lieut. the Hon. R. Craven, who is one of the Electrical Engineers Volunteers going to South Africa, has been granted the temporary commission of captain in the army.

Cromer.—The Urban District Council on Tuesday agreed to purchase a site for an electric lighting station and storeyard at £800. It was stated that the original price asked for the land was £1,370.

Barking.—During the month of November applications were received for 54 8-c.p. lamps, and in December for 90 8-c.p. lamps; also current for a five-ampere radiator. During December 20 8-c.p. lamps were disconnected.

Islington.—With a view to a greater demand, the Electricity Committee of the Borough Council recommend that, at the expiration of the present quarter, the price for electrical current during the hours of daylight be reduced from 3½d. to 2d. per unit.

Darlington.—At the last meeting of the Darlington Gas and Electric Lighting Works Committee the engineer, Mr. R. P. Lund, reported that the demand for electricity was slowly increasing and more places of business and private houses were being wired.

Glasgow and West of Scotland Engine-keepers' Association.—A lecture was delivered on Tuesday by Mr. T. Crichton Fulton, A.I.E.E., on "The Glasgow Electric Tramway System." Numerous lantern slides illuminated the lecture, which was attended by a large and appreciative audience.

Share Market.—Little was doing in electric shares during the week. Lighting shares were weaker, with the exception of Westminsters, which rose to 12¼ to 13¼ on account of the dividend. Traction hardened, and British Electric Traction ordinary and preference rose ¼, and Potteries ordinary improved to 12.

Coventry.—It is proposed to increase the salary of Mr. Ram, manager of the electric light works, to £400 a year, and to extend the electric light works at an estimated capital expenditure of £18,000. At the meeting of the Town Council on Tuesday, both these recommendations were referred back for further consideration.

Bray.—With regard to the organisation of technical education in Bray, there is a proposal to take some portion of the mill building and to convert it into a drawing office, classroom, and workroom. The building is to be lighted by electricity, and the machine tools will also be driven electrically. A fitter from the electric light station is to assist in the manual training of the pupils.

Perth.—Mr. John Lambert, Dundee, has been elected electrical engineer. During the past two years Mr. Lambert has acted as outdoor assistant to the city electrical engineer. Under his personal supervision the large works involved by the extension of the lighting and tramway systems have been carried out, and that in a manner entirely to the satisfaction of the department. Mr. Lambert is a member of the Institute of Engineers and Shipbuilders and an associated member o ithe Institution of Electrical Engineers, London. The salary is £200.

Stirling.—The Lighting Committee have decided to charge for current on the maximum demand system at the rate of 7d. per unit for the first hour and 2d. per hour afterwards. The cost of four electric lamps for corner of Glebe-crescent, Gladstone-place, and Park-terrace is estimated at about £96, and the matter will be delayed until a trial of the new open-type arc lamps has been made. The engineer has been instructed to advertise the following scale of charges for current for motors: ¼ h.p. to 2½ h.p., 4d. per unit; ½ h.p. to 2¼ h.p., 3d. per unit 3 h.p. and over, 2d. per unit.

Guildford.—At the meeting of the Town Council last week a report of the General Purposes Committee was agreed to, which stated that they had considered the plan submitted by the electricity supply company showing a proposed extension of their mains through Tuns-gate and South Hill-road, but as the main through the latter road was proposed to be laid on land which was not at present part of the road, the committee recommended the Council to approve the plan so far as the works were proposed to be executed between High-street and the junction of Pewley-hill and South Hill-road.

Edinburgh.—At Tuesday's meeting of the City Council the following notice of motion was given: "Remit to a special committee, consisting of the treasurer, the convener of the Electric Light Committee, and three members from each of the Treasurer's Committee and the Electric Light Committee, to get a report from the town clerk, the city chamberlain, and the accountant auditor of the city, backed up and so advised by opinion of counsel, on the following questions: (1) whether the provision made and being made for the maintenance and renewal of the more perishable portions of the electric lighting undertaking is sufficient; and (2) whether the present method of dealing with that matter is the best and most efficient available under the statute; and (3) if not, what alternative would they suggest."

Stock Exchange.—The Stock Exchange Committee have appointed Feb. 6 special settling day for the British Motor Traction Company's 205,839 5 per cent. cumulative preference shares of £1 each fully paid. Nos. 1 to 205,839, and the Mica Manufacturing Company's 5,795 shares of £1 each fully paid, Nos. 1 to 4,967 and 5 308 to 6 135, and 55,000 vendors' shares of £1 each fully paid, Nos. 6 136 to 61,135; and also ordered the Commercial Cable Company's further issue of £177,951 sterling 4 per cent. 500-year debenture stock to be quoted in the official list. Applications have been made to appoint a special settling day in and to grant a quotation to the Electric and General Investment Company's 19,900 6 per cent. cumulative preference shares of £5 each fully paid, and to appoint a special settling day in the Colonial Rubber Estates, Limited, 20,007 shares of £1 each fully paid. Nos. 1 to 20,007 and 65 000 vendors' shares of £1 each fully paid, Nos 20 008 to 85,007 and to allow the following securities to be quoted in the official list: Cape Electric Tramways, Limited, 400,000 shares of £1 each fully paid, £140,000 5 per cent. mortgage debentures and £315,000 6 per cent. mortgage debentures; and the City and South London Railway Company's 10,000 shares of £10 each fully paid.

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Mansfield.—From the report of the Electric Lighting Committee adopted at last week's Town Council it appears that the committee have given a general approval to the report of Mr. Hammond, and have also approved a site in Rock valley for the erection of the works. The scheme is estimated to cost about £20 000. A dust destructor will be provided.

Electrical Measuring Instruments. — Messrs. Everett, Edgcumbe, and Co. have forwarded to us a list of the electrical measuring instruments made by them. The firm stated that they have completely remodelled both their direct-reading and recording instruments so as to reduce to a material extent the number of parts required. We notice that the ammeters are made in sizes ranging from 50 amperes up to 600 amperes, while the range of the voltmeters is from 50 volts up to 700 volts.

Bristol.—In their last report the Electrical Committee state that they consider, in consequence of the large increase in his work, that Mr. Harold Faraday Proctor, the city electrical engineer, is not sufficiently remunerated, and they recommend that his salary be increased to £600 per annum as from Jan. 1, 1901, and to £700 as from Jan. 1, 1902, on condition that he undertake not to determine his engagement for two years from Jan. 1, 1901, which condition the committee are informed Mr. Proctor is prepared to accept, provided the increase of salary recommended is granted by the Council.

Edinburgh —Under remit from the Town Council, the Electric Lighting Committee at a committee on Tuesday again considered the subject of the appointment of a deputation to visit English towns in connection with the provision of condensing plant for M'Donald-road station. The committee have resolved to adhere to their former recommendation that a deputation be appointed, but limiting the number to five members, and suggesting the names of Councillor Mackenzie (the convener), Bailie Murray, Councillors Harrison, M'Michael, and James Stewart. It was also decided that the places to be visited should be Oldham, London, Bolton, and Brighton.

St. Marylebone.—We extract the following from this week's agenda of the Borough Council: "The Finance Committee resolved that the Council be informed that the expenses attending their application to the Board of Trade for an electric lighting provisional order are estimated not to exceed £500, and that the committee approve of such estimate. The Lighting Committee resolved that the Council be recommended to retain Mr. Terence Granville Bacon in his appointment as temporary electric inspector, at a salary of three guineas per week. A notice has been received from the Metropolitan Electric Supply Company as to laying a 5in. pipe along the south west side of Park road and the north side of Upper Park-place, from the west side of Upper Baker-street to the east side of Upper Gloucester-place."

Newark.—Mr. Vesey Brown has submitted plans of proposed works on the Water-lane sites for schemes of lighting estimated to cost not exceeding £20,000 and £30,000 respectively, and explained them to the committee and recommended the larger scheme as being the more economical, taking into account the probable requirements of the town in the course of two or three years. The committee, after discussing the two schemes, have decided to recommend the Council to adopt the larger one, at an estimated cost not exceeding £30,000, and that application be made to the Local Government Board as soon as practicable for sanction to a loan of £30,000 for the purpose, and that on such sanction being obtained the purchase of the sites in Water-lane of Mr. R. Chatterton and Miss Handley be proceeded with.

Personal.—Mr. Ivor Bevan has joined the Board of Crompton and Co., Limited.—Mr. C. S. Vesey Brown, having obtained the appointment of general manager to the Northern Counties Electricity Supply Company, Limited, Newcastle-upon-Tyne, has resigned his post as electrical engineer to the Corporation of Lincoln.—Mr. James Enright has been appointed electrical adviser to the Urban District Council of Heston and Isleworth.—Mr. Herbert Lindley, late of Browett, Lindley, and Co., of Patricroft, has been appointed general manager to Galloways, Limited, Manchester, who are taking up the construction of high speed engines for electric installations.—Mr. W. McClelland has resigned his position at the Manchester Corporation electricity works after 13 years' service with the Corporation. He has been at the electricity works since their beginning as an assistant to Mr. Wordingham, the city electrical engineer.

Presentation.—On Saturday last an interesting function took place at the works of Messrs. Callender's Cable and Construction Company, Limited, Oldham-place, Liverpool, when a large gathering of the local official staff and workmen assembled to bid good-bye to their late assistant engineer, Mr. W. J. Hide, who has left the service of the company to embark in business on his own account, in conjunction with Mr. A. Lester Taylor and Mr. Archie Kelly, as consulting electrical engineers and electricians. Mr. F. A. Pocklington, the chief engineer for the Lancashire district, on behalf of the entire staff, asked Mr. Hide's acceptance of an illuminated address and a box of scientific instruments, and spoke in eulogistic terms of Mr. Hide's ability and devotion to duty, combined with his kindly and unassuming manner. Mr. Price and several others followed with speeches, expressing regret at Mr. Hide's removal, and tendering him all good wishes for his future career.

Ramsgate.—The Gas and Water Committee last week recommended that the Corporation invite tenders for the laying of connecting cables for the supply of electricity along the front of the town and through the following streets: High-street, from the market to the bottom of Chatham-street; Harbour-street, to the London, Chatham, and Dover Railway Station, King-street to Boundary-road; Queen-street to Addington-street; and that the light railway company be approached and asked upon what terms they will be prepared to supply electric current in bulk. Exception was taken to this report, which was, however, carried, it being remarked that by inviting tenders they were not binding themselves to anything whatever, but were merely getting an idea of the price. It did not follow that they were going to accept any tender for lighting if it could be shown at some future meeting that it could be done cheaper by their own works.

Wharfedale —On the invitation of the Yeadon District Council a conference of representatives of local authorities in the Wharfedale union was held on Monday in the Guiseley Town Hall for the purpose of discussing the proposals of the Yorkshire Electric Power Company, who have lodged a Bill in Parliament asking for powers to supply electricity in bulk over a large portion of the West Riding, including most of the districts covered by the Wharfedale union. The authorities represented were the Yeadon, Guiseley, Rawdon, Horsforth, and Ilkley District Councils, and the Menston Parish Council, and Mr. G. H. Teale, chairman of the Yeadon Council, was voted to the chair. Mr. A. G. Lupton and Mr. Robert Hudson (directors), and Mr. Baker and Mr. John Sturgess (engineers) were present as representing the syndicate. After discussion the conference decided that each Council represented should consider the question separately and report to a further meeting to be held as early as possible.

Private Bills.—Since our last report the Examiners of Private Bills have passed the following Bills which will now be reported for first reading: Piccadilly and City Railway, London County Council (General Powers), Metropolitan District Railway, King's-road Railway, Notting Hill Electric Lighting, Charing Cross, Euston, and Hampstead Railway (No. 1), Charing Cross Euston, and Hampstead Railway (No. 2) and City and Brixton (Extension of Time), and Bournemouth Corporation. The examiners found that in the case of the Brompton and Piccadilly-circus Railway (Extensions) Bill the money deposits in respect of some of the railways contemplated had not been made, and that there had been non-compliance with the Standing Orders. The irregularity will have to be dealt with by the Standing Orders Committee. The Willesden Urban District Council Tramways and Improvement Bill, which was unopposed at this stage, was marked on the examiner's list as "dead." In the case of the Southend-on Sea Corporation Bill there was also no appearance.

Bangor.—Last week a deputation, including Mr. W. P. Adams electrical engineer of the North Down Tramway Company, waited on the Urban District Council with a view to making definite arrangements for lighting the town with electricity. It was stated that the company proposed to spend £12,000 or £15,000 on lighting Bangor. They were prepared to lay down the mains and also wire the private houses and supply the lamps. In reply to a question, an answer was elicited to the effect that the company would undertake the lighting of Bangor independent of Donaghadee and Groomsport. If these places were included, the cost would altogether be about £20,000. They would agree to supply electric light to private houses at 6d. per unit. For Board of Trade purposes, however, they intended to state the maximum price at 8d. per unit, and they would have power to raise the price to the latter figure in case of emergencies, but, of course, it would be their interest to keep the price popular. They would undertake the lighting of the streets at 3½d. or 4d. per unit. It was the intention of the promoters to commence the undertaking at once, and have it completed in August next. All the councillors appeared favourable to the scheme.

Paisley.—At a recent meeting of the Baths Committee of the Town Council, Messrs. Haran's account for the electric wiring of the baths was discussed. The convener submitted a statement prepared by Mr. Teague, the engineer, showing the contract price to be £217. 10s., while extras had been executed to the amount of £123. 19s. 8d., thereby bringing out a total expenditure of £341 9s 8d. It appears that the extras charged for have been incurred on the engineer's instructions and on his own responsibility, without consultation with the convener or any member of the committee. The engineer explained that, owing to the moisture in the atmosphere of the baths, special precautions had to be taken for the protection of the wires, and that in sanctioning this additional expenditure he considered that he was acting for the best interests of the Corporation, and was satisfied that they had full value for their money in the account rendered. The committee was of opinion that as Mr. Teague was the arbiter under the contract, to whom all questions and disputes were referable, and as he had sanctioned the extra work done, the Commissioners had no option, and were bound to pay the amount claimed. They desired, however, to record their strong disapprobation of the unbusinesslike fashion in which the matter had been gone about.

Wimbledon.—The last report of the Electric Lighting Committee to the Urban District Council, which was adopted, contained the following: "Resolved that the electrical engineer be authorised to carry out cable extensions in the following roads and streets, at an estimated cost of £286—viz, Camp View, Wandlebank, Effra-road, Belvedere-drive, Lake-road (north end), and Arthur-road. The electrical engineer reported the position of the undertaking at date, as follows: private lamps connected (in 8 c.p. equivalent) 22,180; private lamps applied for (in 8 c.p. equivalent), 23,711; street lamps connected (in 8 c p. equivalent), 4,128; street lamp-posts to equip electrically, 109; street lamp-posts (equivalent in 8-c.p. lamps), 436; number of consumers on books, 421; maximum load reached, 367 kw." Mr. Caswell, in moving the adoption of the report, referred to the fact that Mr. F. Barnes Spencer, resident electrical engineer to the Council, had accepted another post, but had only taken it on the understanding

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that he should be allowed to remain at Wimbledon until various extensions had been carried out, and the undertaking was put into proper order. He thought Mr. Spencer had acted very honourably indeed when they considered what he had done.

Cape Telegraph Rates.—Sir J. Wolfe Barry, presiding at the fifty-seventh half-yearly meeting of the Eastern Telegraph Company, Limited, held on Monday at Winchester House, pointed out that the traffic had been increased by the military operations in China and South Africa. The tariff to the latter place was reduced from 4s. to 3s. 6d. per word for ordinary telegrams on the 1st inst., and he hoped they might look forward to a further reduction. Although, owing to what the company had done in connection with the war in South Africa, there had been a temporary increase in the revenue, the Board preferred to rely upon the permanent increase of traffic, which they had every reason to hope would result from the development of the country when peace was declared, and when the influence of an enlightened government was properly felt and duly appreciated; so that the great colonies which had now been annexed might form one great union of contented states, and develop in a way which was hopeless under the previous *régime*. At the request of the Indian Government the directors assented last year to reduce the tariff between Europe and India to 2s. 6d per word, with the eventual reduction, under certain conditions, to 2s. per wood; but the company were not free agents in the matter, because there were other companies which had to be considered.—*Daily Chronicle*.

Hull.—At a special meeting this week the following report will be discussed: The Electric Lighting Committee state that the electrical engineer has reported that he considered it advisable to carry out certain alterations at the Dagger-lane station with a view to (1) providing for the increasing number of consumers in the old town; (2) increasing the efficiency of the system as a whole; and (3) reducing the amount of smoke produced at the Dagger-lane station. Ultimately it would probably be found advisable he said, to convert the Dagger-lane station into a sub station, having no steam plant, but only transformers fed from the Sculcoates-lane works, but to do that in one operation would almost certainly entail great inconvenience to the customers at present supplied from Dagger-lane, and the engineer therefore proposed to carry out half of the work during the coming summer. He recommended that the four smallest steam dynamos (equivalent to 310 kw. in all) should be taken out and sold, and that four transformers (equivalent to 360 kw. in all) should be installed in their place. The alterations would meet all the requirements above mentioned, and would especially increase the efficiency of the system, as it would enable the steam plant at Dagger-lane to be shut down through two shifts every day, and all day on Sundays and Thursdays. Having ample boiler power for the remaining steam plant, there would be much less need to force the boilers, and thus less smoke would be created. The estimated total cost of the work is £17,500.

Eastbourne.—The Council at a recent special meeting considered the proposal by the Electric Light Committee for the erection of new electric light works at Roselands, for the laying down of improved plant, the extension and improvement of mains, the remodelling of the present system of arc lighting, etc., at a revised estimated cost of £50,882. Councillor Maude, chairman of the committee, said the Council had added £7,240 to the estimate as first submitted for additional arc lights and an additional steam alternator. They had also added offices and stores, and they proposed to use the chimney shaft exclusively for the electric light works, instead of in connection with the destructor, etc. The cost of building had also augmented the sum to the extent of 25 per cent. This explanation fairly balanced up the two estimates, although it left an odd thousand or thereabouts which the chairman expressed inability to entirely account for. It was ultimately pointed out that the size of the engine-house had also been increased, and that the estimates for the building works had been prepared by different men. The chairman further stated that in the past 12 months there had been an advance in the number of customers from 409 to 492, while the amount of light supplied had increased to the extent of 29 per cent. The financial result of last year's operations was a net profit of £834. 11s. 2d., while they had paid £3,382 bank interest at a high rate, and had contributed £2,600 to the sinking fund. Coal during last year had cost £3,268, as against £2,065 in the previous year. On the whole it was very satisfactory, but it was plain that with the growth of the demand they would be obliged to keep adding to the capital expenditure. He hoped to be able to bring up tenders for the work at the next meeting, and that the work would be speedily carried through. The disturbance of the streets would be principally as to the pavements, the roads being very little interfered with. The Council resolved to apply to the Local Government Board for power to borrow the amount required.

Brighton.—The Lighting Committee at their last meeting resolved that the Corporation would, if required, accept a conveyance from the Board of Trade at the price of £5 of the tidal lands forming the site of their intended works at Southwick, provided that in so doing they would not be deemed to admit any title upon the part of the Board of Trade to the lands in question. The surveyor's specification and bills of quantities for the concrete foundations of the proposed power-house at Southwick were approved, and tenders are to be invited for the performance of the work by special contract. The sub-committee appointed to negotiate for the purchase of premises in Bread-street for the purposes of the extension of the electricity station for the plant necessary for tramway purposes have received an offer from the owners of 20 and 21, Bread-street to sell the freehold of those premises for the sum of £250 and £375 respectively. The sub-committee recommended the Council to purchase the above premises on the terms named. It was resolved that the recommendations of the sub-committee be approved and acted upon. The following letter was read from the Board of Trade (Fisheries and Harbour Department) relative to the Brighton Corporation Act, 1900: "Referring to your letter of the 14th inst., upon the subject of the works which the Corporation of Brighton propose to construct at Southwick, under the provisions of the above-mentioned Act I am directed by the Board of Trade to state that, with their present information, the Board are unable to admit that the tidal lands which will be required for the purposes of the works in question form part of those to which the Board do not contest the claim of Mr. J. M. Carr-Lloyd as lord of the manor, but the matter will be further looked into by this Department. In view of the statement contained in your letter that the Lighting Committee will recommend the Council to accept a conveyance from the Board of Trade (if required) of the rights and interests of the Crown in the tidal lands in question, and in order to facilitate the execution of the works being at once proceeded with, I am to state that upon receipt of the sum of £1 as a nominal acknowledgment in respect of the dredging operations on the northern side of the towpath the formal consent of the Board of Trade will be inscribed upon both sets of the plans which accompanied your letter of Oct. 4 last, one of which will be retained in the records of this office, and the other returned to you as the authority of the Corporation, so far as the interests of navigation are concerned, for proceeding with the execution of the whole of the works in question." These proceedings, with the exception of the portion referring to the property in Bread street, which part was withdrawn, have been approved by the Corporation.

Bath.—At a meeting of the Electric Lighting Committee on Thursday last week a report was presented from Mr. G. F. Metzger (electrical engineer). This report, according to *Keene's Bath Journal*, suggested that the old Brush plant should be replaced by two combined and direct-driven sets of the very latest and most improved design, in order to obtain a high efficiency and a corresponding reduction in working costs. As these proposed new sets would only occupy the space taken up by two existing Brush sets, he suggested leaving the other two Brush engines and the alternators for the present in their existing positions, and they would then be available for light loads during the erection of the two sets. The current carried by the existing cables into the several sub-stations during Christmas week was far in excess of their carrying capacity, being designed for a maximum of 25 amperes, whereas they were called upon to transmit in some cases as many as 43 amperes. The cables got very warm in consequence, and a drop in pressure was the result. In addition to this they ran considerable risk of a breakdown through overloading, and to avoid trouble in the future he presented a scheme for supplying the five principal sub stations with the new feeders. The existing feeders had been cut about from time to time through the old system of house transformers, where a joint was necessary whenever a new customer was added. These old joints had been cut out to the detriment of the insulation, but they were quite good enough to act as feeders of small current to outlying districts, for which purpose he intended adopting them when the new feeders were laid. The only safe practice was to run a separate and independent feeder, to be used only for the one sub station it had to supply with current, and it must not be tapped for any other purpose. To avoid unnecessary expense in excavation and making good, he had arranged for as many feeders as possible to be laid in one trench, and when possible these trenches would be in side streets to prevent the opening of ground in main and important thoroughfares. The cables would each be designed to carry 100 amperes, and each pair laid in a separate troughing. This was necessary, as stray leakages of the continuous current, to be employed for operating the electric trams, were likely to decompose any lead sheathing on other cables, and would rapidly cause serious breakdowns. The estimated cost of the new plant was £8 500, and of the feeders £3,000 The report was adopted, and it was resolved that the engineer should take steps to inspect other works and obtain such information as he might require to enable him to select the most modern and efficient plant. The chairman and electrical engineer were requested to bring up a report with a view to reorganising and strengthening the staff. The best thanks of the committee were tendered to Mr. Metzger and his staff for the efficient manner in which the business of the undertaking had been conducted during the recent flood. Upon the suggestion of the Chairman, the committee unanimously resolved to make a grant of £3 to the men in recognition of their services.

NEW COMPANIES.

The following companies have been registered since our last issue:

Wilson and Bennett, Limited.—Capital, £1,000. Object: to adopt an agreement with W. Wilson and T. Bennett for the acquisition of certain patents relating to a life-preserving apparatus attachable to trams and other vehicles, and to carry on the business of engineers, wagon, tram, and carriage builders, manufacturers of lifeguards for vehicles, etc.

Contract Corporation of South Africa, Limited.—Capital, £10,500. Object: to carry on the business of railway, tramway, harbour, dock, water, gas, electric, and other works.

Hebburn Rope and Sail Works, Limited.—Capital, £20,000. Object: to acquire the whole or part of the Hebburn Rope and

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Sail Works, Hebburn-on-Tyne, and to carry on the business of hemp and wire rope, sailcloth, and sailmakers, rope, cord, and twine manufacturers, wire workers and drawers, telegraph, telephone, and electric light cable manufacturers.

Zanzibar Company, Limited.—Capital, £150,000 in £1 shares. Object: to adopt an agreement with A. H. Neale, to acquire and turn to account charters, concessions, rights, privileges, and agreements of or from the Sultan or Government of Zanzibar or other authority, and to carry on the business of dock, harbour, pier, wharf, railway, telegraph, and telephone constructors, contractors for public and other works.

Badger, Sons, and Co., Limited.—Capital, £3,000 in £1 shares. Object: to acquire the business carried on at Cupola Works, Masbrough-street, Rotherham, as William Badger, Sons, and Co., and to carry on the business of mechanical and electrical engineers, etc.

Moon, Loughlin, and Co., Limited.—Capital, £20,000 in £1 shares. Object: to acquire the business carried on by O. Moon and J. A. Loughlin, at the Luna Works, Factory-lane, Harpurhey, Manchester, as Moon, Loughlin, and Co., and to carry on the business of electrical and general engineers, electricians, manufacturers of electrical appliances, etc.

Barnsley Boiler and Engineering Company, Limited.—Capital, £5,000. Object: to acquire the business carried on by G. Denton at Barnsley, and to carry on the business of boiler makers, electrical, mechanical, and general engineers, etc.

Electric Traction Construction and Equipment Company Limited.—Capital, £20,000. Object: to carry on the business of railway, tramway, boat, and vehicle proprietors, electrical, marine, mechanical, and general engineers, contractors, suppliers of electricity, electric and other motor manufacturers, cycle makers, etc.

Kerbey Bowen Electric Syndicate, Limited. — Capital, £20,000. Object: to take over the freehold yacht-building and electric works on Eel Pie Island, Twickenham, and to carry on the business of ship and launch builders, engineers, electricians, electrical engineers, etc.

Bogota Telephone Company, Limited.—Capital, £25,000. Object: to carry on in the town of Bogota, in the republic of Colombia, South America, the business of telephone contractors, etc.

Pile-Bloc Battery Company, Limited.—Capital, £25 000. Object: to adopt an agreement with T. F. Harvey, H. C. Harvey, and E. P. Harvey, and to carry on the business of electricians, mechanical and electrical engineers, manufacturers of and dealers in Pile-Bloc and other batteries, and electrical apparatus and appliances, etc.

PROVISIONAL PATENTS, 1901.

JANUARY 21.

1306. **A new or improved method of obtaining and steering correct magnetic courses; a new or improved compass and apparatus in connection therewith.** Frank Samuel Pett, 11, Belgrave-gardens, Folkestone road, Dover.

1321. **Improvements in and connected with the transmission of pictures and messages.** Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

1330. **Improvements in electric trolleys.** Charles Arthur Allison, 52, Chancery-lane, London. (The Penberthy Injector Company, United States.) (Complete specification.)

1340. **Improved apparatus for registering maximum electric currents.** Arthur William Brown, 11, Vere-street, Cavendish-square, London.

1347. **Improvements in telephone exchange systems.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

1372. **Improvements in or connected with gas, electric, or other meters.** Jabez William Wedderburn, 30, Boleyn-road, Forest Gate, London.

1396. **Improvements in or relating to wireless telegraphy.** Alfred Julius Boult, 111, Hatton-garden, London. (Manuel Rodriguez Garcia, France.)

JANUARY 22.

1400. **Improvements in electrical switches.** Harry Nunns, South-parade, Halifax.

1401. **Improvements in controlling arrangements for electric lifts.** John Sanders Stevens, Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, Janus Works, Queen's-road, Battersea, London.

1402. **An improved apparatus for the electrolytic production of copper tubes and sheets.** Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

1461. **Improvements in telegraphic relays.** Eugène Ducretet, 72, Cannon-street, London. (Complete specification.)

1468. **Improvements in electromotors.** Walter Best Hodgetts, 6, Bank-street, Manchester.

1470. **Improvements in or relating to X-ray focus tubes.** Harry William Charles Cox, 51, Cricketfield-road, Hackney Downs, London.

1471. **Improvement in electric arc lamps.** Louis Francis Bogia, jun., 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1474. **Improved electric lamp for photographic purposes.** Arthur Lewis Adams, 26, Charing-cross, London.

1484. **Improvements in means to be employed in the electro-deposition of metals.** Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

1485. **Improvements in electrical measuring instruments.** Henry Price Ball, 18, Buckingham-street, Strand, London. (Complete specification.)

1488. **Improvements in electric measuring instruments.** Henry Brooker and William James Russell, 166, Fleet-street, London.

JANUARY 23.

1504. **Improvements in apparatus for governing electric currents.** Alfred Warwick Gattie, 15, Victoria-street, Westminster, London.

1505. **An improved electrical fire-alarm.** Ebenezer Barnard and Harold Stedman, Stour Cottage, Christchurch, Hants.

1506. **Improvements in or relating to arc lamps.** William Routledge, 48, Waverley-terrace, Newcastle-on-Tyne.

1527. **Improved automatic electrical attachment for clocks for ringing bells and other purposes.** William Clapham, Arthur Clapham, and Albert Clapham, 289, Kirkstall-road, Leeds.

1553. **Improvements in poles for supporting electric trolley wires upon electric tramways.** Joseph Slack, 8, Quality-court, Chancery-lane, London.

1564. **Improvements in or connected with electrical switches having intermittent or step-by-step motions.** William Kingsland, 33, Chancery-lane, London.

1568. **Improvements in electric cables.** Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

1573. **Improvements in or in connection with electric lighting devices for tramcars.** Fred Taylor Stewart, 6, Lord-street, Liverpool.

1600. **A system of electric circuits with sectional conductors for tramways and the like.** Karl Hora, Josef Rydl, and Franz Vrečtecka, 1, Queen Victoria-street, London. (Complete specification.)

JANUARY 24.

1624. **An improved winding machine and reel for hose, ropes, electric cables, telegraph wires, and the like.** Frederick Leaver, 77, Beaconsfield-villas, Preston Park, Brighton.

1642. **Improvements in or connected with air, gas, vapour, explosive, self-driving, inexhaustible power, and like engines for power, lighting, heating, refrigerating, electrical, and other purposes.** Céleste Joly, 22, Laurence Pountney-lane, London.

1662. **Improvements in or relating to trolleys and like current collectors for electric railways and tramways.** Robert Renton Gibbs, 6, Lord-street, Liverpool.

1663. **Improvements in or relating to trolleys and like current collectors for electric railways and tramways.** Joshua Hignett, 6, Lord-street, Liverpool.

JANUARY 25.

1705. **Improvements in the electrolytic manufacture of metal wire, rod, and strip.** Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

1721. **Electric balance for indicating or signalling maximum or minimum electric pressure or current.** Bertil Brander, Pitman Hotel, Birmingham.

1742. **Improvements in dynamo-electric generators.** Benjamin Garver Lamme, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June, 28, 1900, being date of application in United States.)

1743. **The electric radiant heat and light cabinet for medical or curative purposes.** Sidney William Anstee, 5, Ravey-street, Great Eastern-street, London.

1769. **Improvements in electric tramways or railways.** Eduard Dussek, 22, Southampton-buildings, Chancery-lane, London.

1788. **Improvements in or connected with alternate-current motors.** Réné Dassy de Lignières, 47, Lincoln's-inn-fields, London.

JANUARY 26.

1809. **Improvements in electric railways.** James Madison Taylor Fife House, Kingston-on-Thames.

1849. **Process for the electrolytic preparation of the bases of the alkaline earths.** André Brochet and Georges Ranson, 70, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Feb. 16.

1900.

1407. **Electric traction on the conduit and road-contact systems.** Brown.

1450. **Push for electric bells or the like.** Holme. (Silfverberg.)

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1566. Electric accumulator plates. Wuillot.

2700. Method of and means for indicating speed or current frequency of electric generators. Mershon. (Date applied for under International Convention, July 12, 1899.)

2994. Process for the electrolytic deposition of nickel or its allied metals or alloys of these metals. Kugel.

3291 Means for fixing electric incandescent lamps and globe holders for use therewith. Wierre.

4157. Electric accumulator traction. Drake and Gorham.

4318. Means of supporting electrodes or plates of electrical accumulators and in the manufacture of such electrodes and tools or appliances for use in such manufacture, and a method of constructing such tools or appliances. Parker.

5046. Electricity meters. Wright and the Reason Manufacturing Company, Limited.

5154. Electric traction on a conduit system. Bennett.

5356. Electric cables. Gray.

14121. Methods of and means for electrically producing light. (Marks.) (General Electric Company.)

16697. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Rice.)

18904. Thermo-electric batteries. Crawford and Turley.

18967. Electric incandescent lamps. Ransford. (Miller.)

19494. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Reist.)

19498. Circuit breakers for electric currents. British Thomson-Houston Company, Limited. (Hewlett.)

19945. Incandescent electric lamps Thompson. (Sinding-Larsen.)

20558. Combined telephone and electric bell circuits. Birnbaum. (Berliner.)

20926. Electric arc lamps. Crompton and Co., Limited, Brunton, and Hodgson.

21486. Gripping appliance suitable for screwing lamp shade clamp rings on and off electric incandescence lamp holders. Cotton, Cotton, and Reddell.

21933. Electric arc lamps. Crompton and Co., Limited, Hodgson, and Ewart.

22285. Current collectors for electric vehicles British Thomson-Houston Company, Limited. (Stewart.)

22288. Means for attaching pole-pieces to electric machines. British Thomson-Houston Company, Limited. (Reist.)

22591. Magnetic ore separators. Barnard.

23391. Electrically-operated switches for controlling circuits at remote points from central stations. British Thomson-Houston Company, Limited. (Sargent.)

23496. Electric switches Headley.

23514. Electric house service or fuse boxes. Burbey and Waterland.

23586. Fusible electric circuit breaker for fire-alarm purposes. Pearson.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Jan. 26	552	536	+ 16	23,745	20,480
Birmingham Trams.	,, 26	4 251	4 116	+ 158	15 174	—
Blackburn Corp'rat'n	,, 13	1 191	—	—	2 724	— *b*
Blackpool Corporatn.	,, 24	164	136	+ 28	28 887	21,221
Blackpool-Fleetwood	,, 26	141	149	— 8	532	571
Bolton Corporation..	,, 27	1,226	—	—	5 412	-
Bradford City Trams	,, 27	759	340	+ 419	2,934	1,370
Bristol Tramways Co.	,, 25	3,853	2 697	+1 156	—	—
Carlisle Tr'mw'ys Co	,, 12	—	—	—	221	—
Central London Ry.	,, 26	5,961	—	—	139 946	*a* —
City & South London	,, 27	1,968	1,092	+ 876	8 022	4,471
Cork E. T. and L. Co.	,, 24	352	318	+ 34	1,186	1 156
Dover Tramways ...	,, 26	169	151	+ 18	635	606
Dublin & Lucan E.R	,, 26	63	51	+ 12	269	213
Dublin U.T., elec. cars	,, 25	3,202	2,837	+ 365	—	—
Dublin S.D. Electric	,, 25	654	609	+ 45	—	—
Dundee Tram Co. ...	,, 23	441	344	+ 97	—	—
Glasgow Corporation	,, 26	8,460	8,333	+ 126	—	—
Halifax Corporation	,, 26	674	548	+ 129	1 293	—
Hull Corporat'n E.S.	,, 26	1,516	666	+ 850	58,355*b*	—
Liverpool Corporat'n	,, 19	7,835	6,622	+1,213	24,008	20,028
Liverpool Overhead	,, 27	1,457	1,571	— 114*	5,994	6,026
Portsmouth Corpn...	,, 26	643	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 27	2,753	—	—	—	—
Southampton Trams	,, 24	643	343	+ 300	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	,, 25	371	233	+ 138	1,300	854

a From July 30, 1900. *b* Since April 1, 1900. * Embarkation of troops.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-126,000	1	–	11/16 13/16
British Insulated Wire, Ord., 1-40,000	5	–	10½-11½
—— 40,001-70,000	5	–	10½-11½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	–	100-105
British Electric Works, Ordinary, 80,001-96,000	1	..	½-¾
—— 6 per cent. Cum. Pref., 1-80,000	1	–	½-¾
—— 4½ per cent. First Mortgage Debentures	103	–	96-97
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4½-4¾
Brush Electrical Engineering, Ordinary	2	–	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	–	2-2½
—— 4½ per cent. Debenture Stock	100	..	105-110
—— 4½ per cent. 2nd Debenture Stock	100	–	101-103
Callender's Cable, Debentures	100	–	109-113
—— Ordinary	5	–	13-14
—— 5 per cent. Pref.	5	–	5½-6
Crompton and Co.	2	–	2½-4
—— 5 per cent. Debentures	—	–	99-103
Edison and Swan United, Ordinary	2	–	1¾-2½
—— 5 per cent. Debentures	5	–	2½-4½
—— 4 per cent. Deb. Stock, Red.	100	–	88-90
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	–	99-100
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¾-2½
—— 7 per cent. Cumulative Pref.	2	–	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
W. T. Henley's Telegraph Works, Ordinary	5	–	13½-14½
—— 4½ per cent. Preference	5	–	5½-6
—— 4½ per cent. Debentures	100	–	105-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	20½-21½
—— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	12	–	38-42
—— 5 per cent. Bonds	100	–	100-103
Telegraph Manufacturing, Ordinary	5	–	10-11
—— 5 per cent. Cum. Pref.	5	–	5½-6
Willans and Robinson, Ordinary, 1-80,000	5	–	10½-11½
—— 6 per cent. Cum. Pref., 80,001-60,000	5	–	6½-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-1
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	–	10-11
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	–	7-8
—— 7 per cent. Preference	5	–	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-80,000	5	–	6½-6¾
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	–	5½-5¾
Chelsea Electricity Supply	5	–	6½-7
—— 4½ per cent. Debentures	100	–	109-112
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (50 p.c. pd.) Red.	—	..	61-63
County of London and Brush Provincial, Ordinary	10	–	8½-9½
—— 6 per cent. Cum. Pref.	10	–	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	103-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4¾-5½
—— 4½ per cent. First Mort. Deb.	100	–	102-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7½-8½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9½-10½
London Electric, Ordinary	2	–	1½-2
—— 6 per cent. Pref.	5	–	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	–	96-99
Notting Hill Electric Lighting	10	–	14½-15½
Oriental, 1879	1	–	1½-1¾
—— £5 Shares	5	–	7-7½
—— £4½ Shares, New	4½	..	5½-6
Orford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	–	70-80
Royal Electrical Company of Montreal	$100	–	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 4 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	–	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	14½-15½
—— 7 per cent. Pref.	5	–	8½-9½
—— 3½ per cent. Deb.	100	–	98-101
Westminster, Ordinary	5	–	12-13
—— 20,001-109,487	5	–	12-13
Electric Railways.—			
Central London, Ordinary	10	–	8¾-9½
—— Pref. Half-Shares	5	–	4¾-5¼
—— ,, ,, deferred	5	–	3½-4
City and South London, Consolidated Ordinary	100	–	50-54
—— Ordinary	10	–	4¾-5¼
—— 4 per cent. Debenture Stock	100	–	115-120
—— 5 per cent. Pref. Stock '91	100	–	138-142
—— ,, ,, '96	100	–	130-135
Liverpool Overhead, 5 per cent. Pref.	—	–	12½-13½
Waterloo and City, Ordinary	100	–	94-97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-16
Brisbane Tramway	100	–	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	–	9½-10½
British Electric Traction, Ordinary	10	–	13-14
—— 6 per cent. Cm. Pf. 80,001-60,000	10	–	12-13
—— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4¼-4¾
—— 5 per cent. Deb. Stock, Red.	100	–	104-107
—— Prov. Cert., all paid	—	–	95-98
Kidderminster and District Lighting and Traction, Pref.	10	–	9½-10½
New General Traction, Ordinary	5	–	3½-4
—— 6 per cent. Cum. Pref.	5	–	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	16-17
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 25,667-40,000	10	–	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
—— 4½ per cent. Debenture Stock	100	–	102-105
Telephones.—			
National Telephone, Ordinary	5	–	4¼-4½
—— 6 per cent. Cum. First Pref.	10	–	13-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	4¼-5¼
—— 4 per cent. Deb. Stock, Red.	100	–	97-100
—— 3½ per cent. Deb. Stock, Red.	100	–	94-97
Oriental Telephone and Electric Company	1	–	1-1½

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NOTES.

Faraday House.—The Board of Control of the Electrical Standardising, Testing, and Training Institution have awarded Joseph Goodman, of Wellingborough Grammar School, a Maxwell entrance scholarship, value 50 guineas, tenable for two years; and Francis Norman Wilson, of Felsted School, a special prize of 10 guineas.

Electrical Trades' Union.—The executive council of this institution have drawn up a number of rules which it is proposed to adopt for wiremen, cable jointers, and assistants employed in the London district. The maximum number of hours constituting a week's work is limited to 53 hours, while the rate of pay for wiremen and cable jointers shall not be less than 9½d. per hour, and for chargemen not less than 10½d. per hour.

Royal Institution.—At the monthly meeting of this institution, held last Monday, Sir James Crichton-Browne (vice-president) in the chair, it was resolved to send an address to the King expressive of their heartfelt sorrow at the loss sustained by his Majesty and the Royal Family in the death of Queen Victoria, and also testifying their congratulations upon his Majesty's accession to the throne. The address is signed by the president, the Duke of Northumberland, K.G.

Book Received.—We have received from Messrs. Carré and Naud a treatise of "Electric Phenomena and their Applications," by M. Henri Vivarez. The price of this volume is 15fr. in England. So far as we can see from a cursory examination, it is one of those excellent French productions which describe the various applications of electricity, giving briefly, clearly, and tersely the principles guiding each application. We shall refer to this at greater length in a future issue.

Telegraphs.—A good deal of ill-humour is apparent just now because of delays in telegraphy, and remonstrances are being made to the authorities. Of course, it is easy to say all wires ought to be underground, but it never strikes one of the grumblers that not only would this involve great expense, but it would bring about other troubles which are not in the minds of the general public. No doubt there will be a gradual extension of underground lines, but for a long time to come the overhead wires will be most in evidence.

Proposed Electrical Contractors' Association. A movement is on foot for the formation of a National Electrical Contractors' Association, to embrace all such local associations in Great Britain and Ireland. A meeting of the originators of the scheme was held on Friday afternoon in Anderton's Hotel, Fleet-street, E.C., at which representatives from Birmingham, Glasgow, Leeds, Manchester, and other cities and towns were present. All information regarding the scheme can be obtained from the convener, Mr. Thomas Guthrie, C.A., 46, Queen Victoria-street, E.C.

A Bristol Guide Book.—"The Bristol Tramways Official Handbook and Visitors' Guide," by Mr. Charles Challenger, must prove of considerable value to those who are strangers to the city. "The best way to see Bristol is from the top of a tramcar," says the author, who is traffic manager to the tramways company. Two comprehensive maps are given showing which lines and suburbs are connected with the three city terminal stations. The "guide" is illustrated throughout, the first part of which is devoted to the tramways timetables, fares, and places of interest on or near the respective lines or routes. The localities "in and around Bristol" are described towards the end of the book, which embraces practically all matters of interest and information to the visitor.

The South Yorkshire Electrical Power Bill.—This Bill has been rejected by the Standing Orders Examiner on the ground that the promoters have not complied with the regulations. It was urged by an opponent to the Bill, when the matter was under consideration, that the promoters had sought to exclude the clauses of the Electric Lighting Acts, and that notice of such exclusion had not been made in accordance with the Standing Orders. More particularly, attention was drawn to the exclusion of the clause as to the liability of the company for a nuisance caused by it in the carrying out of the undertaking. On these grounds the Bill was rejected, but it may interest electrical engineers to know that there is a rival company asking for powers over the same area, and that their Bill has yet to be considered by the examiners.

Automobile Tests.—Last year, it will be remembered, the Automobile Club carried out some extensive trials on the endurance of motor vehicles, which embraced a thousand-mile run up into Scotland and back. The different classes of cars which took part in the test were exhibited at some of the more important towns and cities *en route*. We now hear from New York that the American Automobile Club have made arrangements for a similar endurance test, and, following the example of England, the run is to be made the occasion of a travelling exhibition. An average of 100 miles or more a day is counted on. A prize fund of over £600 has been established, and awards will be made on these grounds: (1) vehicles making fewest stops *en route*; (2) vehicles carrying greatest weight in passengers in proportion to their own weight; (3) vehicles requiring least repairs and maintaining an average speed of from 12 to 15 miles an hour.

Smart Substitution of Steam by Electric Power.—To the Kidderminster District Electric Lighting and Traction Company is due the credit of carrying out a smart piece of work in the replacing of steam by electric power at short notice. It arose out of a breakdown which occurred to an engine at the premises of Messrs. Charles Harrison and Sons, Limited, of that town, owing to the main beam, crankshaft, and connecting rod smashing. The electric company came to the rescue, and in less than two days they had everything completed for working the mill by electricity. The necessary foundations for the motors were put in, and a quarter of a mile of cable laid in the time stated. A delay of only 18 working hours thus occurred before work at the mill was resumed, whereas in the ordinary course, it is stated, it would have taken from four to five weeks to obtain the necessary parts and repair the damaged engine.

Electric Light Accounts.—The requirement of the Board of Trade that all electric light undertakings shall publish each year accounts which have been audited by an inspector of the Board of Trade has done much to bring central-station work in this country up to date. It has resulted in a great competition between the various engineers in charge of electric lighting and power stations for the honourable position of having the lowest costs for generation and the lowest losses in distribution. We notice that at the recent meeting of the North-Western Electrical Association of America the question was raised as to whether it would be advisable for all electric supply undertakings in that country also to publish each year their accounts. The one reason for the movement is that in certain towns the undertakings are asked to pay income tax, and proposals have been made recently to increase this tax, which up to the present is assessed on the gross income of the supply stations. It was rightly urged at the meeting that if the full accounts were given, so that the expense

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were known as well as the income, the companies would receive rather more fair consideration at the hands of the municipal authorities. We believe that any company which supplies this public commodity has everything to gain and nothing to lose by a clear statement of its accounts.

The Liverpool Accident.—The recent snowstorm causing a breakage of telephone wires at Liverpool, these came into contact with the trolley wire of the tramways, and several fatalities occurred. We will not enter into any description of the agonising scenes, but would suggest to the careful consideration of the various engineers interested in tramway and telephone work whether the present system of guard wire is really of practical service. It would seem to the ordinary mind that while a trolley guard, upon the face of it, is more or less useless, a guard to the telephone wires might be made effectual. We presume a guard is to prevent contact, and thus to prevent a circuit being made through the telephone wires. The system adopted is, we know, countenanced in high places, but it is not sound in principle nor is it safe in practice, and has been adopted because it is cheaper than a properly-designed guard, and has been called a due precaution to prevent accidents. The problem is how to prevent a curling wire or curling wires coming into contact with a live trolley wire, and the present system fails to satisfactorily solve the problem.

Induction Phenomena. — The *Elektrotechnische Zeitschrift* gives a summary of an article contributed by K. R. Johnson to *Annalen d. Physik*, in which the author discusses the electrolytical phenomena which occur in the secondary circuit of a Ruhmkorff coil, with special reference to the well-known fact that upon switching a voltameter into the secondary circuit of a Ruhmkorff coil oxyhydrogen gas appears on each electrode. From this it has been concluded hitherto that the first impulse of current generates oxygen on the one and hydrogen on the other electrode, while the second opposite directed current impulse reverses the action. By using electrodes of platinum wire encased in glass, except at the extremities, the author observed that although gas bubbles ascended upon interrupting the circuit from both electrodes, no generation of gas took place, on the other hand, when closing the circuit. He therefore concludes that the electrolytic decomposition of the water arose solely from the wave motion of the breaking current, and that the making current produced no chemical decomposition, or, at any rate, to no immediately apparent extent. Experiments with a Ruhmkorff coil, the condenser of which had a variable capacity (from 0·35 to 2·35 microfarads), showed that the volume of gas generated in unit time is inversely proportional to the square root of the capacity.

Electricians of the Nineteenth Century.—The editors of the *Electrical World* have invited a vote upon the question of the 25 most distinguished men in electrical science and invention during the nineteenth century. Three distinct lists were issued. The first papers were sent to 25 professors of electrical engineering in the States. The names in the following list are those which received the most votes *pro rata*: Faraday, Kelvin, Maxwell, Edison, Henry, Hertz, E. Thomson, Bell, Morse, Ampère, Siemens, Davy, Helmholtz, Ohm, Tesla, Hopkinson, Brush, Oersted, Ferraris, Gramme, Planté, Steinmetz, Joule, Sprague, Weber. Two hundred and seventy-seven members of the American Institution of Electrical Engineers were also asked their opinion upon the same subject. The first three names on this list were Faraday, Kelvin, and Edison, while Maxwell's name appeared ninth on the list. Amongst the other 25 the names of Wheatstone, Röntgen, and Marconi are introduced, replacing three of the names in the professional ballot list. Twenty-five other prominent members of the institution other than those who returned the first list were also asked for their opinion, and again Faraday heads the list with the highest number of votes, while Maxwell and Kelvin are the second and third in order respectively. What particularly strikes one in looking through these names is the cosmopolitan character of the collection.

"The Street Railway Review."—The issue of this Chicago contemporary for Jan. 15 is the tenth anniversary number. In it a number of articles are given to show the progress that has been made in electric tramways and railway work during the past 10 years. The illustrations in these *résumées* are exceedingly interesting. We have open before us now the review which deals with the power stations. It will be remembered that in America the practice of connecting up machines by means of belts was carried to an extent undreamt of on this side of the Atlantic, where we had the advantage of high-speed engines even in the earlier days of electric lighting work. The illustrations, therefore, of the power works established in 1891 in the States show long lines of small engines connected up by belts to individual dynamos or else complicated arrangements of belts and countershafting. In the case of the Boston West End Street Railway station in 1891 the whole of this countershafting was placed under the floor of the dynamo-room, the belts driving upwards through the floor to the dynamos. From the illustrations it would seem also that a most extensive system of jockey belts was used to guide and deflect the belts between the engine and the countershaft. Other articles in this issue deal with the dynamos used in tramway working, in which one is struck by the enormous increase in size in units which has been made, while the design in tramway motors has been completely revolutionised in the last 10 years.

Institution of Junior Engineers.—The first of the series of six lectures on "Works Management" arranged by this institution was delivered at the Westminster Palace Hotel on Tuesday evening by Mr. A. H. Barker, Wh.Sc., when a large number of members attended. The chairman, Mr. Percival Marshall, in opening the proceedings, referred to the opportunities which those present would have in the discussion at the close of each lecture for obtaining special information bearing on their own particular work. The lecturer's introductory remarks dealt with the general state of organisation in this country, with special application to engineering firms. The causes of our present position in the market questions of experience, and selling power of products were then treated. The lecturer then proceeded to emphasise the best method for dissection of orders, and of providing continuous work for operatives. An analysis of the number of employés in different shops and of machines used followed, with prices of equipment. Some valuable curves were exhibited showing the relative cost in each case of machine tools, fitters' tools, etc. The questions of buildings, driving power, electrical *versus* mechanical driving were considered, and the lecture concluded with some figures relating to the determination of various particulars in connection with the size of steam engines and boilers. Mr. Barker supplemented the lecture by further information in reply to questions put to him. The next lecture takes place on Wednesday, Feb. 20.

Tramway Bills: Important Decision. — An important point to tramway undertakings as to the true construction of Standing Order No. 10 was decided by the Examiners of Private Bills at the House of Commons last Friday. This order provides for the notice necessary to be given with regard to new tramways, and the question was whether it applied to tramways already existing, but

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which it was proposed to convert to electric traction. It was stated by the agent representing the Birmingham Tramways Bill that if the order were construed as applying to such cases, it would mean an additional expenditure to the promoters of some £4,000 or £5,000. This being the state of things, it is pleasing to note that the decision of the examiners is that Standing Order No. 10 does not apply to tramways which it is proposed to "electrify." In the words of Mr. Campion, who gave the decision of the examiners when the clause of the Standing Order was drawn up, electricity was not contemplated, and in that way the difficulty had arisen. If anything further ought to be done for the protection of the public, it should be done by an amendment of the Standing Order. The following Bills have also passed the examiners: the Bradford Corporation Improvements (including a tramway scheme); West Cumberland Electric Tramways; South Lancashire Tramways; Bexley Tramways; Scarborough Electric Tramways; London County Council (Tramways and Street Widening); Tyneside Tramways and Tramroads; Chester Corporation Tramways; and Wigan Corporation Tramways.

The Auer Mantle.—Some interesting particulars of experiments relating to the theory of the Auer light have been communicated by Messrs. W. Nernst and E. Bose to the *Physik. Ztschr.* These experiments proved that the mass of the Auer mantel did not, as Bunte thought he had discovered, increase the emissivity, but that a selective emission took place. It was shown that an Auer mantle behaved almost normally in the yellow and the violet portion of the spectrum, but possessed much weaker emissivity in the red than would obtain for a black body, which yielded the same emission in the yellow to the violet portion of the spectrum. It was further ascertained by measuring the emissivity for equal temperatures obtained in the one case by means of a flame, and in the other by an electric current, that the emission is quite independent of the source of the heat. It therefore follows that it is not any special catalytic action of the Auer mantle to which the high economy of the Auer light is due, as has been generally accepted. Since the experiments have proved the radiation from rare earths to be pure heat radiation, an acceptable theory of the high efficiency of the Auer mantle may be constructed on the basis of the selective emission of the materials composing the Auer mantle. As the material composing the Auer mantle radiates very little red light, and, moreover, few ultra-red rays owing to the descending tendency of the curve, hence yields little energy just in that part of the spectrum in which the maximum emission of heat usually takes place, the mantle is consequently enabled to absorb the full heat of the gas flame, and thereby to radiate a relatively large volume of light.

A New Lamp-Hour Meter. — We notice the Allgemeine Elektricitäts-Gesellschaft have introduced a new meter for recording the number of hours during which a lamp or group of lamps connected to either of its circuits may burn. The meter is intended for use principally in connection with small installations, where the provision of a watt-hour meter would be relatively extravagant. The meter is constructed for three or five circuits, the recording systems in connection with which are served by clockwork in such a manner that the time during which a circuit may be switched in is recorded independently. The central system of clockwork common to the several recorders is arranged to work at a certain uniform speed for a total of 250 hours. This clockwork actuates a driving wheel, with which are arranged concentrically the wheels connecting the respective circuit recorders. The action of switching in a circuit serves at the same time to couple up its respective recording system with the common driving wheel. When all the circuits are switched out, the clockwork stops automatically, but the switching in of a single lamp or circuit suffices to again set it in motion, and simultaneously the recorder belonging to the circuit. The arrangement is certainly ingenious, but the several sources of error attaching to it tend to confine its utility within very restricted limits. Perhaps the principal disadvantage consists in that lamps of higher candle-power than those acknowledged might be substituted with impunity, the recorders remaining quite insensible to the change; or, again, lamps of low efficiency might be used with equal freedom from detection.

Iron Losses.—A long illustrated article, entitled "The Dependence of Iron Losses on the Curve Form," is contributed by Dr. Gustav Benischke to the columns of our contemporary the *Elektrotechnische Zeitschrift*, in which the author comes to the conclusion that the hysteresis coefficient η is for varying magnetisations not only dependent on the value of the magnetic induction, but also on the form of the curve. He points out that the more peaked the curve representing the lines of force the smaller proportionally will be the loss due to hysteresis, whence it follows there is magnetic retardation. Further, the usual rule for the iron loss,

$$A = \eta\, n\, B^{1.6} + \beta\, n^2\, B^2,$$

serves only for approximate estimates, but with increasing accuracy accordingly as the loss due to eddy currents is smaller. However, the values given for the coefficient η may be regarded as perfectly correct for testing samples of iron when unit bases are employed for the measurements. When taken as absolute, these values—at any rate, for 0·5mm. plate—are more reliable for comparing a sample of iron than the values obtained by means of yoke methods, because with the latter the shavings used for the test are too much changed by the shaping which they undergo to fit them to the apparatus in question to allow of a reliable idea being formed as to the orginal condition of the sample from which they were taken. The errors arising from this source exceed the limit of error holding for the wattmeter method, provided the measurements be taken between 35 and 55 periods. The coefficient β for the eddy currents may be represented with approximate accuracy by the equation

$$\beta = 15{\cdot}2\, d^2\, \sigma\, (1 - a\, \tau),$$

wherein d represents the thickness of the plate, τ the temperature, a the coefficient of temperature, and σ the vertical factor of the potential curve.

Progress in Electric Heaters. — Mr. James F. McElroy has a good article in the *Street Railway Review* on the progress made during the past 10 years in the art of electric heating. This use of electricity, he holds, has outstripped the advances made in almost all others, seeing that the art of electric heating, as it exists to-day, has been created and brought to its present state of development entirely within the last 10 years. The earliest heaters used a small amount of fine platinum wire, which was run at incandescence, while regulation of temperature, so far as it was attempted, was accomplished by raising the temperature of the wire itself. At the present day, however, the practice is to use a very large quantity of coarse wire, and run it at a lower temperature, not over 400deg. or 430deg. F. A maximum temperature for the wire is set, and the quantity of heat is increased by supplementing the amount of wire surface giving off heat. The first electric heaters used on electric cars were constructed by embedding a fine platinum wire

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in powdered heat-insulating material, which was enclosed in a cavity between two castings. The air was thereby excluded from contact with the wire, and thus the wire could be raised to a higher incandescence than was possible with the wire exposed to the action of the air. This construction, however, prevented the escape of heat from the wire, and, in consequence, the temperature was raised to such a point that the wire was soon destroyed. In the modern electric heaters the wire is exposed freely to the circulation of air currents, and every part of the wire is in direct contact with the moving current of air. Thus the heat generated in the wire is carried by the air current into the space required to be heated. The greatest freedom is therefore obtained, and the temperature of the wire is kept down to a point where the life of the wire is not affected. In the last 10 years the wire has been placed upon its insulated support in such a manner that the expansion and contraction of the wire is fully provided for. The cost of current is now at such a low figure that it is cheaper to heat cars with electricity than with stoves, and the writes states that electric heaters are almost universally adopted in America, and in many of the cities abroad.

Illumination.—The nineteenth article by Dr. Louis Bell on the elements of illumination contributed to the *Electrical World* refers to the Nernst lamp, in the description of which little information is added to that already published. The most interesting part of this article, however, is that which deals with vacuum-tube lighting. In spite of the great success which has been claimed by various inventors for their systems of vacuum-tube lighting, Dr. Louis Bell concludes that the brightness of the original vacuum tube is apt to be greatly overestimated as it is seen in a loom. He adds that an ordinary tallow candle will make a pretty bright vacuum tube loom like a wisp of fog. This low intrinsic brilliancy is only objectionable because it would mean that a very large number of small tubes would be required in order to give a satisfactory illumination. Large tubes are likely not to be so successful, as the light is usually unsteady. The bluish hue of the light would, in the author's opinion, have to be rectified by introducing suitable gaseous mixtures into the tube. Measurements of the light produced by these vacuum tubes show that a much larger proportion of the radient energy is light than is the case with the ordinary incandescent lamp. In fact, the vacuum tubes are from five to six times better than the incandescent lamps in this respect. If, however, the tubes are forced up to anything like a good brilliancy, considerable heating takes place, which decreases the efficiency, as more heat rays are emitted. Dr. Bell then goes on to describe experiments made on the light which is given from insects. He shows, for instance, that Prof. S. P. Langley, experimenting with a West Indian species of firefly (Pyrophorus Nostilucus), was able to obtain a good spectrum to compare with solar light. He found that this light from the firefly was much richer in greens and yellows than sunlight. The maximum intensity was very near the beginning of the clear green, and this light only extended a little way into the red and blue regions of the solar spectrum. For equal light he found that this firefly only expended about one four-hundredth of the energy required by a candle or gas flame. It would appear from this that the consumption of energy is about one-fifth of a watt per candle, which is from 15 to 20 times better than the efficiency of an incandescent lamp, and five times better than an arc lamp. The light-giving process in this firefly is apparently the slow oxidation of some substance produced by it. The problem for the future is to construct this substance in the laboratory, and to combine it with a phosphorescent substance which would give the light more brilliancy in red and blue rays. As Dr. Louis Bell states in conclusion, there is ample scope for experiment and investigation in this direction.

The Heilmann Locomotive.—The *Electrical World*, in calling attention to an article in its columns in the issue of Jan. 12, makes the following caustic remarks on this historic locomotive. In view of the large claims which were made at one time for this locomotive, but with which we never concurred, we think it interesting to give the editorial expression of opinion, which, like the moral story, has a sting in the tail: "We have never been able to see what conceivable excuse for material existence is to be assigned to that composite oddity, the Heilmann locomotive. In our early youth some aggressive and doubtless well-minded temperance society scattered broadcast a tearfully and wonderfully coloured lithograph entitled 'The Black Valley Railroad.' We can see it as if it were but yesterday, a long, sinuous line, running from the fair fields of grace in the upper left-hand corner, down through Tippletown and Sotville, by Drunkard's Gulch and Devil's Home, to the ulterior suburbs of Sheol in the lower right-hand corner. It had trains as many as the heart of manager could wish, all fitted up with café cars, faro cars, and pool-for-drinks cars, and none ever ran back, which must have called for an unconscionable amount of costly rolling stock. And around about the picture ran an alluring fringe of drunkards' stomachs in progressive stages of dilapidation. But its chief glory was in the locomotives—long-wheeled dragons, with firemen amply horned and tailed. And since those days of childhood we have never seen a locomotive so soul satisfying save the Heilmann. A whole power station per train to save the shock of reciprocating parts seems needless at best, and when one considers the necessary loss of energy incurred in so operating, the wonder is not that it has failed of extensive use, but that any human being should ever have thought of such a contraption. And in the present state of affairs, if one really means to try for transcendental speeds, what is the matter with the steam-turbine? We are far from crying down our own wares, but an eight-wheeled locomotive with a 400-h.p. or 500-h.p. steam-turbine on each axle would make speed at a rate that would make even an electric motor bend to its work to keep within sight. Moreover, there is good reason to think that the turbines would not only beat the present locomotive considerably in point of efficiency, but in the matter of cost of operation would push electrically transmitted power quite as hard as would be comfortable. Engineers who are familiar with the modern developments of steam-turbines would do well to sit down and think this matter solemnly over."

The Late Dr. Elisha Gray.—We regret to note that Dr. Elisha Gray died on the 21st ult. at Newtonville, Mass., at the age of 66. In the early days of electrical engineering Dr. Elisha Gray did much pioneering work, and in one in particular—*i.e.*, the invention of the telephone—he has strong claims to the honour of being the original inventor. It was on Feb. 14, 1876, that he filed the caveat at Washington in which the principles of the telephone were described. Prof. A. Graham Bell, however, was granted a broad patent for the telephone on March 5 of the same year. We regret to say that there has been a fierce controversy in the States between these two discoverers, it being alleged that the information in Prof. Gray's caveat was divulged by one of the Government officials to Prof. Bell. Affidavits from the man who was said to have divulged the information were obtained by both sides, with the result chiefly of damaging

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this man's character as a reliable witness, and the question as to who was really entitled to the pecuniary reward from the invention of the telephone can hardly now be settled. The late Dr. Elisha Gray has done, however, good work in other departments, and was recently experimenting with a system of signalling at sea by means of bells. In fact, it was in connection with experiments on this marine signalling that he caught the chill which resulted in his death. As recently announced in these columns, he succeeded in transmitting signals over 12 miles through water. Telephones were used to receive the mechanical vibrations caused in the water. The late scientist was asked by the *Electrical World* to give his vote for the leading nineteenth-century electricians, and replied in the following characteristic way: "I should place Faraday first, especially for his discovery of magneto-electricity; Henry second, because he made the work of Morse possible; Morse third, not so much as an inventor, but as a promoter of what has proven to be one of the greatest civilising agencies of the nineteenth century; Lord Kelvin, because of his service to the science and to the world, especially in making ocean telegraphy a success; Helmholtz, not so much for his contributions to electrical as to science in general, especially his researches in acoustics, which were of such value in leading up to the discovery of the underlying principles of the telephone, a discovery which in its results for civilisation was the greatest one of the nineteenth century. It was a discovery rather than invention, as almost any kind of an electromagnetic instrument would talk when once the fundamental principle was announced. This is why there were so many claimants. Every inventor went to his scrap heap, and some of them found apparatus that could be made to talk now that they had been taught how."

The Albany and Hudson Railway and Power Company.—We notice in the *Street Railway Review* a description of the above company, which last year opened an electric railway between Albany and Hudson, a distance of 36 miles. The line is constructed along a private right of way in order to be able to use high speeds. In consequence of this private way a third-rail system of distribution was adopted. The franchise of the company includes the local lines in the town of Hudson, and traffic arrangements have also been made for the connecting up of the street tramways in Albany. The power required for driving the railway is obtained from water at a point 10 miles from Hudson. Here an available head of 105ft. has been obtained with an average flow of water capable of developing some 2,500 h.p. In the power station three kinds of generators are provided. The first class are 12,000-volt, 25-cycle, three-phase machines used for supplying the long-distance transmission system for the railway working, and for the supply of power to either of the towns in question, or to places along the route. The next type of machine are 2,200-volt, 60-cycle, single-phase alternators, used to supply electric light in Hudson and the neighbouring town of Reusselaer. The other class of dynamos are 600-volt direct-current machines, which are connected on to the third rail at the point nearest the power station in order to avoid the use of rotary transformers in this station. The sub-stations for the railway are situate at Hudson, eight miles south of the power station, and at two points, 11 and 23 miles respectively, north of the power station. A fourth sub-station at Reusselaer is also to be constructed shortly. In these sub-stations transformers for reducing the voltage and rotary converters for converting the three-phase currents into direct currents are placed. Where farm roads cross the line, the third rail is discontinued and connection made between the ends by means of an underground cable. The third rail, which is of steel, is supported on blocks of treated wood, which rest on the end of the ties under the practice recommended by the General Electric Company. The ordinary customary speed of the cars along this line is 51 miles per hour, but it is expected that they will reach 60 miles per hour on certain sections. We are surprised to hear, in view of this, that the regular time for the journey of 36 miles is 1½ hours. This is due, however, to the fact that the cars stop at a number of stations along the road. The fare for the whole distance is 2s. 4d. We understand that up to the present single cars are being run for all passenger traffic, but that the company has ordered two 47-ton electric locomotives from the General Electric Company, which will be used for the goods traffic. The gauge of the line is the same as that of the steam railways in the vicinity.

Electrical Power Distribution at Butte, Montana. — Mr. J. R. Cravath contributes to the *Electrical World* a well-illustrated description of a transmission plant organised in order to supply Butte by the Montana Power Distribution Company. This company owns the water rights on the Big Hole River, 20 miles away from the town, and has erected a transmission line to connect the two places. The transmission is at 16,000 volts, and the supply has now been given over a full year. There has been only one interruption in the supply, which was due to blasting near the pole-line, in consequence of which a rock was projected against the wires, causing them to break. As the power is used for driving large motors over fluctuating loads, the output fluctuates considerably from time to time. The engineer of the station, Mr. Hebgen, has provided heavy flywheels on the turbines, and by this means keeps down all hunting, in spite of these extreme fluctuations. The turbines are governed by Lombard waterwheel governors, which are said to work exceedingly well with the assistance of these heavy flywheels. One point of interest is that the engineer has provided no automatic cut-outs or fuses, either in the generator circuits or on the high-voltage lines. He considers that there is less likelihood of interruption to the system and of danger to the plant by having absolutely no fuses. Apparatus is provided, however, which suddenly opens the main circuit. In consequence of this, it is necessary that the generators shall be able to provide the current in case of a short-circuit, and this they are able to do. The energy power factor on this system for 24 hours is 87 per cent. Few plants of this kind have an accurate record of what their power factor is, and as this figure is not a guess, but is the result of actual tests by an interesting method, it is of value. The method of determining the power factor is this: The plant is operated in the ordinary way, and the ammeter and voltmeter readings are taken to give the apparent watts. Then one of the generators at the power-house is started up and run as a synchronous motor. The field of this motor is over-excited so as to give a leading current. The effect of this is to overcome induction and bring the power factor up toward unity. The excitation is increased until the power factor is unity, which is indicated by the ammeter reaching its lowest position, on a given load. The observed watts will then be the true watts, and can be compared with the previous reading. At present writing, when the load is not too heavy to spare one generator, one generator is run as a synchronous motor with heavily excited field on purpose to bring the power factor near to unity. In this way the one idle generator at the power-house takes care of part of the idle current on the system, and the other generators are run fully loaded on useful current.

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MOTHERWELL ELECTRICITY WORKS.

The burgh of Motherwell is situated about 12 miles from Glasgow, and is one of an important group of towns which lies in the heart of the Lanarkshire coal district. It is essentially a manufacturing town, having, either in the town itself or close to it, extensive iron and steel works and large engineering works manufacturing chiefly roofs, bridges, and cranes. It is, therefore, not surprising that a community so closely connected with engineering should be quick to realise the advantages to be gained by the adoption of the electric light, especially as several of the large engineering works above mentioned have private electrical installations of very considerable extent.

As long ago as 1892 the question of electric lighting was first mooted in the Town Council, and a committee was then formed, having for its convener Bailie Daniel Jack who from that time to the present has taken an active interest in the electric lighting movement, and who still acts as convener of the Special Electric Lighting Committee of the Town Council. In 1892, or shortly after that date, a report was obtained from a Glasgow expert, but no definite steps were taken until 1895, when a provisional

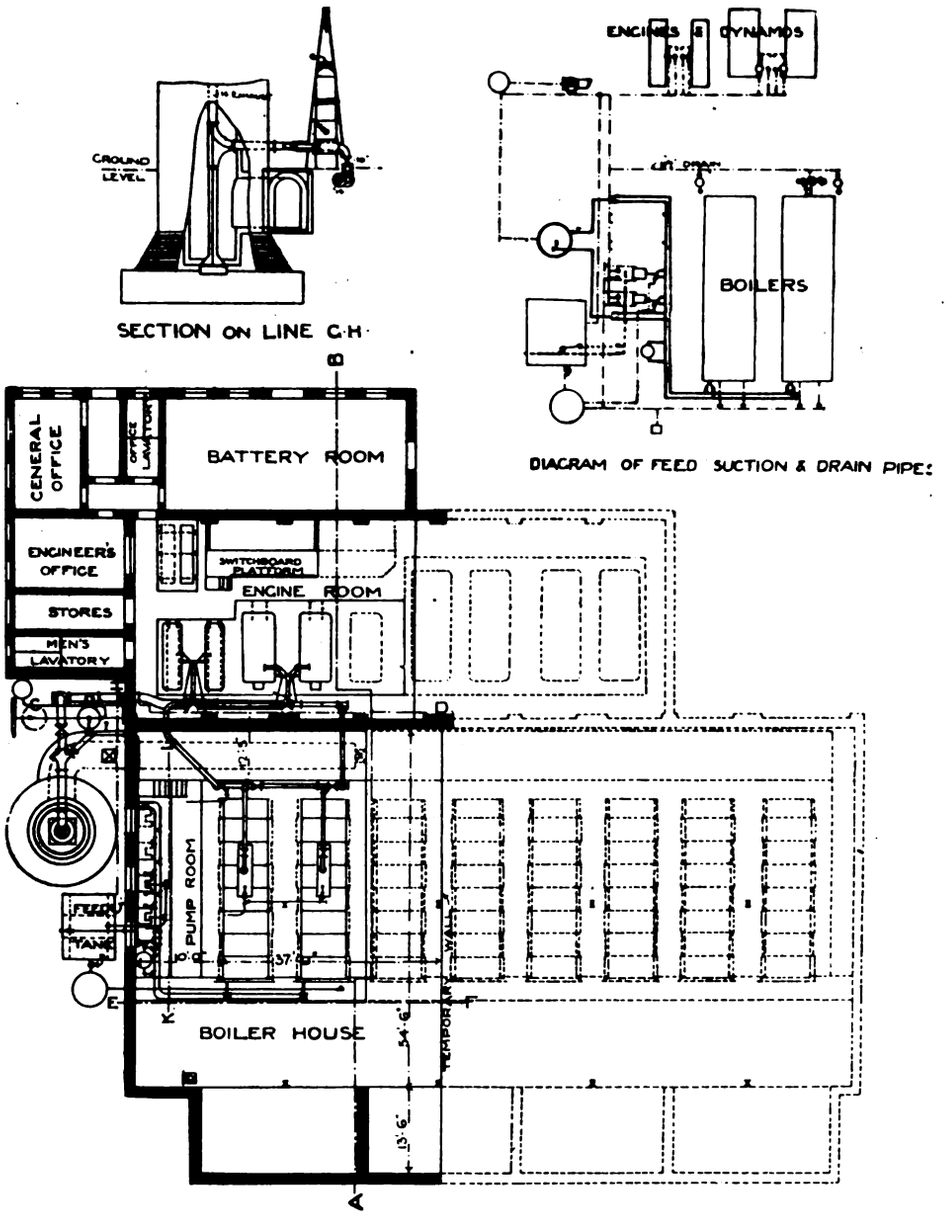
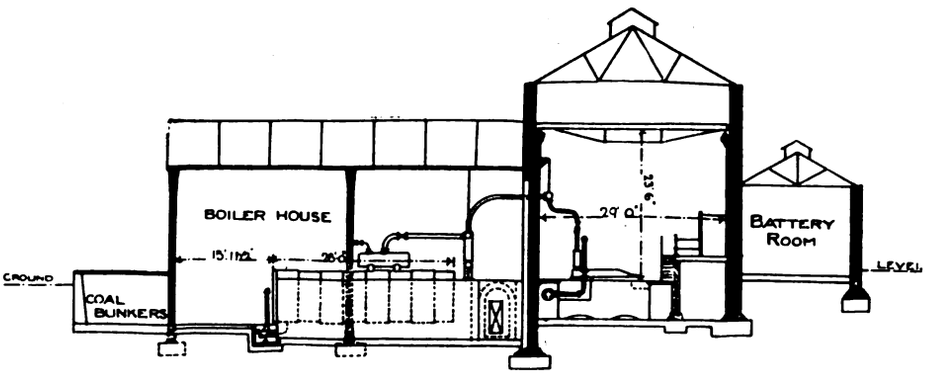


FIG. 1.—Block Plan of Station Buildings, Motherwell.



SECTION ON LINE A B

FIG. 2.—Section of Station Buildings, Motherwell.

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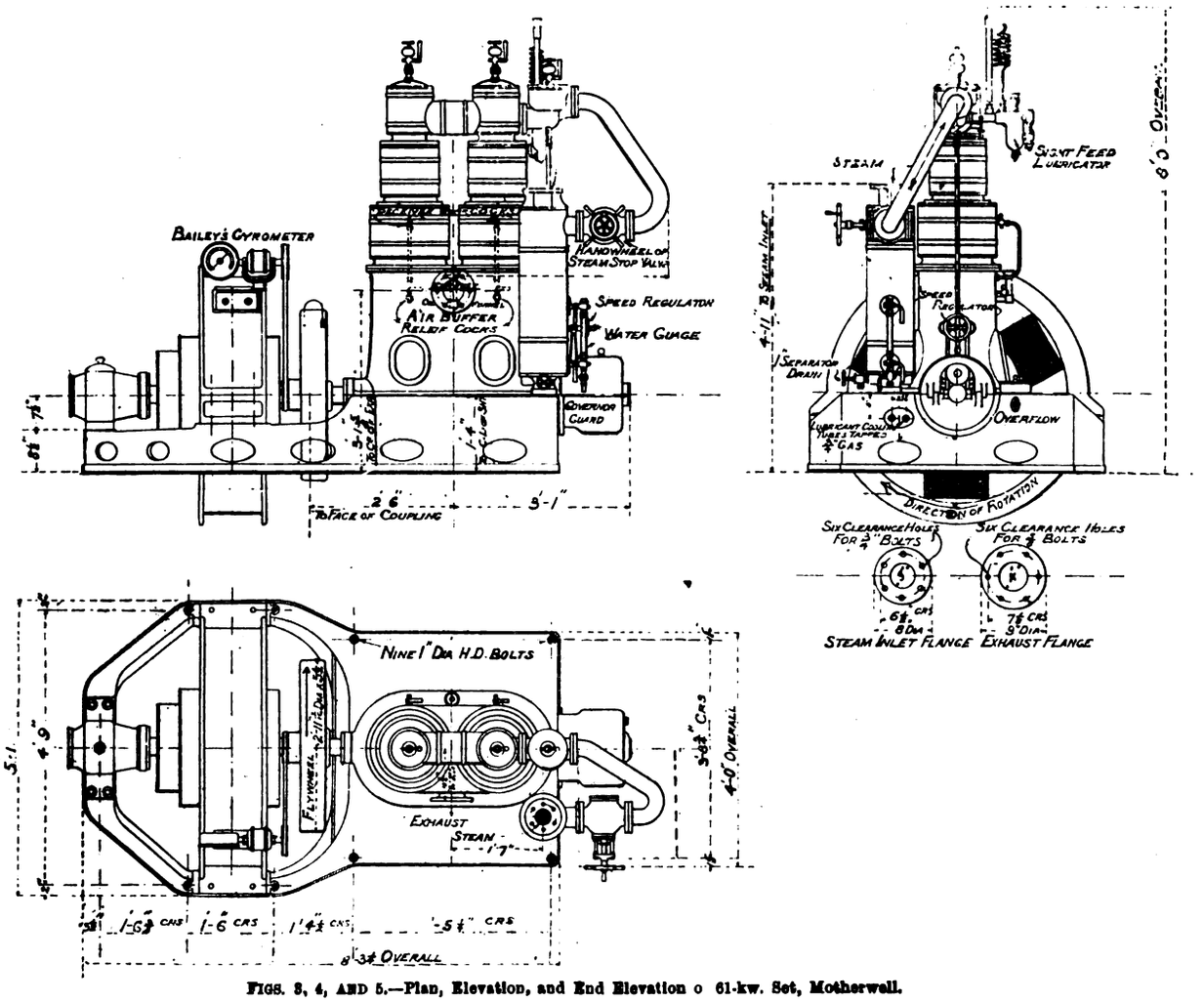
order was obtained, and in 1898 the Council appointed Dr. A. B. W. Kennedy as their consulting engineer. Dr. Kennedy prepared a report on a low-tension continuous-current scheme, involving an estimated expenditure of about £24,000. This scheme has been practically completed on the lines of Dr. Kennedy's report, the amount expended on the original scheme having almost coincided with the above estimate. Owing, however, to the brisk demand for current even at the start of the undertaking, additional cables have been laid down, bringing the expenditure up to date to close on £30,000.

The station buildings (for block plan and section see Figs. 1 and 2) occupy a fairly central position to the south of the town, and have the advantage of being only about 100 yards from a coal pit, so that coal is procured on very favourable terms. The buildings are of brick, and their general design and appearance reflect credit upon the architect, Mr. James Cowie, of Motherwell. The boiler-room is sunk below the ground level about 10ft., and the coal is tipped from the wagons directly through openings in the front wall of the boiler-house on to the storage space in front of the boilers. These latter are two in number, of the Lancashire type, 28ft. long by 8ft. in diameter. They were built by Mr. George Sinclair, of Leith, in accordance with Dr. Kennedy's specification. Each has two internal furnaces of 3ft. 3in. diameter, reduced to 2ft. 9in. at the back of the boiler; also a steam drum having a diameter of 2ft. and a length of 8ft. The working pressure is 160lb. per square inch, and a test pressure of 275lb. was applied with the boilers in position. The boilers are fed by two direct-acting vertical-pattern feed pumps, made by Messrs. J. H. Carruthers and Co., Glasgow, each of which is capable of delivering 1,400 gallons per hour against the boiler pressure of 160lb. The feed water is obtained from the Corporation supply mains, and is first led into a large cast-iron tank fixed outside the boiler-house. All the drains from the steam and exhaust piping and from the engines are led into this tank, and the feed water is pumped through a Royle's exhaust-steam feed-water heater into the boilers. Duplicate steam and water connections are connected to each feed pump. The main steam-piping is arranged on a modified ring system. The steam-pipes are of welded steel, with flanges screwed and brazed, and all piping under steam is covered with magnesia sectional lagging. The pipe connections are shown in Fig. 1.

Leaving the boiler-house, the engine-room is the next feature of interest. It is a lofty, well-ventilated room, lined all round, except on the "extension" end, with white glazed brick, and is traversed by a 10-ton hand-power crane made by Messrs. Marshall, Fleming, and Jack, of Motherwell. There are at present installed two 61-kw. steam-driven sets, also two 24-kw. balancers and a booster set, consisting of two boosters having an output of 40 amperes at 60 volts, driven by a motor to work off the 460-volt 'bus bars. All the generators are by Mavor and Coulson, Glasgow, the two larger machines being direct-coupled to engines of the Willans and Robinson 2 G/s size,



FIGS. 3, 4, AND 5.—Plan, Elevation, and End Elevation o 61-kw. Set, Motherwell.

having two cranks, and capable of indicating 100 h.p. when running at 460 revolutions per minute with a steam pressure of 150lb. at the engine stop-valve, while the smaller machines are coupled to engines of the same firm's 2 E size, indicating 40 h.p. when running at a speed of 520 revolutions per minute with the same steam pressure. Elevations and a plan of one of the 61-kw. sets are shown in Figs. 3, 4, and 5. The generators are of the multipolar continuous-current shunt-wound type, the larger machines being wound to yield 127 amperes each at a potential of from 480 to 520 volts, with a variation of speed not exceeding 5 per cent., while the two smaller or balancing machines have each an output of 100 amperes at from 230 to 260 volts terminal potential. A spare armature is provided for each size of machine. There is also an armature supplied for the balancing sets to enable them to be run across the 460-volt 'bus bars if required. To facilitate this, a double-pole throw-over switch is provided on the magnets to enable the shunt windings to be connected in series or parallel, the windings being con-

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nected in parallel for running on the 230-volt circuit and in series when required to run across the 460-volt bars. The shunt-regulating resistances are placed under the switchboard gallery, the regulation being effected by means of sliding switches erected on the handrail in front of the switchboard platform. The booster set, it should be mentioned, was supplied by Messrs. Thos. Parker, Limited. Each of the above machines has a Ferranti meter in circuit, these being mounted on the front of the switchboard platform, together with a main two-pole fuse for each machine.

The switchboard was supplied by Messrs. Lowdon Bros. and Co., of Dundee, and is of Dr. Kennedy's standard design, its connections being shown in Fig. 6. The measuring instruments are all of the Kelvin type, the ammeters being of the sector pattern. Double 'bus bars are fixed on the back of the board, and arrangements are made for plugging any feeder to any generator direct to the battery, or to the 'bus bars for parallel working. The boosters are capable of being plugged on to the battery charging circuit, meter-testing circuit, or special "milking" circuit for the cells. Each of the main generators has a maximum and minimum automatic cut-out provided for it; there are at present four feeder circuits. The switchboard is equipped with two of Dr. Kennedy's special battery regulating switches, the action of which has already been described in detail in these columns. The battery is divided into two sections

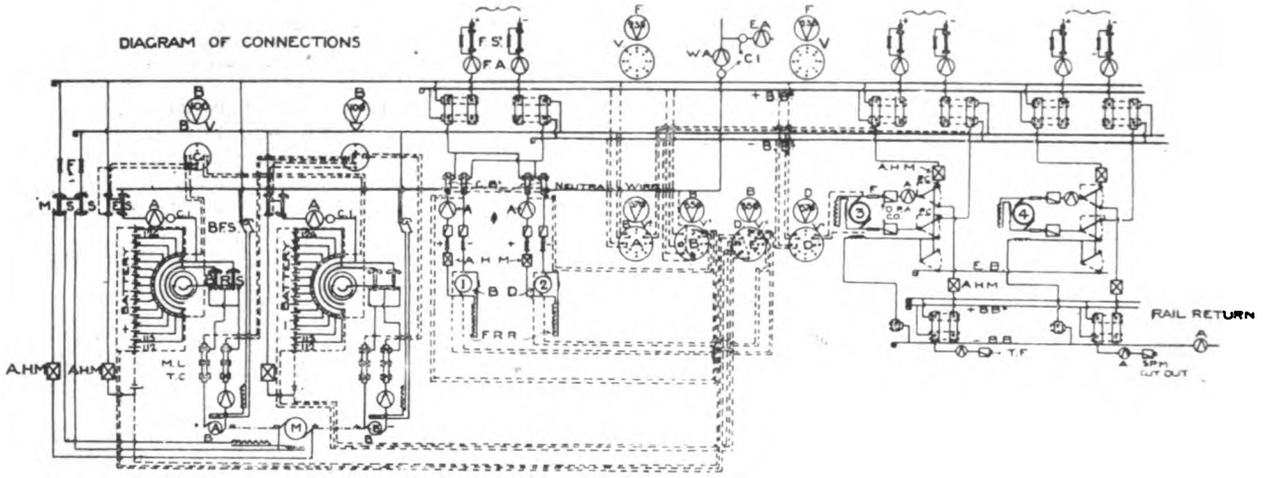

Fig. 6.—Diagram of Switchboard Connections, Motherwell.

(one for the positive and one for the negative side of the three-wire system) of 130 cells each, and is of the Electrical Power Storage Company's well-known K.W.S. type. The battery is capable of maintaining a discharge rate of 40 amperes for five hours, or 60 amperes for three hours. The cells are contained in glass boxes, and are arranged in double tiers on wooden stands. It may be added that the approximate weight of each cell complete with acid is 195lb. The connections between the different sections of the battery and from the regulating cells consist of round copper rods, painted according to polarity, and led across the beams of the cell-room on porcelain insulators. The rods from the regulating cells are led to a point directly behind the switchboard, where they are led through the wall into the engine-room, and connected to the regulating switches by means of short lengths of insulated cable. In circuit with each battery is an Aron reversible battery meter, which records all the current discharged by the battery, but only records 85 per cent. of the charging current, the remaining 15 per cent. representing the loss in the battery. This proportion of the charging current is shunted by a special arrangement in the meter; thus, in charging to the extent of, say, 230 ampere-hours put into the battery, the meter only registers 200 ampere-hours, and discharge may be continued until the meter registers zero. This arrangement will no doubt be very convenient, but the battery cannot always be expected to work with a loss of only 15 per cent., and allowances ought to be made for this in the future. At one end of the battery-room is a connection for two flexible cables to run the whole length of the room, which are to be used for "milking" any cell which may be out of order.

One of the most striking features of the station is only seen on reaching the space underneath the switch platform and engine-room. The easy means of access to the connections under the switchboard and to the exhaust piping is at once apparent. The feeders and pilot connections are led in from the street in a spacious tunnel, which enters a large chamber directly under the switch platform. All connections and regulating resistances are in sight and easily accessible, as also are the main and shunt connections from the generators and boosters, which are supported on insulators fixed to the concrete floor of the engine-room. It is possible to walk upright all round the foundations of the engines, and the repair of any joints in the exhaust, drain, and water piping will be rendered a simple matter by their accessible position.

The cables were laid by Callender's Cable and Construction Company, Limited, and are of their well-known bituminised fibrous type, lead-covered, armoured, and laid direct in the ground. Three of the four feeders are concentric, while the fourth is triple, the third wire acting as the return middle wire to the station. The distributors are triple concentric. The public lighting at present consists of 30 arc lamps, but it is intended to add to these about 500 incandescent lamps of 32 c.p. for lighting the less important streets of the burgh. The arc lamp-posts were supplied by Messrs. McDowall, Steven, and Co., of Glasgow, and are of very neat design. At present the equivalent of about 2,250 8-c.p. lamps are connected, although the station was only opened officially on the 25th of last month.

With such a good start already made, there is every indication that the lamp connection curve will rise at a rapid rate, and with such a well-designed station under his charge there is every reason to expect that the energetic burgh electrical engineer, Mr. S. E. Britton, will make the Motherwell electricity undertaking the success which it deserves to be.

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 115.)

4.—Sub-Stations and Sub-Station Gear.

The following notes are intended to apply principally to sub-stations used for the distribution of alternating current, transformed from high-pressure feeders to low-pressure distributors by the use of static transformers. In a general way, however, it will be seen that some of the notes apply equally well to sub-stations in use as balancing stations on a low-tension network, or as distributing stations where polyphase currents are used to feed and continuous currents to distribute. We may include under this heading street-box transformers and distributing manholes for both low and high tension currents.

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A rule of first importance is that, for whichever purpose intended, the sub-station should, if at all possible, be placed above ground, as there is a great amount of risk to life and gear if the sub-station is below ground, owing to the awkward task of getting the gear down and removing it if it breaks down. Again, the cost of lowering gear into the ground is very high, being about four times the cost of moving it into place on the level for labour alone, independent of the risk of breakage. Of course, a sub-station underground costs very little in the first instance — merely the cost of the material and building—while above ground there would be the cost of the ground itself, or a yearly rental. But if a house were purchased and the lower part were used as a transformer-room, the smaller cost of maintenance would more than cover the rental of the part so used, and the upper part could be used as stores, or as a dwelling for one of the permanent staff of workmen—such as a foreman—and the rent of this part would, therefore, also be returned; so that a sub-station above ground could be made a paying investment. Sub-stations above ground can also be kept much cleaner and drier than those below ground, and can be better and more easily ventilated. If a house is hired or bought and it has a cellar, so much the better, as the getting in of the cables will be much more easily accomplished. The ground floor will need to be removed entirely and a floor substituted, made of concrete laid on iron joists. Such a floor can be easily made by building brickwork piers, on a good foundation, from the cellar floor to the required height; iron joists, of dimensions suitable to the span and the weight to be carried, are then to be placed in position, resting on the brick piers.

Underneath the iron joists, and pressing firmly against them, a wooden ceiling must be constructed of planks, so

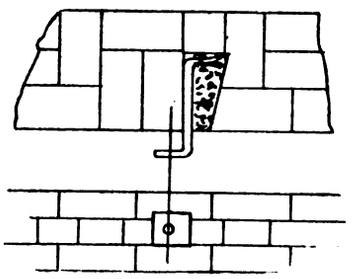

FIG. 10.—Plan and Elevation—Iron Wall Bracket.

thick and so well supported from the floor of the cellar that they will not bend perceptibly; the ceiling must touch closely all four walls. On the top of the iron joists, which should not be more than 3ft. apart, should then be laid a covering of coarse mesh wire netting. Cement concrete, made of three parts of clean stone to one part of cement, may then be shovelled on until sufficient has been laid to cover the iron joists by about 1in. After this coarse concrete has set for one day, a fine surface may be given to the floor by trowelling over it a fairly wet plaster made of cement and sifted sand, in the proportion of 1 of the former to 2 of the latter. After the whole mass of the floor has been standing for, say, two weeks, the wooden ceiling underneath the iron joists can be removed. The brickwork piers, on which the iron joists rest, should be tied into the walls of the cellar during the process of building them. The walls of the room to be used as a transformer-room should be stripped of old paper and whitewashed. As it will be necessary to fix gear to these walls, irons should be let into them, of such a form that vertical or horizontal battens of iron can be fixed to them; these battens in turn carrying the switchboards, etc.

A glance at Fig. 10 will show a suitable form of iron. If the walls are not more than 9in. thick, it would be better to pass bolts right through them, having on the outside large iron washers. The gear might also be fixed to the walls by leading in or cementing in lewis bolts where required. This method is not so good as the former, as it does not give so much scope for future alterations or extensions. Cables would be brought first into the cellar of the house through earthenware pipes let into the walls, and then passed up through the concrete floor through more pipes, which could easily be constructed in the floor at the time of making it; and if the cables have to cross the cellar ceiling before passing up into the transformer-room, they can be cleated to the iron joists. If there is a fireplace in the transformer-room, so much the better: it will often come handy for the sweating of cables, etc. If the house should have no cellar, the ground floor can be removed and the concrete floor laid solid in its place; and if the new floor comes, say, 2ft. below the level of the ground outside, the cables can quite easily be introduced, doing away with the necessity for a cable trench inside the transformer-room, which would be necessary if the new floor were on the same level.

If a site only had been purchased, the sub-station could be built to suit any requirements, if carefully thought out before building operations were commenced. The ideal house for this purpose would, of course, be a detached one. If an underground sub-station has been decided upon, care must first be exercised in the selection of a suitable place. It must, of course, be placed as nearly in the centre of the load as possible, but should not be placed, if it can be avoided, where it can annoy any shopkeeper or interfere with any business As a general rule, it is best to construct a sub-station at street corners, and if possible, totally under the footway. If it is not possible to get it under the footway, the manhole entrance and the top light should be so placed, the main portion of the building being below the road. If it has to be placed altogether under the road, then the manhole entrance will have to be of a stronger design, and the sub-station must be electrically lighted. An underground sub-station can be built of either cast-iron plates or brickwork. The latter, however, gives the best

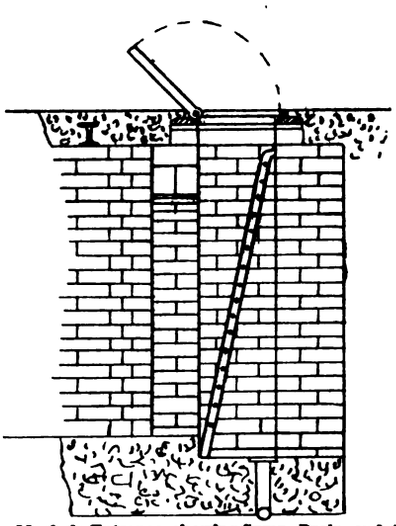

FIG. 11.—Manhole Entrance, showing Sump, Drain, and Arched Entrance to Interior of Sub-Station.

results; it will last longer, and is considerably cheaper. It can also be built with cement concrete, made and laid *in situ*, but walls made so would give some trouble in the fixing of gear, as it would not be at all easy to cut holes in good concrete, and irons could not very well be built in place. The shape of the sub-station must conform to the ground at the disposal of the engineer, but for the Board of Trade requirements—viz., 90 kw., this being the maximum output allowed from any one sub-station—the floor space should not be less than 80 square feet None of this space should be taken up by the entrance ladder; this should be placed outside the main building, as shown in Fig. 11, and need not be used as a way for gear, but may be simply large enough to allow a man to enter, say, about 2ft. square. The entrance for gear should be through an opening left in the roof, and normally covered with a light of suitable form, such as a Hayward's light, which can be made to any size and shape desired. Of course, if the sub station is situate entirely under the roadway, there will of necessity be only one way down for gear and attendants.

If cast iron is used for the construction, it would have to be in the form of plates at least 1½in thick. A flange for joining the plates would have to be provided, cast on all round the plate, and machined to enable a watertight joint to be formed. The flanges would be turned to the outside of the sub-station, so as to leave a flush wall inside. The plates when bolted together could advantageously be backed with concrete to a thickness of, say, 9in. at least. If the sub-station were on the footpath, the roof could be flat with

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impunity; but if in the roadway, the roof would need to be built in the form of an arch with brickwork. Perhaps the only time when cast iron would be best employed would be when building a sub-station or transformer pit in wet clayey soil, where also, as sometimes happens, it is impossible to drain the pit, owing to the sewer not being at a sufficient depth or to the absence of a sewer. Cast iron, then, backed with concrete would easily provide a suitable and absolutely watertight chamber, not to be procured in any other way in some localities If cast iron is employed in the form of a flat roof, one or two small girders should be laid across the roof, on the outside, projecting, say, 18in. on each side, covered with wire netting and laid with concrete, in the way above mentioned.

If the sub-station is to be built of brickwork, the walls should be at least 14in. thick, the bricks being hard and laid with good cement mortar, all joints being filled full. The inner brickwork can well be laid with white glazed bricks; these make an excellent job and can be easily washed. Or the walls can be faced with glazed tiles. The former method is the better. If the sub-station so built is entirely under the footway, the roof may be formed of concrete, as above, laid on girders *in situ*; the top level of the concrete would then be the paving level. The iron frame containing the centre light, and the frame carrying the manhole cover, must be placed in position on the wood ceiling and levelled with the surrounding paving before the concrete is thrown on. After a week, a roof so made will be quite strong enough to carry foot passengers, and the wood ceiling underneath may be removed. If the sub-station is under the road the excavation must be considerably deeper, to allow an extra thickness to be given to the roof, which must be arched in brickwork. The sub-station in this case should be narrowed one way as much as possible, to make the arch span less, and therefore stronger.

When excavating for a sub-station of large size, the excavation must be at least 6in. longer and 6in. broader than the actual brickwork dimensions, to allow for timbering the sides of the hole; the timbers being withdrawn gradually, and the space outside the brickwork being filled with fine soil well rammed as the building proceeds. Before commencing the building of the walls, a floor of concrete 12in. thick should be laid down first, the walls being built on this floor; thus the floor will extend to the outside of the walls all round. If possible, the sub-station should be drained through a non-return ball-trap; although when built in sand there is really not much need for a drain, probably no need, as any little surface water finding its way through the entrances would collect in the sump, the floor being sloped to this end. If a drain is used, it should always be placed under the entrance ladder, where also the sump should be formed, as in Fig. 11.

A method which has been tried for building a watertight sub-station, but without much success, is as follows: A floor is first put in of concrete, which is then floated over with bitumen or some similar hard-setting compound. When this is hard, a chamber of 9in. brickwork is built, and inside this is also built a chamber of 4½in. work, quite independent of the 9in., and at about 2in. from it all round. The cavity thus left between the walls is filled with the compound or bitumen, which is poured in—or ought to be—at about every four rows of bricks. This method has probably failed owing to the shifting nature of clay soils in some cases, and in others to bad workmanship, the brickwork having been carried too high, or the bitumen not being hot enough. The writer saw one of these in construction, and the bricklayer was in the act of pressing in semi-solid bitumen with his trowel. Judge the result! When a sub station is built under the road, and the manhole also comes under the road, the manhole cover must be of a heavy design, and have a surface which will prevent the slipping of horses; such a cover can be procured formed of wrought iron, into the surface of which is let a number of plugs of wood. Where banked transformers are not used in a central sub-station, but single transformers are dotted about in the street as the load requires them, it is best to build a small brick chamber with 9in. walls, and in this chamber to place an ordinary sub-station type of watertight transformer. The chamber should be drained if possible Very often a single cast-iron case, containing the switch gear, both primary and secondary, as well as the transformer, is used. This is by no means a good method, as it is almost impossible to do any work on the transformer connections under these circumstances. In the first place, a jointer has to lie on his face to do anything at all; again, terminals inside the case are always alive, which, of course, is very risky indeed.

(To be continued.)

"ARMACELL" INSULATING VARNISH.

The qualities required of a varnish to be successfully used in the insulation of the various parts of electrical machinery are exceedingly varied. It is not enough that the varnish should give a good insulation at ordinary temperatures, as when the part insulated becomes heated after a long run, it is of the utmost importance that the varnish should not soften, with a consequent fall in insulation resistance. Another point is that the varnish must be flexible, so that the articles which are varnished can be bent without breaking the protecting film. Another point which has to be complied with is that of adhesion to the great variety of substances which enter into the construction of the modern dynamo, transformer, or other electrical machinery using high-voltage currents. As is to be expected, the only way to arrive at a really good varnish for general use is by conducting a long series of experiments, in which various defects may be eliminated. We have recently had a long interview with the specialist of Messrs. Griffiths Bros. and Co. on this matter, who has placed at our disposal a number of facts which have been arrived at by independent authorities with the varnish now being placed on the market under the name of "Armacell." The insulating properties of the varnish were first experimented with by soaking paper in it, and afterwards baking the paper up to 200deg. F. A number of samples of paper varnished with varnishes of slightly different compositions were then submitted to a well-known electrical firm in order that they might be tested to destruction by applying a gradually increasing voltage More experiments were then made by Messrs. Griffiths Bros. and Co. with those types of varnish which had given the best results, and new samples of paper were prepared and submitted to another electrical firm. Higher results were obtained from a number of these samples, and again the process of experimenting on the varnish was repeated. As a final result the most successful varnish was then selected, and experiments made with it at still higher voltages. This was ultimately submitted to the Imperial Physical Technical Institute at Charlottenburg, when not only exhaustive tests on the insulation of varnished paper and its resistance to high voltage, but also on the permanence of the varnish at high temperatures were made. The varnish paper tested in England was always dipped twice in the varnish, and also baked twice before being tried, and the following summary of results on one thickness only of the paper will be of interest. Thus Messrs. Crompton and Co. in May, 1900, found that the single thickness of paper would resist from 4,320 up to 9,600 volts alternating. In June the same year Messrs. S. Z. de Ferranti, Limited, also experimented with the varnished paper, and found that certain samples resisted 10,000 volts alternating. The most interesting results, however, are those obtained at the Reichsanstalt at Charlottenburg. Both paper and copper sheets were submitted, the former to be tested as regards their resistance to high electric pressures, and the latter as to their resistance against temperature. In the case of the paper slips, the samples delivered were 14cm. long and 8cm. wide. They had been coated, according to the statement of the firm, twice with the varnish on both sides. To test same, the pieces had been placed one after the other between two round brass electrodes of 50mm. diameter, have been pressed together under a pressure of 2 kg. and connected with the poles of a many cells accumulator battery. The resistance between the electrodes had been measured at 1,000 volts. The voltage was now gradually increased till the paper broke down. In cases where a breakdown did not occur at the highest direct-current voltage available—*i.e.*,

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11,000, the above-mentioned brass electrodes were connected with the poles of an alternating transformer. We give the results in full:

No.	Thickness.	Resistance between the electrodes at 1,000 volts, 75 per cent. moisture of air.	Breakdown voltage.
1	0·185mm.	29,000 megohms.	10,990, direct.
2	0·215mm.	27,000 ,,	8 550, alternating.
3	0 208mm.	18,500 ,,	8 850 ,,
4	0·271mm.	38 700 ,,	10 800 ,,
5	0·237mm.	167,000 ,,	10,200 ,,
6	0·22mm.	103,500 ,,	9 750 ,,

The copper samples submitted were of 11cm. length, 6cm. width, and 0·05mm. thickness. According to report of the firm, they had been dipped twice in Armacell varnish and been baked after the first dip for two hours, after the second dip for eight hours at 180deg. F. The coat could stand sharp bending of the copper sheet without breaking. Previous to the tests, the copper sheets had been kept each five hours at a temperature of 302, 480, 570, and 660 degrees F. The changes noticed on the varnish coats after the above experiments were the following: (*a*) 302deg. F.—The coat seemed to have darkened somewhat, but no other changes were noticed. (*b*) 480deg. F.—The coat breaks when bending the sheet at a radius of about 1mm. (*c*) 570deg. F.—The coat was almost black, and breaks when bending at a radius of 2mm. (*d*) 660deg. F.—The varnish coat is black, and breaks when bending the sheets at a radius of about 5mm. The copper below was found entirely clean and bright. (*e*) At about 750deg. F. the coat was destroyed.

Only last week some more tests were made at Messrs. Crompton's works, in which paper samples stood from 8,000 up to 10,000 volts. A higher voltage than 10,000 could not be applied to the samples with the testing apparatus then available. The question now arises as to how this varnish is best to be used in dynamo work. In all those wire-wound armatures in which replaceable coils are required, it is well to varnish each section of wire as it comes off the former. The section should then be heated up to about 200deg. F., after which a second coat and second baking makes the insulation secure. The practice of certain Continental firms is also to varnish their armatures as a whole after the conductors are all in position and connected up to the commutator. In this case the armature is heated up in an oven for a considerable time to a temperature of about 200deg. F., in order to drive off all moisture and air in the insulation. It is then dipped when heated in the varnish, which in this way is enabled to get into all the pores and in the interstices of the armature. After drying, the whole armature is again baked to 200deg. F. The result is a perfectly watertight coating of insulation, which has been found to give great satisfaction in practice. From the large amount of correspondence which Messrs. Griffiths Bros. and Co. have shown us we gather that the successful results they have obtained are due not to any incidental discovery in manufacture, but rather to careful tests extending over a very considerable period.

Another point in which the varnish may find considerable application is that of protecting all exposed metal parts of high-tension switch gear. It is found that without baking a hard dry surface is obtained after about 36 hours' drying, and the insulation so obtained would be a great protection in cases where old and dangerous switchboards cannot be replaced at once. The tests of the mechanical properties of the varnish on a copper backing given above show how it will withstand mechanical distortion. The Brush Electrical Engineering Company have experimented on the insulating properties of the varnish on copper. The experiments were made by placing two small discs one on each side of a copper sheet coated with two layers of "Armacell." The voltage was then increased until the insulating properties of the varnish gave way under the strain. This occurred in one sheet on three successive tests at 5,090, 4,970, and 4,500 volts respectively. The same firm also tested samples of varnished paper, and obtained confirmatory results to those detailed above. It is, however, in the manufacture of electrical apparatus, rather than in the protection of exposed switch gear, that "Armacell" should find its greatest use, and we wish the makers every success in the supply of the varnish for this purpose.

THE SPRAGUE MULTIPLE-UNIT RAILWAY SYSTEM.*

BY EDW. CHILTON.

The multiple-unit system takes its name from the fact that it has to do with trains made up of many units, any one of which is an independent converter of electrical energy into mechanical energy, so that a single car or a train of 25 cars or more can be started and controlled as smoothly and with much more flexibility than can a train pulled or pushed by a single motor unit. Such a system is admirably adapted to handle trains under elevated or other steam road conditions, for, as will be seen later, it has many strong features that combine to save labour, time, and material in operation, and the cost of maintenance of roadways and structures.

In a multiple-unit train every coach has its own motor, controllers, resistances, car-wiring cables, air brake, hand brakes, heat and light fixtures, and trolley, plough, or contact shoe for transmitting current from the line to the motive and auxiliary apparatus on the car. The main distinctive feature introduced on multiple-unit trains is that the whole train or any part of it can be operated from any controller on any coach. Take any number of single ordinary surface trolley cars, for example, equipped with any style of motors and K2 controllers, and extend their car wires as indicated in Fig. 1, providing the ends with suitable couplers so that any number of cars can be electrically connected. In Fig. 1 A A are the taps that go to the controllers on one car, and B B are the taps that go to those on the other; C, C, and C are the couplers. The result of so connecting two cars or more is to place all of the motors on the same set of car wires so that all of them or any of them can be operated from any controller.

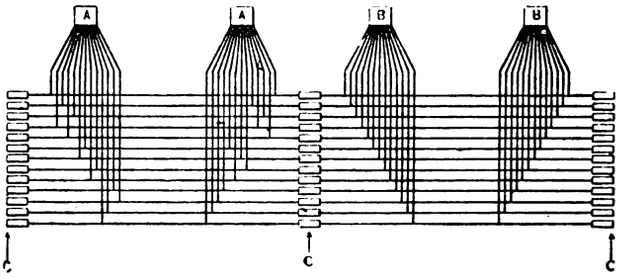

FIG. 1.—Diagram of Connections between Two Cars.

Such a train of cars would constitute a multiple-unit train system, but such a system is open to several very serious objections. In the first place, such an arrangement necessitates the transmission and handling of large currents. For example, if the controller on one of the end cars is being used, the current from all of the cars has to pass through that controller. Suppose that the train has six coaches, and that each coach, when the train is under full headway, takes a current of 300 amperes. Now, the wiring on the last car in the train has to carry only its own current of 300 amperes, but the wiring on the car next to it has to carry the current of two cars, or 600 amperes, and the wiring on every car must carry its own current and that of all cars behind it, so that the wiring and the controller on the first car must handle 1,800 amperes—the current of six cars.

As any car is liable to be the front end or operating car, if the full benefit of the multiple-unit feature is to be enjoyed, the wiring of every car must be able to stand with safety a normal current of 1,800 amperes and an abnormal current of perhaps twice this during the period of acceleration. The cost of the car wiring alone for such a system would evidently be prohibitive. Also, it would be impracticable to construct a controller of reasonable size that could satisfactorily handle currents of 3,000 or 4,000 amperes, as it would be required to do at times.

A third and more serious objection is the impracticability of making a coupling device to satisfactorily transmit large currents from one car to the other; such a coupling must necessarily be flexible, so that it may respond to the various contortions and vibrations of the train; and it

* From the *American Electrician*.

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must be light, so that it can be easily handled when taking on or cutting off an additional coach. The fulfilment of either of these requirements is practically impossible under the conditions. The fourth objection to such a system is that the current for the whole train must be collected by one car, for the current cannot get through the controller on any car except the one whose controller is in use.

Any system, then, that requires the transmission of the main working current from one car to another must be set aside as undesirable. The main working condition to be fulfilled in the design of any multiple-unit system of control is that the working current be delivered directly to the car that utilises it. Every car must have its own trolley pole and wheel, or contact shoe, as the case may be. Suppose a train of six ordinary trolley cars, equipped as usual, and mechanically coupled, but electrically independent of each other; further, suppose that by a system of signals the six motormen on the cars could be made to operate their respective controllers in synchronism—that is, all the controller drums to advance or retard at the same rate, and rest on the same notch at the same time. Such a train of cars, with a motorman on each car, all acting under the same impulse, would be a multiple-unit train; but such an arrangement, besides being almost impracticable, would defeat one of the strongest arguments in favour of the multiple-unit system of control—namely, that of economy in operation.

There have been several devices designed to take the place of the motorman on each car, and all of them are practical and ingenious. On all of the systems—of which there are three—the car has the ordinary equipment of motors and resistances. In one system there is no individual motor controller of the usual type; the resistance is cut in and out, and the series-parallel combinations of the motors are effected by means of electromagnetic switches, operated by means of a small switch situated on the platforms of the car, and known as the master controller. In another system the main controller drum and all of its accessories are operated by means of compressed air, stored in a reservoir and admitted to cylinders whose pistons operate the controller mechanisms. The air supply is controlled by means of valves actuated by electromagnets, energised by dry or storage cells. The battery circuit includes a small controller, situated on the car platform, and called the operating box.

In the system that forms the specific subject of this article—the Sprague system—the main controller is rotated by means of a small motor connected to the drum shaft. The motor is controlled by means of a small platform controller called the master controller. On all three of these systems there are two independent sets of circuits on each car, one being the main motor circuit, and the other the control circuits; there is no electrical connection whatever between them. In fact, on the Westinghouse system this condition is emphasised by the fact that the main motor circuit is, of course, operated by current from the trolley, while the control circuit is operated by battery current. In all cases the main motor circuit bears about the same relation to the control circuit that the telegraph-pole line has to the local sounder circuit inside of the office.

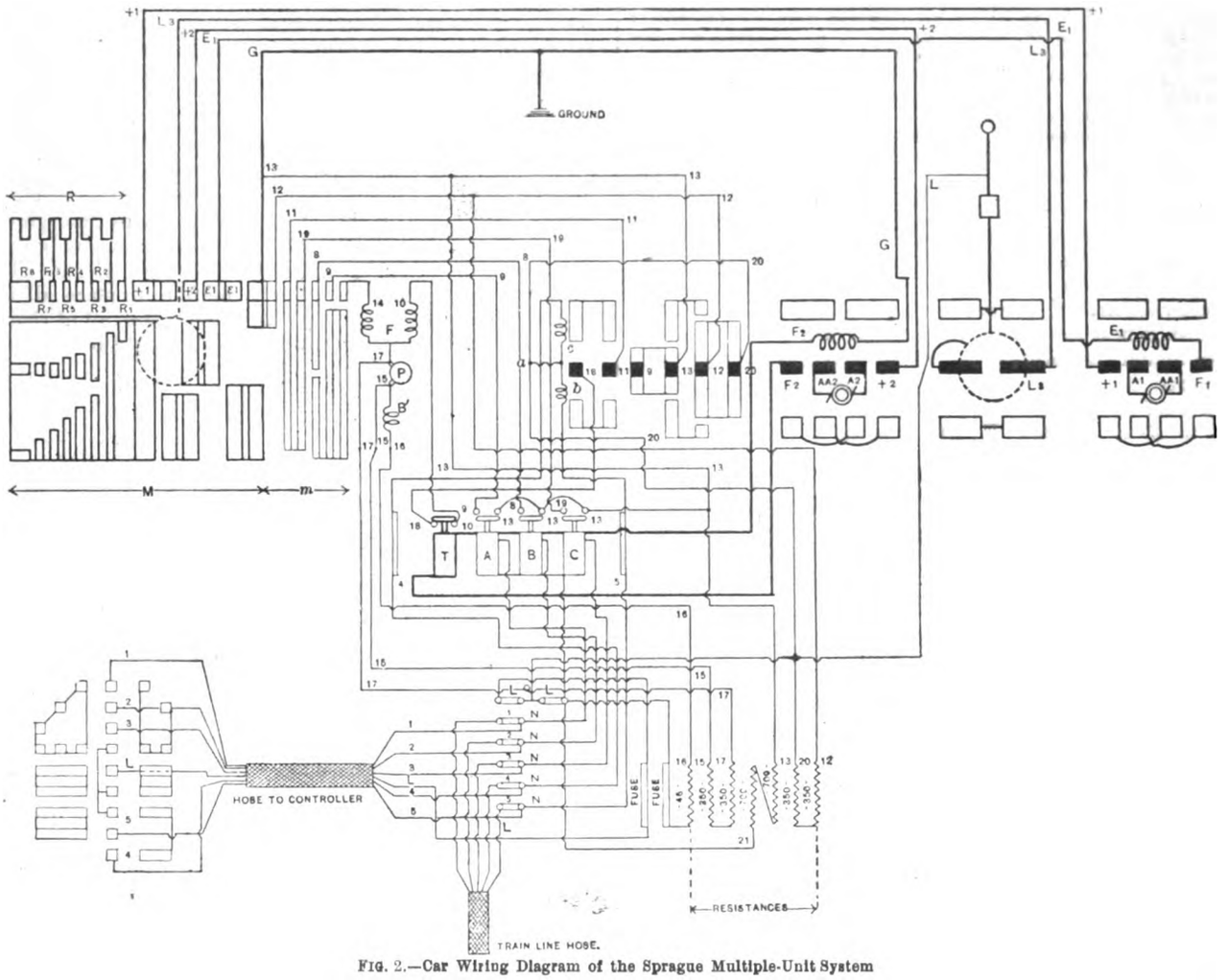

FIG. 2.—Car Wiring Diagram of the Sprague Multiple-Unit System

In the case of a multiple-unit car the control circuit is closed first; this operates a mechanism—an air-valve, or electromagnetic switch or a motor—which closes the main motor circuit to start the car. Fig. 2 is a car-wiring diagram of the Sprague system of control as applied to a car equipped with two motors. Here the heavy lines all belong to the main motor circuits; they represent wires and connections that carry the main current that propels the car. The light lines represent the connections of the control circuits; M is the main controller drum, and *m* is the control circuit part of the main drum. It is mounted on the same shaft, but has no electrical connection in common with any of the main motor connnections, save the ground connection, which is necessarily in common to all devices working on a ground-return circuit; P is the armature of the pilot motor that drives the main controller; F 10 and F 14 are the two field coils of the pilot motor (these two

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coils are so connected that when one of them is used the pilot motor runs in one direction, putting the main controller "on," and when the other field coil is used the direction of the motor is reversed, running the controller "off"); B^1 is a solenoid coil in series with the pilot motor, which releases a spring-impelled clamp brake that stops the motor immediately the current ceases to flow through it. The brake and motor are so related that when the motor is "on" the brake is "off," and when the motor is "off" the brake is "on."

A is a seven-section resistance coil, which is unique in that the conductor is an air-insulated iron casting. Fig. 3 shows how each leaf of the resistance coil is constructed. These leaves are mounted on a substantial slate base, and allow the currents of air to have a clean sweep through them. The reverser is a drum operated by two electro-magnets, as indicated in Fig. 4. As the current entering the junction of the two solenoids, which are in multiple, takes the path *a b*, through one coil of the path *a c*, through the other, the reverser drum is pulled one way or the other against the restraining tension of a strong centralising spring. The reverser coils are a part of the control circuit, and the reverser cannot be operated, and hence the car cannot be started, unless the control circuit is in order. Furthermore, if this circuit should get out of order while the car is under headway, the reverser coils become dead and unable to hold the drum against the pull of the spring, which brings it back to the "off" position.

Both the reverser and main drums are provided with powerful magnetic blow-out coils to prevent arcing. The reverser drum, like the main drum, carries contacts for both the main motor circuit and the control circuit, but there is

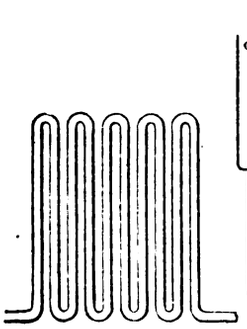

FIG 3.

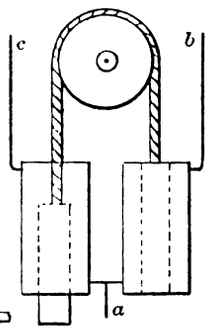

FIG. 4.

no electrical connection between them. L and L are two line switches that admit current to the pilot motor and to the reverser; both must be closed in order to operate the car, and both must be open to entirely "kill" it. T is what is called the throttle; this device makes it impossible to accelerate above a predetermined rate and saves the apparatus much abuse. It will be seen that the main current flows through it. If this main current rises above a certain value the plunger lifts the copper disc off the pegs 10 and 18, interrupts the pilot motor circuit, and stops the advance of the main drum. As soon as the current falls to the limiting value the disc drops, the motor starts, and the controller resumes its progress.

The three solenoids, A, B, C, to the right of the throttle are called relays, and are a part of the control apparatus. The left-hand relay, A, is called the coast relay, because it is used to run the main controller down to the "off" position, when it is desired to have the train coast along without power; the relay B operates to start the pilot motor and run it up to the last series notch, but no further; and the relay C runs the pilot motor up to the last multiple notch. The master controller, K, controls the pilot motor and the reverser coils. This controller has a neutral position, just as the old Sprague street-car controller had, and the car is started ahead or back according as the controller handle is thrown to one side or the other of the neutral point. There are three forward positions on the controller drum, but only one position marked on the top. There are two reversing positions on the drum, but only one notch marked on the top.

Fig. 5 shows the controller top. When the handle is in dotted position *a*, the controller is at the "off" position; when at position *b* the pilot motor does not start, but the reverser drum is thrown to the "ahead" position, and the relay A is picked up. In the position *c* the relay B picks up, starts the pilot motor, and this runs the car motor controller up to full-series point, when the pilot motor stops. If the handle be advanced to the position *d*, the multiple relay, C, operates and the motor controller is run up to full multiple position. This is as far as the handle will go counter-clockwise. If the motorman releases the handle in this position its spring will carry it back to the position *b*, but no further, because an interference tongue on the handle goes against the right-hand side of the "off" position lug and stops there. Then the reverser drum remains in position, ready for the next start, but in the meanwhile the relay A has operated to run the pilot motor in the reverse direction, so that the main controller drum is run to the "off" position.

In order to get the master controller handle past the lug to the "off" position, it is necessary to press a button which raises the interference tongue on the handle and allows it to pass the lug on the dial. As soon as it passes this lug the reverser drum is thrown back to the "off" position, in which position the main motor circuit is open in about 14 places. Should the motorman allow the controller handle to go from any "on position to the "off" position quickly, it does not give the pilot motor time to run the main drum to the "off" position, so that the main circuit is opened solely by the reverser; but as the reverser opens the circuit in 10 places, and as it is provided with a powerful magnetic blow-out coil, indicated by the dotted lines, no arcing can take place.

In order to reverse the motion of the car the master controller handle must be released from the "off" position between the lugs, and moved over to the left-hand side. This operates to make the current pass through the other reverser field coil, with the result that the

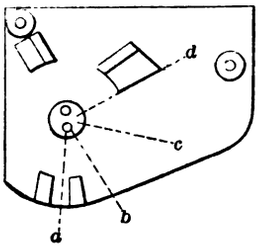

FIG. 5.

reverser drum is thrown to the "backward position, reversing the armatures of the two main motors, and with them the direction of motion of the car. As a rule, the motormen run between the positions *b* and *d*, rarely having occasion on the road to drop the reverser back to its "off" position. The series of switches, N, are all operated by a single handle and serve to cut out the train line. The train line is composed of seven very small flexible wires running the full length of the train; these are the wires of the control circuits and carry but little current. They are connected between coaches by means of couplers little larger and no heavier than an ordinary air-brake hose coupler. By means of the train line cut-out switches, one or more cars can be cut out of a train without interfering with the operation of any of the other cars on the train, and the train can even be operated from one of the cars that is cut out.

THE WANNSEE RAILWAY.

In our issue of Dec. 28 last. we referred in a note to a paper read by Herr Bork, director of railways, before the Cologne Association of Electrical Engineers in which the author gave some interesting information regarding the Wannsee Railway. The full text of the paper has since appeared in the German technical Press, and having regard to the importance of the subject we take this opportunity to enlarge upon our previous summary. In introducing his paper, Herr Bork remarked that although many arguments had recently appeared both for and against the electric haulage of trains on standard-gauge railways, the matter

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had made but little substantial progress in Germany. This might be ascribed principally to the circumstance of setting up a fictitious value for the capabilities of electric traction. Amongst other things, it had been maintained that electric traction on ordinary railways would permit of the attainment of adventurous speeds (200 km. to 250 km. per hour), and of starting accelerations far exceeding those at present obtained. But even admitting the practical possibility of fulfilling such demands, purely economical reasons quite excluded their realisation. Apart from the fact that such high speeds were very seldom required, it was very evident their attainment on railways of the ordinary surface type was impracticable. A special and costly type of permanent way would be required for such speeds, besides which the working cost would necessarily be very high. To cover these extraordinary costs very high fares would have to be introduced on such railways, which would incidentally render the development of their traffic a questionable matter. Moreover, it should not be forgotten that the great increase of speed involved increased danger, notwithstanding every conceivable precaution.

In the opinion of the author a healthy development of electric traction on railways might be expected only if demands strictly consistent with practical requirements were enforced. Speeds must, accordingly, be taken as a basis which shall exceed those at present in vogue only in special cases, and in other respects the new system should not be required to more than equal the conditions now obtaining in regard to steam locomotion. The observance of this moderation was all the more necessary in that the conversion from the old method of traction to the new could only take place gradually, the two systems existing in the meantime side by side. In certain cases it would even be desirable to permanently maintain both methods of traction. Accordingly it should be made a condition that the existing rolling-stock be made available both for electrically-driven and steam-hauled trains. Further, the existing permanent ways must be still available for steam locomotion after their equipment for electric traction. The electric service should also provide at least the same reliability and security as the system hitherto in vogue, while the arrangement provided in connection with the electric service must in no case entail extra supervision of the permanent way.

While observing these conditions, the electric haulage of trains, if it was to be practically realised, must show a general saving in the working costs as compared with the existing system. Only in individual cases, as, for instance, for suburban and district lines, might the advantages common to electric traction justify its introduction for train haulage, despite a slight increase in the working costs. But purely theoretical reasoning was not alone calculated to convince one as to whether electric traction could comply with the enumerated conditions. A large number of questions was involved which practical experience alone could decide. Having regard to the many different systems of electric traction, and especially to the varied choice of currents, arrangement of feeders, electrical equipment of the motorcars, etc., the practical trials could naturally not extend to all. However, certain arrangements might be selected which came principally into consideration for certain conditions. Since electric traction appeared to be pre-eminently adapted for suburban and district railways, with frequent services of trains, it was only natural to select such conditions for the experiment. Moderate distances were generally the rule with such railways, for which the employment of continuous current seemed advisable. But whether the energy was conveyed to the feeding points in the form of high-pressure alternating or polyphase currents and then converted into continuous current for the motor supply, or whether it appeared more advantageous to employ continuous currents direct, with or without the use of accumulators, depended upon local conditions. To what extent the direct employment of alternating or polyphase currents could be advantageously extended to these railways was still an open question, but so far as existing evidence enabled one to judge, the employment of continuous current and its collection from conductor rails running parallel with the track was probably the most applicable method at present for suburban and city lines. For this reason, continuous current conveyed to the car motors through a conductor rail had been adopted in connection with the practical experiments now being conducted on the Wannsee Railway. The line potential rarely exceeded 750 volts, while the mean potential was 600 volts. It was proposed to continue the experiments for a period of one year in order to obtain reliable data relative to the varying conditions involved.

The author then proceeded to describe the general arrangement of the installation designed by him and executed under his supervision. The electrically-driven train runs between the ordinary steam-driven trains, with a maximum speed of about 50 km. per hour, the mean speed between any two stations amounting to 35 km. For the present the number of daily journeys is limited to 12, but will be gradually increased to 24. The train, which weighs about 220 tons with a normal load, is composed of 10 cars. Of these, four are of the ordinary German three-axle suburban second-class, five of the three-axle suburban third-class, and one of the two-axle third-class type. The front and rear cars, which are of the three-axle third-class type, have been converted into motorcars, and are driven by means of nine motors mounted direct on the axles. The end compartment of each motorcar corresponding to the two extremities of the train are equipped as driving cabs, while the two adjoining compartments at one end have been made into a luggage van, an equal space being occupied at the other end of the train by the apparatus which serves to heat the cars by means of steam during the winter season. The remaining compartments are reserved for passengers. The train travels backwards and forwards between Berlin and Zehlendorf. When it has reached either terminus the driver has, of course, to change over from one end of the train to the other, since the leading car in the one direction becomes the rear car for the return journey. Beyond this, however, no change whatever is necessary. All the cars are provided with air-brakes. Incandescent lamps are used to illuminate the train. The necessary supply of energy to work the train is obtained from the power station in Gross-Lichterfelde belonging to Messrs. Siemens and Halske. This energy is in the form of continuous current, and is conducted at a line pressure of 750 volts by means of overhead feeders to a conductor rail laid parallel with the track. The further transmission of the energy from the conductor rail to the motors is effected by means of special collector shoes attached to the motorcars, while the railway lines are used as a return. Having regard to the fluctuating nature of the demand, buffer batteries have been provided both in Berlin and Zehlendorf. With the exception of these batteries the whole of the electrical equipment has been supplied by Messrs. Siemens and Halske.

The conductor rail mentioned above is composed of ordinary track rails laid end on end and supported at intervals of from 4m. to 5m. by means of special insulators. The height of the third rail above the horizontal surface of the track is 320mm., and its distance from the track centre 1,570mm. The special insulators are mounted upon wood bases attached to the wood sleepers of the permanent way. By means of this arrangement the normal position of the third rail relative to the track is secured against change. To prevent accidental contact being made by platelayers or other members of the railway staff, the conductor rail is protected by means of boards. Collector shoes are attached to all the axle boxes of the motorcars, so that only very slight variations from the normal position, either in the vertical or horizontal direction, can occur. The current collectors themselves consist of iron contact shoes, which are gently pressed against the third rail by means of a suitable arrangement of springs. The motorcars consist of ordinary three-axle suburban cars, a 100-h.p. motor being attached to each axle. Each motor is capable of developing a maximum output of 150 h.p., so that the aggregate output of the six motors may be raised to 900 h.p. The driving and control of the motors is effected from the front of the train through a controller situated in the driving cab, where, in addition to the other apparatus required for the proper working of the motors, etc., is also placed an electromotor for driving the air-

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pumps in connection with the air-brakes. Both the brake valve for the air-brake and the lever for the hand-brake are placed within convenient reach of the driver.

Three months of practical experience with the system have failed to disclose any serious defects. Starting up is accomplished with extraordinary uniformity of acceleration, and no swinging or concussions are perceptible during the journey of the train. Moreover, the passengers appreciate the absence of noise, smoke, and steam, common to the ordinary service of steam locomotives. The duties of the attendants both during the journey of the train and at the termini are considerably lightened as compared with the steam service. Neither has there been any serious trouble so far as the supply of energy to the motors is concerned, and no interruptions in the supply have occurred. The formation of sparks between the third rail and collector shoes became much less after the rust which had formed on the contact surface of the rail had been removed, and this surface had been subsequently worn smooth by friction with the collector shoes. Previously the rust was found to considerably interfere with the collection of the current. In order to establish a reliable basis for the working costs, careful investigation will be made during the year's trials relative to all the factors governing these costs. In the same way the cost of haulage of steam locomotives obtaining for the present service will be determined. It depends upon the results of these investigations, taken together with the working efficiency of the installation, whether or not electric traction will entirely displace steam upon the Wannsee Railway. According to the figures already available, which are certainly based in part upon estimates, the working costs per train kilometre are about 16 per cent. less for the electric service than for the steam service, so that the substitution of electric traction may, perhaps, also be expected to effect certain economies in the working costs. Accurate figures will not, however, be forthcoming until after the conclusion of the experiments. At present the consumption of current per kilometre-ton amounts to about 23 watt-hours, or about a third of the consumption obtaining in ordinary street tramway work. This difference may be attributed principally to the lower percentage of loss through friction due to the clean Vignolle section rails. But further improvements may be expected in this direction by modifying the present arrangement of the motors in starting, whereby the starting resistance now used, which absorbs about 20 h.p., may be substantially reduced. Current is admitted to the motors for two minutes only of the total period of about four minutes occupied by the train in travelling between any two stations, the current taken varying in amount up to 1,200 amperes. Of the remaining time the train runs by virtue of its acquired momentum for 1½ minutes, and is under the action of the brakes during the rest of the time—that is to say, for the space of about half a minute.

LEICESTER TRAMWAYS REPORT.

(Continued from page 125.)

Power Station.—We have endeavoured to obtain the best and fullest information respecting power stations, not only from the many electric traction engineers and tramway managers of great experience whom we have interviewed both at home and abroad, but also from the directors of tramway and manufacturing companies, and from the chairmen and members of municipal tramway committees, and, as the result of their experience, we found them overwhelmingly in favour of a central power station for large towns exclusively for electric traction purposes on the grounds of control, efficiency, and economy. The undermentioned towns, among others in the United Kingdom, have adopted separate traction power stations—viz., Sheffield, Leeds, Glasgow, Huddersfield, Hull, Bristol, Portsmouth, and Cardiff—and many of those we saw abroad had separate stations, and use the continuous direct-current generating plant. To obtain the best results for Leicester, it appears to us that one main central station, with all the separate electric feeders for each route connected up to it, is required, and at that station should be provided all the reserve or stand-by plant. For economy in power and in copper for feeder cables, in maintenance, and also for simplicity and economy in working, it is most essential—and, in fact, of the first importance—that the power station should not only be separate, but also situate as near as practicable to the centre of gravity of the tramway traffic of the borough and of the surrounding populated districts. We have given much consideration to this question, and have inspected the different routes and localities in search of a suitable site. The one which we think pre-eminently offers the most advantages in meeting the requirements of convenience, centralisation, efficiency, economy in capital outlay and working expenses, is the spare and vacant land already belonging to the Corporation, adjoining the Lero refuse destructor, Belgrave Gate, and having an area of 5,500 square yards. This area provides amply for any extension of the power station which could be possibly required in the future. This is borne out by the fact that the area of the Leeds power station site is only 5,000 yards, including 1,200 yards of reserved area adjoining. The Lero site is situated on the line of one of the greatest traffic routes of the borough, and near to the most densely-populated and busiest part of the town. It is within a short distance of the centre of gravity of the future tramway traffic of the borough and surrounding populated districts, thus affording means of generating and conveniently applying the current at once to the points of greatest traffic, and where the maximum amount of power is consequently required. For power distribution purposes this site commands, within a radius of three miles therefrom, the whole of the possible ultimate tramway routes of the borough, and within a four miles' radius it also commands the whole of the populated districts immediately surrounding the borough. Adjoining this site is a piece of land belonging to the Leicester Navigation Company, having an area of 4,366 square yards, which is part of the public wharf, and has a frontage of 504ft. to the canal basin, and we think it would be wise to acquire this for tramway purposes, such as car-sheds, workshops, etc. This land would doubtless in the future be very useful in such a central situation. We have communicated with the chairman and officials of the Leicester Navigation Company, and, subject to your approval, have obtained an offer to sell this land at 24s. per yard, which includes an easement for coal boats, etc, to lie within a width of 15ft. of this basin along the whole frontage of the land. Such a conveniently situated power station would, we are advised, effect a considerable saving both in the cost of feeder cables and by minimising the loss of current and power in transmission over what would be the case with a station not so centrally situated. An ample supply of water for condensing purposes is here available, both from the canal and from the Willow Brook. Although it is a most desirable and satisfactory size, quite apart from the destructor question, its adoption would give facilities for utilising the heat generated from the refuse destroyed at this place, if satisfactory arrangements could be made with the Sanitary Committee. This would prove to be a financial advantage to both departments—for one, by providing a source of income from the steam generated at the destructor; and for the other, by effecting a considerable saving in the consumption of coal. Probably the Sanitary Committee might deem it advisable to increase the burning capacity, and at the same time augment the steam-producing power by burning even more refuse at this very convenient centre. This Lero destructor is conveniently situated for the delivery of the steam direct from the cell boilers (which would be provided by the Sanitary Committee) to the engines of the proposed adjoining power-house, in order to augment the volume of steam supplied from the coal-fed boilers. The coal required at the Lero can be delivered by canal direct from the Derbyshire and Nottinghamshire coalfields, and the Leicestershire coal could be shot into barges from the railway trucks at the Soar-lane Wharf, and conveyed to the Lero by canal at a few pence per ton. In an electric traction scheme there is also the facility afforded, if required, of conveying in the night time on the tramlines coal from the different wharves in the town, and which are situated

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comparatively near to the Lero site. In fact, a new invention is now in successful use in Geneva, by which any railway truck of coal can be run on to a very low-built bogie wagon and electrically conveyed over the tramlines, thus giving the advantages of a railway siding at any place. The coal could by means of conveying plant be automatically delivered from the boats into the bunkers over the boilers, from which it would be discharged by gravitation direct into the boiler furnaces by mechanical stokers. With the facilities available at this site, a substantial saving to the Corporation in cost of fuel would be effected over the cost of the same where a railway siding existed, but no refuse destructor. The power station buildings should be sufficiently spacious to provide ample room for power machinery for a reasonable time to come, and be so designed as to be readily adaptable for extension in future, but only sufficient power machinery for the present requirements need be provided, as the number of units could be readily increased from time to time as required. The site is one which does not call for expensive buildings from an architectural point of view. In our investigations we have ascertained that for simplicity, efficiency, and economy, both in construction and working, it is of the greatest importance in a scheme for a large town like Leicester that the engines, dynamos, and electrical arrangements should be simple and uniform throughout, especially designed for traction purposes, the whole in one central station, and under one controlling authority. The ideal arrangement necessary is simply the one centrally situated power-house, containing the necessary number of units of engines and dynamos and other generating plant, with one switchboard, to which all the dynamos or generators would be electrically connected, and from this switchboard a separate and independent feeder cable would be run out to supply traction power along each route. By these arrangements each line would be independently worked directly from the power-house: the same staff who manipulated the supply and distribution of the current to the different routes would also manipulate and control, under the same roof, the engines and dynamos which produced it. In cases of accident on any line, they would be able at once to control or switch off, if necessary, that particular section, and during the hourly fluctuation of the traffic, and consequent variation of power required, they would also be in a position to use and regulate to the greatest advantage and economy the exact number of engines and dynamos required at any moment. The continuous direct-current type of generating machinery should be adopted, so that the power would be generated and supplied at once to the lines at the voltage required by the regulations of the Board of Trade, thus obviating the necessity for any sub-stations for the transformation, distribution, or storage of current, which would entail a heavy extra cost over that of the scheme which we recommend. These advantages are, fortunately, all practicable for Leicester, and there would be no route too long to be successfully worked with direct continuous current from the proposed "Lero" central power station, the conditions of the town being such as to admit of a comparatively simple, effective, self-contained, and economical scheme. We have, at the different towns visited, obtained a great amount of valuable knowledge in respect of the comparative merits of various types of horizontal and vertical, high and low speed engines, and relating to boilers and stoking arrangements, also concerning the different kinds of electric generators we have seen working together with the feeder cable systems adopted in connection therewith, but with which we do not intend in further detail to burden this report, beyond the descriptions already given herein. We may, however, mention that the engines, dynamos, the whole of the feeders, and other electrical equipments throughout the town must be used exclusively for traction purposes. The Tramway Committee's permanent resident electrical engineer-in-charge would then, with great advantage to the undertaking, superintend the maintenance and working of all the machinery and electric equipment of the power station, lines, and cars, as is the case at most of the towns and cities we have visited, and which duties would require his exclusive services. We have every reason to believe that such a scheme and arrangements would ensure the minimum cost possible, both in capital outlay and working expenses. The whole would be under the control of one special tramways committee, with undivided responsibility, and who would be provided with every facility, under the best possible conditions, for making the undertaking a complete and unqualified success.

Car-Sheds and other Depôts.—We found that one of the most important requirements of an electric traction scheme is a large depôt, as is provided in other towns, consisting of a spacious shed for the housing of the cars, which should be fully provided with pits or passages for ready inspection, cleaning, etc., of the car equipments, workshops for each branch of repairs, and to be capable of extension for the construction of our own cars, if found advisable in the future. For these purposes a site of very considerable area, at least several acres, would be necessary, so as to be ample for all future requirements. This site should, for obvious reasons, be comparatively near the centre of the town, and situated as nearly as possible to the central power station. We have inspected the numerous sites in the borough, but the one which, in our opinion, is most suitable for this purpose, having regard to the high prices of land near to the centre of the town, is part of the back land, already belonging to the Corporation, adjoining the canal to the north of the Abbey Park-road, a sufficient width of building land being reserved along the frontage of this estate. This land is very conveniently situated, easy of access from the Belgrave-road main thoroughfare, and is also near to the proposed power station site. Besides this main car depôt, small district car-sheds, at or near the various termini, must necessarily be provided so as to facilitate the housing at night and getting to work in the morning of each day. Some of the buildings to be taken over from the present company could be so utilised. This, and also the utilisation of the tramway company's other buildings, are, however, matters which require much greater consideration than we have been able to give up to the present time, and considerable alterations would be necessary to adapt and equip them for electric traction purposes. For district car-shed purposes there is some very convenient, suitable, and comparatively inexpensive land belonging to the Corporation on the Groby-road. We refer to the land which for some years past has formed a tip for house refuse, and a portion of it is occupied as a sanitary depôt, but it is now very little used. A portion of the Corporation estate land, which is situate adjoining the Saffron Brook, at the corner of Hughenden-drive, would be a suitable place for a small district car-shed, as it is sufficiently near to the proposed Aylestone tramway terminus, and easy of access from the main road. All these are questions which demand careful consideration in the preparation of the detailed scheme.

Cars.—We are in possession of much valuable information beyond the many particulars contained in this report in respect of the various kinds of electric cars in use in different towns, including their advantages and disadvantages, which will, we hope, be of much service when the time arrives for deciding this question. For the present, however, we may say that our views are in favour of the single-truck top-seated type, and we were much impressed with the Liverpool car, with its reversed staircase, spacious platforms, etc., and you will remember seeing several other admirable types of cars at the tramways exhibition in London. This is, however, a matter which does not demand any immediate decision, and may, therefore, be deferred for future consideration.

(To be continued.)

ELECTRICAL INSTALLATIONS.

An illustrated descriptive pamphlet of some electrical installations carried out by Messrs. Gilbert Gilkes and Co., Limited, of Kendal, has been forwarded to us. For many years the firm have been engaged in work in connection with the development of water power, and to this account is laid to a certain extent the greatly increased use of the electric current as a means of providing light and of transmitting power. Messrs. Gilkes, however, do not confine themselves solely to installations which are worked by water power, although it has in many cases been

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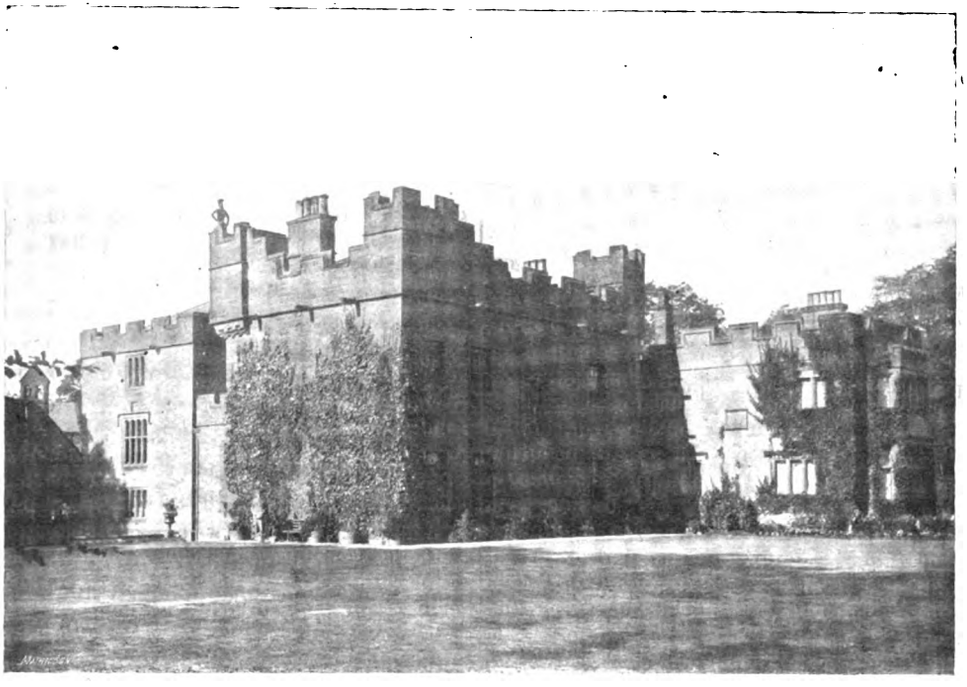
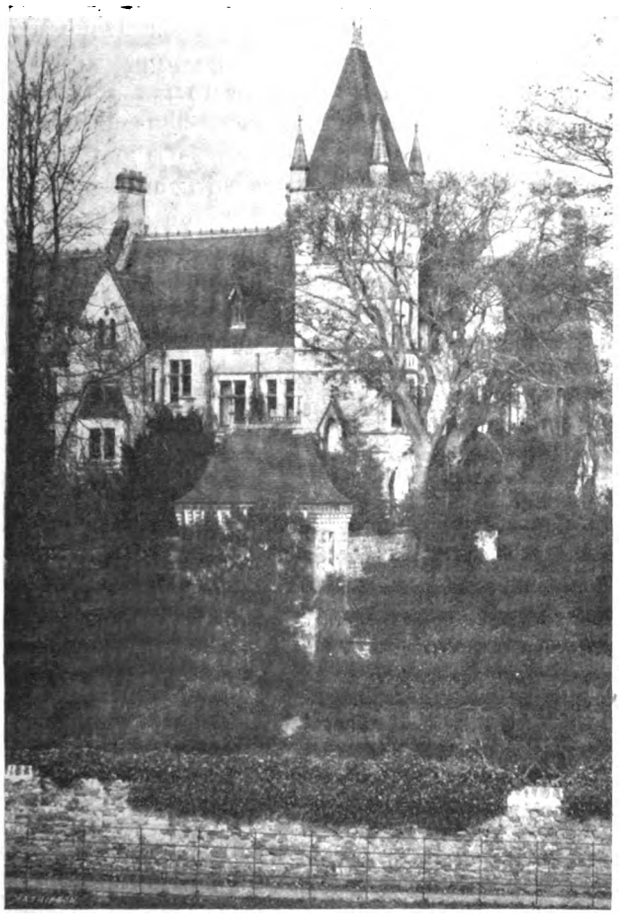
taken advantage of by them. In the pamphlet before us the installation of the country house is chiefly dealt with. Newbiggin Hall, in Westmoreland, of which we give a general view, is noticeable among the list of country mansions for the electric lighting of which this firm are responsible. About half a mile from the house traces of the old head-race of a small mill were found, which brought the water from an adjoining stream to a point at which a fall of about 16ft. could be obtained, but with the exception of the evidence of the earth-work in this head-race, all trace of the old mill had gone. Now a weir has been constructed, the head-race reinstated, and a little stone building has been built for a turbine and dynamo, from which the current is carried underground to a building close to the mansion where the energy is stored in a battery of accumulators. All the comfort of a good light is obtained without in anyway taking from the mediæval effect of this picturesque old house.



Newbiggin Hall—General View



Lunefield—General View.

The next illustration is a general view of Lunefield, now the home of the Countess of Bective. In 1894 this place was fitted with a complete electric installation of some 220 lights. In the village of Kirkby Lonsdale, in Westmoreland, about a quarter of a mile from the house, there is a stream of considerable volume, except in droughty weather, and falling 65ft. in a comparatively short distance. This stream is conveyed through 12in. pipes down to a sawmill, and drives a turbine of 15 h.p. which is fixed in the basement. This is connected with upper rooms which have been adapted to meet the requirements of a generating and storage station. The water supply has not been found sufficient in very dry weather, and a steam engine and boiler capable of supplementing it have been fixed, driving on to the line shaft from which the power is taken in either case to the dynamo. The battery-room is above the generating-room, and contains a battery with a capacity of 360 ampere-hours. An overhead cable slightly insulated, carried on large poles, conveys the current to the house, the line being protected from atmospheric effects by means of lightning arresters. Several cottages, as well as the stables, laundry, and buildings in connection with the home farm, are all supplied with current from the same source.

The above are two excellent instances of the utilisation of water power in the electric lighting of country houses. The firm have also carried out installations at numerous manufactories, among others the Netherfield Works (where the "K" boots are manufactured), Halton Mills, and the Ingleton Water-Power Electric Supply Works. In the case of this latter the result of the construction works has been to create an effective working head of 2ft. at the turbines. The provisions for generating electric current by means of water power at Ingleton are these: At a point about 300 yards up the stream, which flows through the village, a weir has been thrown across it. Near the right bank the weir has a sluice admitting to a 30in. wrought-iron pipe line, which follows for a short distance the course of the stream. The lower end of this pipe discharges into a wooden chute, by which the head-water is conveyed the remainder of the distance to the penstock above the power-house. Within the machinery-room are two "Vortex" turbines, each provided with a separate intake from the penstock and a separate draught-pipe leading to the tail-race. The turbines run on horizontal shafts, each developing from 15 h.p. to 18 h.p., according to the condition of the water supply at the time. Each turbine drives its own continuous-current dynamo by means of a belt. The dynamos are shunt wound to give either 45 amperes at 250 volts or 35 amperes at 330 volts, as required, for charging cells. A simple switchboard is erected near the centre of the room facing the dynamos, and is equipped with the necessary switches and instruments.

The large number of installations which Messrs. Gilbert Gilkes have carried out speaks well in favour of the possibilities in this direction.

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TO CORRESPONDENTS.

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PROPOSED RULES, ELECTRICAL TRADES UNION.

Elsewhere we give the text of a circular that has been circulated by the executive of the Electrical Trades Union amongst the employers in the London district. Although this circular deals with a restricted area, we do not for a moment suppose but that if success crowns the agitation within that area an attempt will be made to extend the area within which the rules hold. It may seem ludicrous to say at this point of the world's history that few men understand the economic laws which govern capital and labour. The misfortune is that proof to the individual at a given moment is impossible, because time is one of the factors in the matter, and results come slowly. Men who draw up circulars like the one referred to are absolutely ignorant of the first principles of economic laws, and they cannot be taught, because they refuse to learn. An autocratic chief in Central Africa is less autocratic than a trades union which interferes with the freedom of the individual. The fact that another man possesses capital is only indirectly of importance to another man; but what does concern the latter is the return for his own labour. That return is not illimitable, but is strictly limited; hence he ought not, or, rather, he cannot, obtain a result not warranted by the conditions of his labour, except by taking what neither the moral law nor the law of the nations considers his just property. The misfortune is that the men's representatives lead them to imagine quantity of labour to be a constant, and the results of labour to be infinitely elastic. Hence they restrict the hours of labour in order to employ more labourers, and endeavour to get a return for the labour that is impossible. This is wrong in theory and ruinous in practice. Labour properly applied creates labour. But we cannot here enter into a long explanation of economic fallacies. Our immediate object is to consider the terms of the circular issued, and it must be borne in mind that we have no objection to unions if legitimately conducted. Men are quite free to combine, and to combine for higher pay and lesser hours, provided they interfere in no way with the freedom of other men or masters. It is a very peculiar state of things that only in certain directions is an effort made to tar all with the same brush. Fancy sane men attempting to argue that all human workers are alike capable of doing just so much work, and incapable of working profitably more than a certain number of hours per week! The stroke set is now the stroke of the worst, and the best man is not permitted to benefit by his skill and knowledge. However, neither masters nor men will consider this question from any other than the personal point, and this resolves itself into a money question. What valid reason can be given for some of the rules suggested? Assume a young man of eighteen years patriotic enough to serve his country for seven years as a soldier. Why should he be debarred from learning this trade if he saw fit? Who is to decide upon the question of "absolute necessity" of work—the employer or the employed; and what is to happen if there is a

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difference of opinion? Who, in the latter case, is to send out to collect the "waifs and strays" of the union not in work; and pray what is to be done when the master says "urgent," and there happens to be insufficient room to employ more men? Up to the present time there has been little or no concerted action between employers, but the growing tendency of various unions to attempt to improve conditions which are really part and parcel of the employers' duties to determine, will bring about a confederacy of employers to ensure freedom of action and prevent undue interference. It is easy for a union to ruin a certain employer or employers, but that does not help the men in the long run. On the other hand, under ordinary conditions of fair competition no employer can be unduly hard upon his men, otherwise his men are free to distribute their services elsewhere.

FORTHCOMING EVENTS.

FRIDAY, FEB. 8.

Royal Institution of Great Britain.—At 9 p.m., discourse on "History and Progress of Aerial Locomotion," by Prof. G. H. Bryan.

Sanitary Institute.—At 7 p.m., "Meteorology," by Mr. W. Marriott.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, paper on "Electric Power Supply in the Metropolis," by Mr. Louis F. Awde.

Institution of Mechanical Engineers.—Extra meeting at 8 p.m., adjourned discussion on "Power—Gas and Large Gas Engines for Central Stations,' by Mr. Herbert A. Humphrey.

Physical Society.—At 5 p.m., Burlington House, annual general meeting; address by the President. Council meeting at 4.30 p.m.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Cycle Resistance," by Mr. H. E. Wimperis.

SATURDAY, FEB. 9.

Institution of Electrical Engineers (Students' Section).—Visit to the generating station and depôt of the Central London Railway, Shepherd's Bush.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. "Diatomite," by Mr. R. B. Stewart.

MONDAY, FEB. 11.

Society of Arts.—At 8 p.m., "The Bearings of Geometry on the Chemistry of Fermentation," by Mr. W. J. Pope" (Lecture I.).

TUESDAY, FEB. 12.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Adjourned discussion on "The Present Condition and Prospects of the Panama Canal Works," by Mr. J. T. Ford.

Royal Institution of Great Britain.—At 3 p.m., Prof. J. A. Ewing on "Practical Mechanics" (Lecture IV.).

Institution of Electrical Engineers (Manchester Section).—Ordinary meeting, at 7.30 p.m., "The Training of Electrical Engineers," by Dr. John T. Nicholson.

WEDNESDAY, FEB. 13.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the Victoria and Albert Museum, South Kensington.

Institution of Electrical Engineers.—At 7.30 p.m, students' meeting. Papers: "Electro-Chemistry at the Paris Exhibition," by Mr. M. Solomon; and "Accumulators at the Paris Exhibition," by Mr. J. H. West.—(Glasgow Section), ordinary meeting at 8 p.m.

THURSDAY, FEB. 14.

Institution of Electrical Engineers.—At 8 p.m., adjourned discussion on "Capacity in Alternate-Current Working," by Mr. W. M. Mordey.

FRIDAY, FEB. 15.

Royal Institution of Great Britain.—At 9 p.m., discourse on "Electric Waves," by the Right Rev. Monsignor Gerald Molloy, D.D., D.Sc.

SATURDAY, FEB. 16.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the Willesden generating station of the Metropolitan Electric Supply Company.

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., social meeting.

Incorporated Association of Municipal and County Engineers. Council meeting.

REVIEWS.

Fowler's Electrical Engineer's Year-Book for 1901. Published by the Scientific Publishing Company, 53, New Bailey street, Manchester. Price, 2s. 6d.

Following up the success scored by his "Mechanical Engineer's Pocket-Book," Mr. Wm. H. Fowler has now written and compiled a volume, the chief aims of which are to supply the scientific, practical, and commercial information which the electrical engineer requires in the course of his daily work. The value of this production as a handy book of reference of convenient size is undeniable, inasmuch as the information given throughout its 424 pages may be said to be thoroughly reliable and up to date. The science of electricity is fully and ably treated, special attention being directed to the subject of electric traction, which is now assuming such important features. The information contained in this part of the book is particularly interesting and instructive. The various systems of supplying current for traction purposes are considered by the author, and many illustrations accompany the descriptive matter. Valuable tabular information will be found at the end of the volume, and we consider it may confidently be relied upon in everyday practice.

THE LATE M. Z. GRAMME.

By the courtesy of Mr. H. Thompson Lyon we are enabled to give the accompanying portrait of the late

M. Z. Gramme, whose recent demise was recorded in our issue of Jan. 25 last.

WIGAN ELECTRICITY WORKS.

With respect to the description of the Wigan electric light and power works which appeared in our issue of Feb. 1, we have now received from Messrs. W. T. Glover and Co. more complete information in connection with the cables which they supplied. It will be remembered that all these cables were laid and jointed by the Corporation staff, so that the contractor simply supplied the materials, which were all tested by Mr. H. Collings Bishop before the cables, etc., left the makers works. The following lengths of the various classes mentioned were supplied: 8,000 yards of ·5 square inch diatrine paper low-tension concentric lead-covered cable, with 3mm. thickness of insulation and ·105in. thickness of lead on each conductor; 35,000 yards of ·2 square inch low-tension diatrine paper cable, lead-covered and double jute served, with a 2½mm. thickness of insulation and ·085in. thickness of lead; 17,500 yards of ·1 square inch single ditto, having a thickness of insulation of 2½mm., and a lead covering ·085in. thick;

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1,000 yards of seven-pair telephone cable with paper insulation (dry core) lead-covered, braided and served over all, each conductor being composed of No. 20 National wire; 1,000 yards of ·05 square inch diatrine twin house service cable, lead-covered and jute served over all, with a thickness of insulation on each conductor of 1½mm., and over conductor of 1mm., and a lead covering ·085in. thick; 3,000 yards of ·025 square inch ditto, with a thickness of lead of ·085in. and a diameter over lead of ·910in; 2,000 yards of ·0125 square inch ditto, with a thickness of lead of ·085in. and a diameter over lead of 800in.; 8,000 yards of three-core pilot cable, each conductor being composed of $^{7}/_{22}$ vulcanised insulation; 5,280 yards of ·3 square inch low-tension single diatrine paper cable lead covered and double jute served; 5 280 yards of $^{7}/_{20}$ low-tension single diatrine paper cable, lead-covered and braided over all; one mile of $^{7}/_{18}$ low-tension single diatrine paper cable, lead-covered and braided over all. The insulation resistance specified for the above cable was 2,000 megohms. Messrs. Glover and Co. also supplied three miles of two-pair telephone cable with diatrine paper insulation, lead-covered, braided, and served, to which a test pressure of 600 volts was applied for 15 minutes, the specified minimum resistance in this case being 50 megohms.

We have also received from Messrs G. and J. Weir more particulars of the three direct-acting feed pumps which were supplied by them for feeding the boilers, two of which are 7in. diameter by 21in. stroke, while the other is 5½in. diameter by 15in. stroke, all working at a pressure of 160lb per square inch, and when running at 12 double strokes per minute, deliver 4,000 gallons and 1,700 gallons of water per hour respectively. The steam admission valve on those pumps is so constructed that they may either use the steam expansively or not, according to the duty they may be performing for the time being, and as the change from the one condition to the other is effected by the simple movement of a spanner, it is an easy matter to adjust the amount of expansion to suit the working of the pump so that it will always run quietly and slow down at each end of the stroke. This action is not only conducive to economy of steam, but it enables the water-valves to close gradually without shock, and prevents that rapid wear and tear, breaking of joints, etc., inseparable from pumps which knock incessantly at each end of the stroke.

CATALOGUES.

We have received from the British Westinghouse Electric and Manufacturing Company, Limited, a copy of their circular No. 1,038, which describes the tramway motor of the firm's manufacture known as the No. 49 type. This motor was placed upon the market in 1897, and is claimed to have satisfactorily met the demand caused by the increasing practice of employing larger and heavier cars and higher speeds on city and suburban electric tramways. The company have taken a lead in the production of these circulars, which it would be difficult to beat. Both the descriptive matter and the illustrations contained in the publication under notice surpass in merit the contents of many text-books with which we are acquainted. Much information of a thoroughly practical and useful nature relating to the motor is given in this circular, a perusal of which is therefore to be recommended, especially having regard to the high standard of excellence to which the practice of the Westinghouse Electric Company, Limited, in electric traction work has attained.

Messrs. Korting Bros. send us a copy of their new descriptive catalogue of ejector condensers and spray cooling plant. This is also a well-executed production of its kind, and contains many dimensions, together with other particulars, relating to the firm's condensers, which it will be to the advantage of station engineers to have at hand.

From the Keighley Electrical Engineering Company, Limited, we have a catalogue which contains a quantity of useful information relating to their manufactures, besides prices, etc. Several types of dynamos and motors are illustrated, special attention being drawn to the firm's slow-speed, multipolar open-type motors. Mention may also be made of an electric hoist combination designed to meet the demand for a compact and simple electrically-driven hoist for use more particularly in private houses, flats, restaurants, offices, etc., where comparatively small weights are being constantly moved from floor to floor. Further space is devoted to switchboards, switchboard fittings, motor starters and regulators, house service fuse-boxes, junction boxes, lubricators, etc., at once showing the varied character of the company's productions.

Messrs. W. B. Haigh and Co., Limited, have sent us a copy of their latest catalogue of wood-working machinery and electrical appliances. A number of pages are devoted to the illustration and description of combined engine and dynamo sets of various types. A neat combination, suitable for a ship-lighting or small private plant, is shown on p. 10, being a vertical high-speed enclosed engine coupled direct to and mounted on a common bedplate with a compound undertype dynamo of the firm's make. One of the firm's type "E" enclosed motors is also illustrated, and seems, so far as we can judge, especially adapted, as claimed, for exposed positions.

ELECTRIC LIGHT IN NORTH LONDON.

Messrs. W. C. C. Hawtayne and Robert Hammond have reported to the Joint Committee of the Councils of Edmonton, Enfield, Southgate, Tottenham, and Wood Green on the scheme for the generation and distribution of electricity in those districts. We have received copies of the reports of these engineers, which we give in full. The first is that of Mr. Hawtayne:

Gentlemen,—In accordance with the instructions I have received from you at various meetings of the Joint Committee, and following out your request that I should consult with Mr. Robert Hammond before sending in my final report, I beg to inform you that I have with him considered most carefully the proposals for the establishment of electricity supply works for the districts of Edmonton, Enfield, Southgate, Tottenham, and Wood Green, under the control of a Joint Board appointed by the several districts named, and have the honour to report to you as follows:

On Nov. 9, the day following my appointment as your engineer, the plans of the whole district were put before me by Mr. Shelton and Mr. Eachus at the former's office in Tottenham, full information being given me as to the sites available for the necessary works. After carefully inspecting the plan and thereafter visiting certain sites in company with Mr. Shelton and Mr. Eachus, I came to the conclusion that the site, since selected, at Edmonton was the most suitable. It is excellently situated for a large undertaking of this nature, and its proximity to railway and canal will facilitate the delivery of materials both for construction and working, and will enable you to obtain the raw materials (coal and water) for the generation of electricity at favourable rates. The population of the whole district is approximately 250,000, and the assessable value approximately £1,000,000. The most densely populated portions are in the south—Tottenham and Wood Green—but the whole district is being rapidly built over, and offers an excellent field for the establishment of an undertaking of this nature. I have spent a considerable amount of time in going over the whole of the district accompanied by my assistants, in order to form an opinion as to the probable demand for electricity, and the result of my survey is the scheme now presented to you. In my estimates I have allowed for distributing mains throughout the principal streets where a demand for current may be expected from private consumers. Here I may explain that the standard electric incandescent lamps are of 8 c.p., 16 c.p., and 32 c.p., larger sizes being used in special cases, also arc lamps, heating apparatus, etc. It is convenient in dealing with a demand of this nature to reduce all to a common value, and the total private demand is generally reckoned in the equivalent of lamps of 8 c.p. I consider it quite safe to assume that the equivalent of from 100,000 to 110,000 such lamps will very shortly be connected to the private distributing mains provided. It is found in practice that not more than from one-third to one-half of the maximum possible private demand is ever made at one time. In this case I assume one-half—that is, the equivalent of from 50,000 to 55,000 lamps alight at one time. In addition to the demand by private consumers, I have allowed for the sale of electricity for public lighting; assuming that 500 arc lamps, or a proportionate number of smaller lamps, are erected in the five districts, one-half of these are taken as burning from dusk to midnight, and the remainder from dusk to dawn. In addition to the above I have provided 500 kw. of plant for power purposes throughout the district. I have not in the present estimate provided any plant for traction purposes, as the committee considered it better not to do so; but if terms can be made with the authorities controlling these undertakings in the district, additional generating plant can always be provided later, and the profits of the undertaking will naturally be increased.

Many local authorities and companies are now arranging to let out on hire motors, heating apparatus, etc., and to wire on a rental system the premises of consumers who do not care to

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face the initial capital expense of introducing electric lighting. I have therefore provided a sum of £25,000 for this purpose under the heading "Free Wiring." In considering the most suitable system of supply, regard must be had to the nature of the demand, the extent and future development of the district to be served. The most suitable system in my opinion is an alternating-current one, the electricity being generated at high pressure and conveyed to suitable positions in the area of supply, where it will be transformed to a low pressure for distribution to consumers. This system is equally suitable both for lighting and power purposes, and I have based my estimates on its adoption. The committee having, at a later meeting, decided that Mr. Robert Hammond should be asked to consider my report, with a view to supporting the Bill, I placed myself in communication with him. In the first place I had prepared a scheme as described above on what is technically known as the two-phase system, but after several conferences with Mr. Hammond I prepared further estimates for a three-phase system, with the result that I am in agreement with him as to the adoption of such a system for the undertaking. I have also discussed with Mr. Hammond my estimates of capital expenditure, revenue, works cost, etc., and the figures I now present to you are the outcome of the conferences we have had together. I am still of opinion that the item for buildings under capital expenditure can be considerably reduced, and I am also of opinion that the estimated expenditure of £22,025 on the output of 3,524,400 units is too liberal. I should expect to reduce this by approximately £2,000 per annum, increasing the net profit by a corresponding amount. I am for the present accepting Mr. Hammond's figures for these items. I now set out the estimates referred to:

CAPITAL EXPENDITURE.

Generating station buildings, shaft, etc., coal and ash conveying plant, etc., and purchase of site	£38,000
Generating plant	84,740
Mains, high-tension feeders, low-tension distributors, transformers, and sub-stations	109,260
Public street-lighting	25,000
House services and meters	40,000
Free wiring	25 000
Legal, expert, and engineering fees and contingencies	23,000
	£345,000

FINANCIAL RESULTS.	Kilowatts.
Plant capacity	4,000
Less reserve	1 000
	3 000
Loss in distribution	600
	2,400

To be utilised as follows:	Kilowatts.
Public lighting—500 arcs maximum load or equivalent	310
Private demand	1,590
Power along canal and generally throughout district	500
	2,400

REVENUE FOR 3,524,400 UNITS.

Public Lighting.

842,400 units at 2d.	£7,020

Private Demand, 1,590 kw.

Say, private lighting 53,000 lamps all burning at one time (106 000 connected), requiring 1,590 kw.

1,590 kw. for 400 hours at 7d. = 636 000 units at 7d.	18 550
1,590 kw. for 600 hours at 2d. = 954,000 units at 2d.	7,950

Electric Power.

700 kw. installed, with a maximum load of 500 kw. 500 kw. with 25 per cent. load factor = 1,092,000 units at 2d.	9,110

Free Wiring.

10 per cent. on £25,000	2,500

Meter Rentals

4,250 at 6s.	1,275
Total	£46,405

EXPENDITURE.

The total cost of producing the before-mentioned 3,524,400 units should not exceed 1·5d. per unit, including management expenses and ample allowance for maintenance and repairs on buildings, plant and mains, etc. The total annual expenditure will thus amount to	£22,027

SUMMARY.

Revenue (as above)	£46 405
Expenditure (as above)	22,027
	£24,378
Interest and redemption at 5¼ per cent. on £345,000	£18,112
Margin to the good	£6,266

The broad principles of the scheme, the figures of which are before you, have been so often discussed at the meetings of the Joint Committee that it is not necessary to say anything further in this respect with regard to the profitable nature of the undertaking or its future development. The committee has been approached by those who are willing to furnish a supply "in bulk," leaving the councils to distribute to the consumer, those making the offer claiming that they are able to supply at a low figure on account of the large amount of electricity generated. The scheme now before you is also for generating on a large scale and for distributing by a joint staff, and therefore carries the principle of combination right through. A sum of £400,000 is included in the Bill as the cost of the undertaking. The present scheme allows for an expenditure of £345,000, and the margin between the two figures is sufficient to provide for extensions to the private lighting mains, or for the public lighting of the whole of the district, and for extensions of the generating works. It must not be supposed that the Joint Committee will require to raise the whole of this sum to commence with. The works will take some time to construct, and the greater part of the capital will not be expended till the works are nearly in a position to commence supply.

From my experience of what has taken place in other districts, I should expect that by the time the works are finished a large number of consumers will be ready for a supply, and that a gross profit should be made practically from the commencement. The Bill provides that only interest on the capital expended should be paid for the first three years, the repayment of principal being left over till that period has elapsed. The value of such an arrangement is that the large contribution to sinking fund which has to be provided by local authorities, and which in the first year or two of many undertakings has turned a gross profit into an apparent deficit, will not have to be considered by the Joint Committee, who can, in my opinion, embark on this undertaking with every confidence in its future success, and secure for the ratepayers of the five districts the profits that may well be expected from the sale of electricity for all purposes. I shall be pleased to go through this report with the Joint Committee, and explain any points which may not be quite clear.—I am, gentlemen, your obedient servant,

Jan. 18, 1901. (Signed) W. C. C. HAWTAYNE.

The following is the report submitted by Mr. Hammond:

Gentlemen,—The report of your engineer, Mr. W. C. C. Hawtayne, dated the 18th inst., submitting the scheme and estimates of the proposed electricity supply undertaking for the districts under the jurisdiction of the above-named Councils, has had my careful consideration, and I beg to certify that it fully embodies the result of our various conferences. The method proposed to be adopted for the generation and distribution of the electrical energy is, in my opinion, well suited to the requirements of the district, and after closely working out the estimates of the capital expenditure I am convinced that the amount of £345,000 is adequate to establish the undertaking on the lines recommended. With regard to the annual costs, exclusive of interest and sinking fund charges, I feel that on the basis of an output of 3½ million units per annum, and upon the load-factor forecast by your engineer, you may safely rely upon getting your costs as low as 1½d. per unit. The revenue, based on your engineer's estimate of the probable demand likely to arise in the district, has been calculated on reasonable rates of charge, the average price under the scheme for electric lighting and electric power, exclusive of the public lighting, working out at 3·19d. per unit, which is far below the average charged throughout the United Kingdom. The 2d. per unit for public lighting is, I believe, the same figure as that at which offers have been made by a company proposing to supply in your district. On the points referred to by your engineer on which I am inclined to take a less optimistic view than he, I deem it prudent to adhere to the figures set out in the report. If in actual practical an improvement on them is shown, so much the better for the scheme. With regard to the extent to which the demand for electric lighting and electric power is likely to prevail, I understand that the estimated demand of from 100,000 to 110,000 lamps has been fixed upon, after a careful survey of the whole of the district, and I think you may safely rely upon that demand being made within a reasonable period. Of course you will understand that during the early stages, whilst the business is being founded, the smaller output will not return the same ratio of profit as is shown in your engineer's estimates of the financial results that will be obtained when the undertaking is a going concern, and when the whole of the £345,000 shall have been expended. Before that amount has been spent, however, the supply of current will have commenced, and judging from the experience of other places, the revenue will soon show a surplus over working charges. In your case the Bill relieves you from providing during the first three years any instalments for the sinking

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fund, and I am of opinion, therefore, that the amount of any charge upon the rates will be small and cannot extend over more than a very limited period, after which there will have been secured to the ratepayers of the district an undertaking which is certain to prove a valuable asset.—I am, gentlemen, yours obediently, (Signed) ROBERT HAMMOND.

Jan. 21, 1901.

A meeting in opposition to the scheme was held at Tottenham on Thursday night last week, Mr. Pearce presiding.

Mr. OFFOR spoke for an hour and a half as a representative of the company. He said the terms proposed by the company to the District Councils were to supply electricity for private consumption at 3½d. per unit, and public lighting at 2d. per unit. Those terms were still available. On June 29, 1899, the company gave notice to the Councils of their intention to apply to the Board of Trade for a provisional order, and at the same time forwarded another copy of their proposals as the basis upon which they would work that order. The terms were two years' notice to purchase at the end of 12 years, the value to be based upon the profits of the year in which the Councils desired to take over the concern. Last year the company adopted a system of long-distance transmission which had never before been attempted in this country, and a company was formed for the purpose of establishing works over the large area in the northern suburbs. If the company secured a provisional order to make and supply electric light, they would act strictly in accordance with the terms of that order, but not so with the promoters of the Councils' Bill. He quoted a number of clauses which the Councils in their Bill sought exemption with a view to showing that they desired to shirk many of the obligations imposed on them by an order. Electricity was not an article in universal demand, and if there were only one-tenth of the ratepayers going to use it, it was scarcely a sound business principle to ask the remaining nine-tenths to pay for it. The mere electric light business was not a paying business, because the hours of demand were very short; but with the tramway supply, and the supply of power to factories, the hours were far longer, and helped to make that undertaking profitable.

Mr. Offor having answered numerous questions, a resolution protesting against the Council's action was proposed by Mr. BRENT, and seconded by Mr. SNELLING. A number of votes were recorded in favour, but in the noise and confusion that ensued nobody seemed to be aware that contrary votes had been asked.

A public meeting of ratepayers of Enfield Highway took place on Monday night at the Assembly Hall for the purpose of confirming the action of the Enfield District Council in combining with the District Councils of Edmonton, Tottenham, Southgate, and Wood Green in promoting the Bill. Councillor David Weston presided, and was supported by the most prominent members of the Enfield District Council. Mr. W. C. C. Hawtayne was present.

Speeches having been delivered by the Chairman and Mr. Hugh Trenchard,

Mr. HAWTAYNE made a long speech. Taking first the Councils' joint scheme, he remarked that they had heard a good deal of talk about the supply of electricity in bulk, and the District Councils taking that and distributing it to consumers. Suggestions had been put forward that the supply in that way would come cheaper to the consumer. The North Metropolitan Company already had a Bill through Parliament in which they had power to charge 4d. and 2d. per unit respectively as the maximum, and that maximum they could hold to until they wished to pay more than 8 per cent. dividend. Before they could supply at 4d. they had to consider the cost of the buildings, generating plant, etc. In the present scheme the land and buildings would cost £38 000, £84,740 for plant, and distribution would cost £199,260, or a proportion of 11·1 per cent. for land and buildings, 24·4 per cent. for plant, and 57·9 for distribution. How did it compare with what had taken place elsewhere? Take Croydon, where electric lighting was entered upon with fear and trembling. There a company started and made certain terms with the Corporation, amongst them one allowing the latter to buy within 10 years by paying a premium. Inside a year the Corporation paid the fine, and bought it back into their own hands, the capital outlay being 40 per cent. on mains and 54 per cent. for plant and buildings. At Ealing the cost for plant and buildings was 43 per cent., and for mains 52·5 per cent. In 1896 companies had £5,831,000 invested in electric light works. In the same year local authorities had £500.000, whereas in 1899 companies' capital rose to £9,265,000 and local authorities' to £13,776.000. In 1897 companies in London were asked to supply 1,682.000 lamps, local authorities 149.000, and in 1900 companies 3,040,000 and local authorities 473,000. The North Metropolitan Company, with the same set of directors, called themselves at Durham the Durham Power Distribution Company, at Kent under the name of the County of Kent Company, at Surrey under the name of the Surrey Company, at Sussex under the name of the Sussex Company, and so on. He had read the speech made by Mr. Offor to an opposition meeting at Edmonton, and all he could say was that there was very little in it. Mr. Offor had quoted a number of clauses which he said the Councils in their Bill sought exemption with a view to showing that they desired to shirk many of the obligations imposed on them by an order. While this and other Bills were going through he (Mr. Hawtayne) was asked to go into the matter for some of the councils. He could tell them the clauses that the North Metropolitan Company tried to shirk—well, numberless was not the word. Mr. Offor had quoted a number of towns where electricity was said to be a failure. He had compared those statistics with the Board of Trade returns, and had found, with the exception of two, that all had made profits. The scheme was a pretty liberal one, and it dealt very liberally with Enfield, and mains could be carried almost broadcast all over the district.

Mr. E. J. BETTS moved a resolution to the effect that that meeting recommended the parishioners to vote for the Council's scheme at the ensuing poll.

Mr. CHAPLIN seconded with a few remarks.

The resolution was put and carried unanimously.

A statement on behalf of the District Councils promoting the Bill has been issued, in which it is stated that the committee are proceeding generally on the following basis: (1) that electrical energy could be produced more economically by the five districts in combination than by each of the districts acting separately, and that the system could be worked as a whole more efficiently and at less cost by one staff than by five; (2) that the electrical energy required for the service of the five districts could be provided by the local authorities more economically than by any company, because the undertaking in the hands of the local authorities must be administered solely with a view to the public advantage of the consumers and the ratepayers by whom the local authorities are elected, whilst it must properly be the primary duty of the directors of a company to consider, in the first instance, the pecuniary interests of the shareholders; because any margin of profit which otherwise would go to shareholders of the company can be applied under the local authorities' scheme for the benefit of the ratepayers; because money required for capital expenditure can be raised at a less rate of interest by the local authorities than would be required if it were raised in the form of shares or stock of a company; because, speaking generally, experience shows that similar undertakings can be and are successfully managed by local authorities.

APPOINTMENTS VACANT.

Electrical Engineer, Lincoln Corporation, £300 per annum.

Assistant Electrical Engineer, Cape Town, South Africa, £20 per month. Full particulars in our advertisement columns.

Traveller, large electrical accessories supply house. Full particulars in our advertisement columns.

Manager, electric lamp business. Full particulars in our advertisement columns.

Traffic Assistant, electric lighting and tramways department, East Ham Urban District Council, £150 per annum, Feb. 14.

Outdoor Assistants, East Ham District Council, £150 per annum, Feb. 10. Full particulars in our advertisement columns.

Shift Engineer, Dundee Corporation, lighting and traction department, £2. 5s. per week, Feb. 20. Full particulars in our advertisement columns.

Cable Jointer, Leith Corporation, paper cables and plumb joints, 35s. per week. Full particulars in our advertisement columns.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as

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to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

349. What is the method of calculating the sizes of cables and mains for two-phase and three-phase currents?—E. M. R.

350. Would the combined efficiency of a continuous-current steam generating set be the same whether the plant consists of a single generator coupled to an engine, or whether, in the place of the former, two machines each of half the capacity were adopted?—W. M.

ANSWERS.

Question No. 342.—What is the most effective method of taking weekly rough test for insulation resistance on three-wire continuous concentric cables with the neutral wire earthed at station end, and with current always on the mains? And, again, what is the effect, and the best method of procedure, in the event of a permanent short-circuit developing on the above mains—firstly, with motor balancer running for balancing purposes; and, secondly, with cells in use for balancing, the machines running on the outers being provided with minimum cut-outs only? Also state what difference of pressure this short-circuit would make on the lamp circuits on each side of the system.

Answer to No. 342 (*awarded* 7*s.* 6*d.*).—In cases where the middle wire of a three-wire system is earthed at the station end, the following test will be found very useful in obtaining the insulation resistance of the network during working. In the diagram, A is a low-resistance

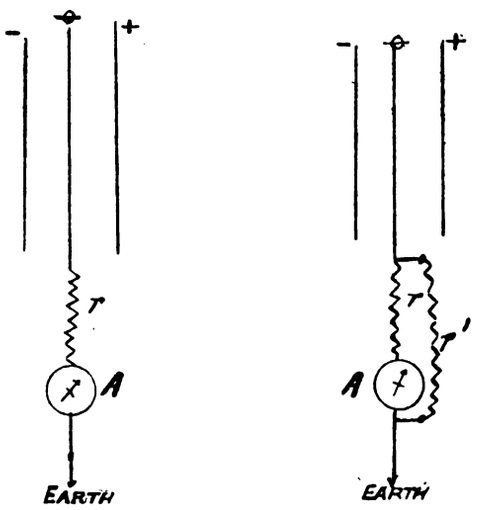

FIG. 1.

ammeter, connected through a resistance, r, to the middle-wire 'bus bar and earth. A deflection, d^1, is obtained when this latter connection is made, which should be carefully noted down. The instrument should now be shunted with a resistance, r^1, equal to r plus the resistance of the ammeter, A, and reading d^2 is taken. The insulation resistance of the network is derived from the formula

$$F = \frac{d^1 - d^2}{2\,d^2 - d^1}\, r^1 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this test r should be about the same value as the fault resistance of the network to be tested.

In Fig. 2 a diagram is given showing an arrangement for making the above test without breaking the neutral wire connection from earth. P is a three-way plug, numbered 1, 2, 3. Block No. 2 is connected to the neutral or third-wire 'bus bar through a fuse, f. The rest of the diagram should be easily understood, and it will be seen that the earth connection need not be broken, the plug being replaced between 1 and 2 and left so after the test. The ammeter, A, should be one giving readings to either side of the zero line, so that by suitably noting the deflections the faulty main can be discovered, except in such cases as when the insulated resistance of positive and negative mains are about equal, when no current would flow through the instrument, so that while the ammeter indicates no fault, yet there may be a relatively large one on both the outers. In the event of a fault occurring on the neutral, the readings of the ammeter would only be seriously affected when the fault was a very bad one. In the event of a fault occurring on the positive side such as to nearly balance the fault on the negative side, a very simple way of getting over the difficulty is to destroy the balance by putting on an artificial fault, either on the positive or negative main. The calculation is then made by formula (1), whence the true insulation becomes

$$\frac{1}{F} = \frac{1}{F^1} - \frac{1}{f} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where f is the resistance of the artificial fault.

In dealing with the remaining part of this question, it may be said that the effect upon the pressure and supply general will depend somewhat upon the nature of the short-circuit and the method adopted in the laying and connecting of the mains. Assuming the short occurs in a distributor of the triple-concentric type between one of the outers and the neutral the result may be serious, especially if the resistance of the fault be very low, causing a heavy current to flow to that portion of the network. The action of the balancer under these conditions would not require any great amount of thinking about, for, owing to the short being on the one side of the system, the machine connected to that side to maintain the balance would, when the short occurred, have a very great demand for current, with the result that the engineer would see the balancer fuse blow between the neutral wire. Owing to the large copper drop in the middle wire, it will be seen that the volts on that side of the network must drop considerably, while the pressure on the other side would rise to a high value unless the balancer is capable of dealing with the large out-of-balance current, which is very unlikely. If a battery were used in conjunction with

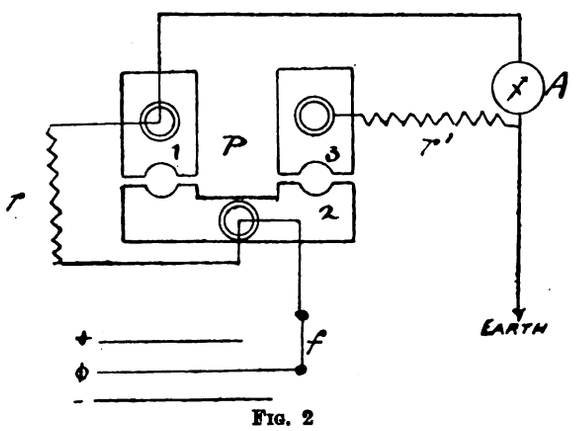

FIG. 2

the balancer, the action of the former would be that of helping the balancer to deal with the extra current, so that we might expect a relatively larger current to flow from the cells on the one side, and a correspondingly heavy charging current through the other half of the battery. If, owing to the extra demand upon the balancer, the fuses blew this cutting out, the machine then balancing, the greater part of main generator voltages would be on the lamps near the fault, so that either the service fuses go or the lamps burst. In any case, the consumer's fuses round about the position of the fault would be sure to blow, and the ringing of the telephone bell would be resorted to by the enraged consumer, from whom a very good idea as to the position of the fault may be obtained.

In networks so arranged that each section is coupled to the other by a fuse, the heavy current rush would, of course, blow such fuses, and so possibly isolate the faulty section, which would lead to its discovery. It will be clear, from what has already been said, what the effect on the battery would be, since the greater part of the short-circuit current must flow through the other half of the battery, when the latter was in circuit alone and no balancer. The drop or difference in pressure may be in some parts of the system as high as 50 volts.

In the event of the short-circuit occurring between the outers, the drop in pressure would, of course, be more equal over the whole network, and the greater part of the work would come upon the main dynamos, and the fault should be fed until it either burns out or is localised. If

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the fault be in one of the feeders, a glance at the ammeters will give a good idea as to one that is shorted. It is not always wise to try and burn out the fault, as some individuals do, owing to the great strain upon the mains when the current is heavy, which would probably do more harm than good; so that it may be necessary to shut down for a short time if the fault be serious, and the section found and isolated as quickly as possible. In most modern stations the arrangement of mains has been carefully designed with these troubles in view, whereas the older systems were so intercoupled that the hack-saw had to play an important part before the mains could be split up to isolate a section.—A. H.

Answer to No. 342 (*awarded* 7*s.* 6*d.*).—The total insulation resistance of a network may be determined from readings taken with a voltmeter of known resistance, the instrument being connected first between either outer main and earth, and then between either outer and the neutral wire.

Let V_2 = P.D. measured between + main and earth;
V_0 = " " " − " "
E_2 = " " " + " neutral;
E_1 = " " " − " "
r_2, r_1, r_0 = insulation resistance of + neutral and − conductors respectively;
G = resistance of voltmeter;
F = combined fault resistance of the three mains.

Then $$\frac{V_2}{r_2}+\frac{V_2}{G}+\frac{V_2-E_2}{r_1}+\frac{V_2-E_2-E_1}{r_0}=0;$$

or, $$V_2\left(\frac{1}{F}+\frac{1}{G}\right)-\frac{E_2}{r_1}-\frac{E_2+E_1}{r_0}=0 \quad . \quad . \quad . \quad (1)$$

Similarly, $$\frac{V_0}{r_0}+\frac{V_0}{G}+\frac{V_0+E_1}{r_1}+\frac{V_0+E_2+E_1}{r_0}=0,$$

or, $$V_0\left(\frac{1}{F}+\frac{1}{G}\right)+\frac{E_1}{r_1}+\frac{E_2+E_1}{r_2}=0 \quad . \quad . \quad (2)$$

Combining (1) and (2), we have

$$(V_2-V_0)\left(\frac{1}{F}+\frac{1}{G}\right)-\frac{E_2+E_1}{F}=0,$$

whence $$F=G\left\{\frac{E_2+E_1-(V_2-V_0)}{V_2-V_0}\right\} \quad . \quad . \quad . \quad (3)$$

As the potential of V_0 is negative, V_2-V_0 will be the sum of the voltmeter readings without regard to sign.

In order to get an idea of condition of the mains the usual practice is to remove the earth connection on the neutral and connect first + and then − main to earth (through a resistance if necessary), and read the values of the resulting earth currents on a suitable ammeter. The value obtained when the + main is earthed may be taken as inversely proportional to the combined I.R.E. of the − and neutral mains.

With regard to the best method of procedure when a permanent short-circuit developes, the question does not state whether the short is from + to ±, − to ±, or + to −. In the latter case the short will not affect the balancing of the system. If the motor balancer consists of two similar machines connected one across each side of the system, and mechanically coupled together with fields "crossed," the only result will be that it will probably run somewhat slower. If cells joined across the outers are in use, balancing by varying the position of the middle-wire contact, the battery unless properly fused would probably be ruined, as the sudden drop in voltage of the generating plant will draw an abnormal current from the battery. If the short-circuit occurs between either outer and the middle wire, the effect, however, is very different. With a balancer as above described the machine whose armature is connected to the faulty side of network will be instantly overloaded, and if not protected by mechanical cut-outs or fuses will probably be burnt out. The effect on the cells would be similar, those cells on the faulty side being greatly overloaded. This is due to the large out of balance caused by a "dead short" on one side of the network. The actual difference of pressure produced will depend on the magnitude of the out-of-balance or fault current, which again depends on the resistance of the short-circuit itself and the mains between the generators and the short, and more especially on the resistance of ± conductors between the station and the fault. If the neutral is the same size as the outers, the pressure on the faulty side will be one-third that on the other side. As the neutral is generally about one-fifth to half the size of the outers, the out of balance will probably exceed the above figure. If the short-circuit is not of exceedingly low resistance, the best procedure will be to reduce the total pressure until the high side is at normal voltage. Then, provided the feeder and distributor neutrals are large enough, machines might be coupled up to the faulty side to supply the out-of-balance current at normal pressure.

In the case of a very serious short developing on one side of the system, the only safe plan is to shut down the faulty side till the faulty section can be cut out. If, however, the network is suitably fused to the capacity of the feeders and distributors, the fault can be removed by supplying sufficient current to blow the fuses near the fault, thus interrupting supply to a comparatively small portion of the network. To assist in effecting this, the feeder nearest to the short could be disconnected, thus causing a rush of current into the faulty district, blowing the distributor fuses and isolating the section. The above question opens up very large issues, and it is quite impossible to state the best method of procedure without knowing more of the design and arrangement of the plant and mains, but the above will indicate the lines on which action should be taken.

It should be noticed that the capacity for damage at the moment of a sudden short depends largely on the capacity of the dynamos in use at the time, and also on the way the fields are excited. With shunt machines excited separately, the power they will give out is only limited by the capacity of the engine to supply the necessary torque and the capability of the armature conductors to carry the excessive currents.—E. M.

Question No. 343.—In stations supplying energy on the three-wire system with 400 to 500 volts between the outers, the Board of Trade require the neutral wire to be earthed at the station. What are the advantages and what are th dangers of such a proceeding

Best Answer to No. 343 (*awarded* 10*s.*).—The chief advantage in earthing the neutral wire of a three-wire system is that it makes it impossible to receive a shock of, say, 500 volts, unless the two outers are touched simultaneously. For example: a person making contact with the earth when touching the neutral wire does not receive a shock because the neutral is also earthed, and when making contact with either of the outers it will be obvious that he will receive a shock of only half the voltage of the outers, or 250 volts. Next, take the case of the neutral *not earthed*, and assume an earth develops on one of the outers on any part of the system. Under these conditions, a person making contact with the neutral wire would receive a 250-volt shock, and by touching the opposite outer would receive a 500-volt shock; this, of course, assuming he was making contact with earth at the same time. A 500-volt shock is more than unpleasant, and, as recent occurrences have shown, if received under some conditions may even prove fatal. The importance of protecting the general public from such occurrences will be obvious.

Another advantage of earthing the neutral wire is that it helps to keep the system free from faults by cutting them out when they attain a certain magnitude. Take, for instance a fault developing on one of the outers, either on a consumer's premises or on the mains. As soon as the resistance of the fault becomes low enough to allow the necessary current to pass, the fuse protecting that part of the circuit blows and cuts the fault out; thus the position of the fault is at once detected, and must be repaired before put into circuit again. Under these conditions it is rarely a 500-volt short-circuit occurs, it being unlikely faults would develop on both the outers at the same time. It will be seen, then, the two principal advantages of earthing the neutral wire are (1) the prevention of 500-volt shocks and short-circuits, and (2) the detecting and cutting out of faults, thus reducing leakage to a minimum.

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The disadvantages of such a system are (1) that meters require to be specially connected up; (2) that there are dangers from electrolysis. The first of these troubles—viz, meters having to be specially connected up—may be easily overcome with care. The two diagrams will show the two methods of connecting meters to the mains. Fig. 1 is where the series coil of the meter is on the neutral wire. It will be seen that if an earth comes on, on the consumer's side of the meter on the neutral main, another conducting path will be formed, and only a portion of the current will pass through the meter, the amount depending on the resistance of the line and the resistance of the fault through to earth. Fig. 2 is where the series coil of the meter is on the outer. It will be seen that if an earth occurs, as before, on the consumer's side of the meter, on the neutral main, it will not affect the meter, as the total current must still flow through the outer. This is an important matter, as if the meter is connected as shown in Fig. 1, a consumer may not be paying for the whole of the

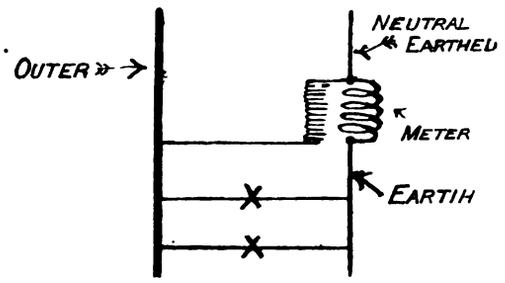

FIG. 1.

energy consumed; further, if an unscrupulous person became aware of this fact, he could make a good earth connection on the neutral side of his circuit, and leave the neutral switch off altogether. This could prove an easy way of robbing the electricity supply company, and might only with difficulty be detected. The most important danger is the second—viz., electrolysis. When a consumer's insulation resistance is low, also that of the mains, the current escapes to earth through gas or water mains or any other conducting medium. In a large town where there is an extensive system of mains, and a large number of consumers, the leakage current will probably amount to

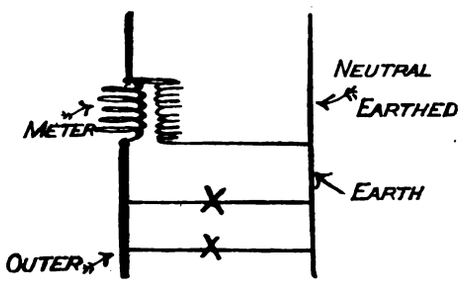

FIG. 2.

a number of amperes. Now, though this may be, comparatively, a small current, it must have a tendency through electrolytic action to eat away the pipes in private houses and the mains in the streets, with the well-known results.

The best arrangement for earthing the neutral wire is through a Kelvin or other earth recording ammeter. It should be arranged that, when a prearranged maximum current flows, the ammeter is automatically cut out and a high resistance cut in, which still leaves the neutral earthed, but prevents a heavy current from passing. This is valuable also inasmuch as it prevents a large current passing through a low-resistance earth, which, though too high to allow a "dead short," will be low enough to allow a current to pass which would heat it and possibly cause fire. As far as present experience goes, however, the advantages of earthing the neutral wire far outweigh its disadvantages.—E. T. W.

Answer to No. 343 *(awarded* 5*s.).*—The object of a three-wire system is to greatly increase the range of low-tension distribution. The Board of Trade limit the pressure between any two conductors to 250 volts, therefore to obtain the full advantage of a three-wire system to conform to the Board of Trade regulations the inner is earthed, and a difference of potential up to 500 volts maintained across the outers. The Board of Trade allow in special cases, as for motors, etc, the use of 500 volts on a consumer's premises. The question resolves into which is the better plan: the middle wire to be permanently earthed, or arranged so that it can be removed at will. The potential of earth is generally taken as zero, but this is not so, as a difference of potential often exists between two points of the earth's surface; for this reason only one earth is allowed, and that at the generating station. When we earth the inner, the negative cable will be at a lower potential than earth, and it is known that the negative always tends to assume earth potential, due to a phenomenon called "osmosis," whereby moisture tends to creep from the positive to the negative pole, so when we earth the inner the danger is increased. This phenomenon ("osmosis") was the constant source of breakdown when rubber cables were used for low-tension distribution with the inner earthed, as a leak caused water to get through the pores in the rubber insulation, and the conductivity of the leak gradually increased, until the whole of the rubber on the negative was completely destroyed. If one outer gets to earth and the earth at the station is permanently connected, it will seriously damage the cable; the pressure on the other side of the system will be greatly increased, causing considerable damage to consumers' lamps, etc. For this reason no three-wire systems of wiring should be allowed; by only having two-wire installations this danger is materially decreased. The location of faults is more easily accomplished by means of a movable earth than with a permanent earth; with the latter there is more danger of a complete breakdown. The great objection to earthing the inner in any manner is the danger of electrolysis chiefly to water-pipes and the danger of fire often caused by contact with a gas-pipe. To guard against these, motor frames, radiators, etc., should have an efficient earth connection. No arc-lamp covers should be allowed to get "alive"; no concentric system or any earthed system of wiring should be allowed. To conclude, the removable earth connection has all the qualities of a permanent earth, in addition to which there is simplicity in detecting faults both on the inner and outers. It seems to me that if the Board of Trade changed their regulation from a permanent earth to a removable one, this regulation would be improved.—W. A. J.

Answer to No. 343 *(awarded* 5*s.).*—In stations supplying energy on the three-wire system the chief object of earthing the middle wire is to enable a consumer to be supplied at such a pressure that no one of the conductors brought into his premises will exceed the pressure defined by the Board of Trade to be low pressure. Much difference of opinion exists as to the advisability of *permanently* earthing the middle wire. Now, the question asks what are the advantages and dangers of such a proceeding?

The chief advantages are the following: (1) the extreme difference of pressure that can be attained by any one of the conductors from earth is halved, and can, therefore, be handled with great safety; (2) the stress on the insulation is halved; (3) all three conductors may be taken into a consumer's premises up to and including 500 volts across the outers, without contravention of the regulations laid down by the Board of Trade; (4) immediate notice of a leak on one of the outer conductors is given.

The dangers of *permanently* earthing the middle conductor are: (1) if a leak exists on one conductor, current is continually forced through it, thus causing in many cases complete destruction of the insulating material; (2) a leak on one conductor produces a short-circuit on one side of the system of distribution (unless the earth connection is removable at will). As a set-off against these dangers it must not be forgotten that the first consideration is continuity of supply, and if a leak developing on one conductor causes a short-circuit, the chances of interruption are increased manifold beyond what they would be if the earth connection could be removed until the fault had been localised and repaired. It is quite clear that the chances of a leak occurring on one conductor are many times greater than those of two leaks occurring on two

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separate conductors simultaneously. It may be argued that if the earth connection is liable to be removed, all the advantages of making it *permanent* are done away with, since the distribution of pressure will alter when it is cut off. To some extent this is true, but it must be remembered that connection would only need to be removed for short periods and at long intervals. The advantages of introducing resistance in circuit with the earthed end of the middle wire in order to prevent a dead short-circuit would be a point in favour of the above proceeding, and, therefore, in practice but little risk would arise.—A. H. M.

Question No. 344.—State whether there is any preference between three-core or triple-concentric cable for underground three-phase distribution. Give reason for reply.

Answer to No. 344 (*awarded* 10*s.*). — There are two headings under which we may consider this question: (1) when the cable is being used as feeders; (2) distributors.

(1) For feeders there is nothing much between the two systems. Three-core or "clover leaf" cable is more expensive than triple-concentric, but this advantage is balanced by the cost of joint-boxes and jointing, as these items are much simpler with three-core than with triple-concentric. This also applies to both systems when used as distributors.

(2) The primary advantage of three-core over triple-concentric for distributors is that by using a split box it is not necessary to cut the cable to make a service connection. This is of very great importance, as the conductivity of the cable is very seriously reduced by this continual cutting; also with alternating currents there is a certain amount of vibration, which tends to loosen screws in service boxes, and as concentric cables have more of these than three-core, the risk is, therefore, greater. A service on a three-core is much easier to make than the same on a triple-concentric, a service box on three-core costing from £1 to £1. 10*s.*, this amount being about doubled for triple-concentric. The labour also being less, the approximate saving on a three-core service is about £1 to £1. 5*s*. Even when a split box is used, it is always necessary with a triple-concentric cable to cut one at least of the cables at every service for lighting and two for motors.

The conclusions to be drawn from the above are that for mains there is not much between the two systems, but for distributors three-core is much better.—W. A. J.

LEGAL INTELLIGENCE.

BRITISH MOTOR TRACTION.

In the Chancery Division, before Mr. Justice Buckley, on Friday last, the case of the British Motor Traction Company, Limited, and the British Motor Company, Limited, *v.* the Century Engineering and Motor Company, Limited, came up for hearing.

Mr. A. J. Walter, for the plaintiffs, stated that, by consent, the parties would take an order restraining the defendants from infringing plaintiffs' patent, together with an agreed sum for damages.

In the action of the British Motor Traction Company, Limited, *v.* London Autocar Company, Limited, Mr. A. J. Walter stated that the parties had agreed to treat the motion to restrain infringement as the trial during the continuance of the plaintiffs' letters patent, and that there should be an enquiry as to damages, with delivery up of the infringing articles and payment by defendants of the plaintiffs' costs.

His Lordship assented.—*Financial Times.*

PIRIE v. THE ELECTRIC CHEMICAL COMPANY (1900).

Last Friday, in the Chancery Division of the High Court, Mr. Justice Farwell heard the motion of Mr. Stewart Smith in this case for the appointment of a receiver in the interests of the debenture holders.

Counsel stated that the company was incorporated in February of last year with a nominal capital of £200,000 in £1 shares, and its object was to acquire certain works and to work a new electrolytic process. A sum of £40,000 had been subscribed on debentures, which were a charge on the whole of the assets of the company except its foreign and Colonial patents. The debentures had become due in consequence of a winding-up resolution having been passed a day or two ago, the confirmatory meeting being summoned for the 21st inst. The undertaking had proved unprofitable, and the directors had closed the works and discharged all hands. They considered that the best course for all interested was to wind up the company, but to have certain plant and machinery running occasionally to keep it in proper condition for sale.

The application was not opposed, and his **Lordship** made an order appointing Mr. Robert Shaw receiver and manager.

ELECTRICAL ADVERTISEMENTS.

In the King's Bench Division, before Mr. Justice Bruce and Mr. Justice Phillimore, sitting as a divisional court, on Jan. 29, the case of Hull *v.* the London County Council was heard. It was an appeal on a special case from the decision of the magistrate at Clerkenwell, who fined the appellant 40*s.* and 2*s.* costs for erecting over his shop at 209, Seven Sisters-road, an electric sign, which, as alleged, was an obstruction within Section 73 (Sub-Section 8) of the Metropolitan Building Act of 1894. The appellant's case was that the information preferred on behalf of the London County Council was invalid, because it was not laid within six months from the time when it arose. The other point was that the sign was not an infraction of the Act, as it did not extend beyond the general line of buildings.

On the conclusion of the arguments of counsel, their lordships reserved judgment.

FACTORY INSPECTOR v. THE BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT COMPANY.

The Protection of Switchboards.

At the Greenwich Police Court, on Thursday week, before Mr. Kennedy, the hearing was continued of the summonses against the Blackheath and Greenwich District Electric Light Company, Limited, at the instance of Mr. Joseph Owner, H M. inspector of factories, alleging that at their works at River-terrace, East Greenwich, a person named Arthur Robinson was killed on Oct. 22 in consequence of their having neglected to securely fence certain machinery upon the premises, and, further, that they had failed to register an accident within one week of its occurrence, and that certain machinery dangerous to persons employed on the premises was not securely fenced.

Mr. Gray was counsel for the Home Office, and **Mr. Blanchard Wontner**, who defended, in opening his case, said the man Robinson was engaged at the time he met his death in putting a handrail in front of the switchboard, so that the magistrate was actually asked to convict the company for doing what, on the contention of the prosecution, the Act required them to do—*i.e.*, put a fence around it. Under these circumstances, he submitted it was idle to ask for a conviction. He then proceeded to call evidence for the defence.

Mr. John Archibald Constable, the defendant company's resident engineer, said that the switches were in a gallery 14ft. above the ground, to which a stone staircase gave access. No one was allowed to go into the gallery except those actually employed upon the switches. After the fatal accident to a man named Harbord in March the switches were raised to a height of 5ft. 9in. from the ground, indiarubber mats were provided, and the matter of providing new switches was laid before Sir Frederick Bramwell's firm. In the meantime it was thought proper to place a handrail in front of the switches. A carpenter named Ford was employed on the work, and he and the men engaged by him were warned as to the danger, and told that on no account were they to touch the switches, and again cautioned shortly before the accident occurred. Mr. Robinson smilingly remarked then that he was not likely to touch anything. The handrail was to be fixed to the switchboard by the company's own employés, and it was the intention to do that on Sunday morning, when the current could be switched off without inconvenience. A man was told off to see that the carpenters did not go near the switchboard, but they went to it in his temporary absence, being anxious, as witness supposed, to get on with the work. Since the accident vertical guards had been put upon the switchboards, and the adoption of an improved switchboard—either enclosed in a case or underground—was under consideration. As to the non-registering of the accident, witness did not know he had to record it in a particular book, but he did make an entry in his own book, and the matter was reported at once to the Board of Trade.

In reply to Mr. Gray, witness said that Harbord, the victim of the first accident, should not have touched the switch; it was his duty merely to regulate the voltage. The men wore gloves to work the switches, and were ordered to use one hand only.

The further hearing was adjourned for a week.

ACTION TO RECOVER AN ELECTRICAL INSTRUMENT

In the City of London Court last week Messrs. Wharton, Laing, and Down, Limited, 82A, New Bond-street, electrical engineers, sued Mr. George Taylor, electrical engineer, of Lombard-street, for £17, the price of a testing instrument which, it was alleged, had been taken away by the defendant without leave, and which he had declined to return.

Mr. Commissioner Kerr pointed out that the action had been brought for goods sold and delivered. The plaintiffs ought to have brought an action *in detinue* or trover.

Mr. Strouts, who appeared for the defendant, said he intended taking that objection, but, as a matter of fact, he had advised his client to return the instrument at once.

Mr. Commissioner Kerr said all he could do was to non-suit the plaintiffs, and allow the defendant his costs.

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COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; S. Barclay Heward, Esq., 96, Ashley gardens, Westminster, S W.; Harvey Ranking, Esq., 28, Westbourne-terrace, Hyde Park, W.; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors (with abstract of accounts) to be submitted to the half-yearly ordinary general meeting of the Company, to be held at the offices, 71, Finsbury-pavement, E C., on Feb. 5, 1901, at 12.30 p.m.:

The receipts from all sources for the past half-year have amounted to £46,740. 5s. 3d., and the cost of working has been £26,280. 14s. 10d., leaving a profit of £20,459. 10s. 5d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £22,988. 16s. 4d. After making provision for the debenture stock interest, a balance remains available for dividend of £15,342. 9s. 7d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891 and 1896, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,248. 14s. 7d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165 000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2 749 055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22 458 6 9
Dec. 31 1893	3,093,351	22 067 14 10
June 30, 1894	3,383 154	23 564 10 7
Dec. 31, 1894	3 275,649	23,540 12 8
June 30, 1895	3,113,199	23 711 5 4
Dec. 31, 1895	3,172 438	23 780 3 6
June 30 1896	3 192,672	24 021 13 0
Dec. 31, 1896	3 368 480	25,456 6 9
June 30, 1897	3,437,810	26,403 3 6
Dec. 31, 1897	3,337,861	25 472 12 10
June 30, 1898	3,478,977	26 356 16 4
Dec. 31, 1898	3,462,814	26,319 14 10
June 30, 1899	3,540,098	26.749 3 0
Dec. 31, 1899	3,442,942	26 197 14 10
June 30, 1900	4,169,717	33,608 2 3
Dec. 31, 1900	5,018,842	44,716 3 11
Total since the opening of the line	66,891,822	£508,128 13 6

Your directors have the pleasure to report that there has been a steadily growing increase in the receipts during the past half-year, which still continues, and when the extension to Islington is opened and the connections with the other railways are completed much more satisfactory results may be expected. There has been a considerable increase in the working expenses owing to the increased mileage of the trains due to the longer length of line, and this has been further added to by the high price of coal and other materials. Considering that the whole of the preference dividend and the interest on the debenture stock has been charged against revenue, and the traffic during the early part of the half-year had not had time to develop, the result of the half-year's working may be considered as fairly satisfactory. The extension to Islington has made rapid progress, and the tunnels and other underground works are very nearly completed. The building of the surface stations at Old-street and City-road have been commenced, and the lifts are being prepared. It is hoped that this extension will be opened for traffic in about six months from the present time. The subway at London Bridge, constructed jointly with the Brighton Company, has made considerable progress. The exchange of traffic with the Central London Railway by means of the special subway at the Bank is growing steadily, and as the convenience it affords becomes more widely known is likely to assume considerable proportions. The buildings at the generating station, required in connection with the working of the Islington line, are completed, and the new engine and boilers are being supplied. The arbitration to decide the amount to be paid in connection with St. Mary Woolnoth Church for the occupation of the churchyard and the easement under the church has been held, and it is hoped that the arbitrator's award will shortly be given. The additional locomotives referred to in the last report are in course of delivery. To meet the traffic expected on the opening of the Islington extension, your directors have deemed it prudent to order 10 more locomotives, which are under contract to be delivered within the current half-year The 10,000 ordinary shares recently offered to the proprietors were all subscribed for. Your directors regret that the shares were issued at so large a discount, but the present value of the ordinary stock obviously precluded them from making the issue price higher. The proprietors will be asked to approve a Bill now pending in Parliament for powers to construct a subway from the terminus at The Angel, Islington, to the Agricultural Hall, and to raise additional capital for that and other purposes. A Bill has been deposited to connect the Islington station of this Company with the Euston station of the Hampstead and Charing Cross Railway. As this line would be a great public convenience, and connect this railway with the Great Northern, Midland, and London and North-Western Railways at their respective termini, your directors have agreed that if the Bill receives the sanction of Parliament they will undertake to work the line and provide the electrical power required subject to a satisfactory agreement, the terms of which will be submitted to the proprietors for their approval at a later date. The director retiring by rotation is Mr. Charles Grey Mott, who is eligible for re-election. The vacancy caused by the death of Mr. Sampson Hanbury has been filled by the election of Mr. Harvey Ranking. The retiring auditors are Messrs. Turquand, Youngs, Bishop, and Clarke, who offer themselves for re-election.

Dr. Revenue Account.	£	s.	d.
Maintenance of way, works, and stations	938	6	7
Locomotive and generating power	8 800	7	1
Carriage repairs	836	1	11
Traffic expenses	12 338	12	8
General charges	2 279	19	7
Law charges	10	10	0
Rates and taxes	970	7	5
Passenger duty	106	9	7
	26,280	14	10
Balance carried to net revenue account	20,459	10	5
	£46,740	5	3

Cr.	£	s.	d.
Passengers (5,018,842)	42,325	19	11
Season tickets (647)	2 390	4	0
Parcels, etc.	234	11	4
	44 950	15	3
Transfer fees	18	5	0
Rent of property	1,690	15	11
Sundry receipts	80	9	1
	£46,740	5	3

Dr. General Balance Sheet.	£	s.	d.
Balance from net revenue account	15 342	9	7
Unclaimed dividends and interest	85	15	11
Interest payable or accruing and provided for	2 559	0	5
Contractors' retention fund	39 842	13	1
Sundry outstanding accounts	20,613	11	3
Loan account	185,500	0	0
Reserve fund	1,000	0	0
	£264,643	10	3

Cr.		£	s.	d.
Cash at bankers, current accounts	£13,435 16 0			
On hand	763 8 8			
		14,199	4	8
General stores		5,986	1	0
Sundry outstanding accounts		14,406	11	5
Investments—balance June 30, 1900	116,500 0 0			
Less proportion of interest received applied in reduction of premiums	500 0 0			
		116,000	0	0
Debenture stock issued against loans		30,060	0	0
Balance from capital account		83,991	13	2
		£264,643	10	3

The thirty-third ordinary general meeting of the Company was held on Tuesday at the offices of the Company, 71, Finsbury-pavement, E.C.

The **Chairman** (Mr. C. G. Mott), who presided, said that the dividends which were paid on the old short line could not be kept up, owing to the competition of the County Council's trams, and it became necessary to extend the line first to Clapham, and to obtain powers for an extension to Islington. The latter, it was hoped, would be finished within the next six months, and the intermediate stage had been passed with a diminution of only ¼ per cent. in the dividend. The piece of line at the City station was lying idle, and negotiations were in progress for selling it to the Brixton company. With regard to the proposed line from Islington to Euston, the City and South London Railway were trying to make some arrangement to work it, and he (the chairman) hoped to place before the shareholders shortly a fair scheme for that purpose. The subway at London Bridge was making rapid progress, and the subway at the Bank was being more used every day. It had been found necessary, in order to construct the Islington extension, to issue 10,000 ordinary shares, and, owing to the condition of the money market, they were issued at a discount. The Company had a small Bill before Parliament for power to construct a subway at Islington and to raise additional capital. As regards the net revenue, the increase amounted to £7,470.

After some discussion the report and accounts were adopted, and dividends at the rate of 5 per cent. per annum on the preference stock and at the rate of 1¼ per cent. per annum on the ordinary stock were declared.

At a special general meeting subsequently held, the Bill to confer further powers upon the Company for the construction of works and acquisition of lands and the raising of capital, and for other purposes, was unanimously approved.

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NORTH METROPOLITAN TRAMWAYS.

At the meeting on Feb. 1, **Mr. Geo. Richardson**, who presided, said in November the London County Council desired to know at what figure the Company would surrender the lease now held by them, but the directors replied that they were not prepared to name a price. As a fact, they were not going to give away their rights in all those parts which remained with them because they had an immense outlet to the northern positions of London, and held the key to the position. They had held this for 23 years, and were now in the advantageous position of being brought in contact with the light railways now being constructed by the Middlesex County Council. They were not prepared to discount this great future in any way. He moved a resolution declaring a dividend at the rate of 5 per cent. per annum, free of income tax, on the ordinary shares, which was adopted.

GREAT NORTHERN AND CITY RAILWAY.

The fifth half-yearly general meeting of the proprietors of the Great Northern and City Railway was held at the Westminster Palace Hotel.

Sir Charles Scotter, who presided, said that 2¼ miles of tunnel were already completed, and at the present rate over a quarter of a mile would be finished every month. The tunnels were constructed wide enough to admit the largest rolling-stock built in this country, and would enable the carriages to have side doors, which would open in the tunnels themselves, which could not be done in existing electrical railways. Again, they would be able to adopt any form of electrical power that was at present known; in fact, they would be able to adopt what was known as the multiple-unit system. It seemed to him that the time had arrived when America was going to be cut out by the invention of the Gans system, and that system could not be applied to small tunnels. He was also told that the cost of installation was from 40 to 45 per cent. less than any known system, and that the cost of working was much less. The motors also could be fixed so as to work directly upon the wheels of the carriages, and consequently the use of heavy locomotives would be avoided. Another important point was the substitution of bricks for cement for the lining of the lower half of the tunnels, and that, with the absence of heavy locomotives, would, he hoped, make them free from the vibration which was alleged against other electric railways.

The Earl of Lauderdale seconded, and the report was adopted.

ANGLO-AMERICAN TELEGRAPH.

The ordinary general meeting of the Anglo-American Telegraph Company was held on Friday at Winchester House, E.C.

The **Chairman** (Mr. F. A. Bevan), who presided, said the receipts for the half-year under review were over £16,000 less than for the previous half-year. The diminution was not altogether owing to the loss of the German traffic. To a great extent it was explained by the fact that the "Minia" had not been so much employed. The amount available for dividend was less by £38,920 than for the previous period. The dividend for the half-year would be at the rate of 32s. 6d. on the ordinary stock, as against 43s. 6d. and 5s. on the deferred stock. The renewal fund had been increased by £28,035.

The report and accounts were adopted, and the dividends as recommended therein were declared.

SOUTH LANCASHIRE ELECTRIC TRACTION.

The first ordinary meeting of this Company was held on Monday at Liverpool.

Sir John Willox, M.P., who presided, said the directors had allotted £500,000 of debenture stock, in respect of which £111,992 had already been received in cash, and 51,132 6 per cent. preference shares. The directors would shortly invite tenders for the construction and equipment of the lines. The first section to be taken in hand would be the line from Prescot to Liverpool. The next section to be taken in hand were those running from Haydock through Newton-in-Makerfield, Lowton, Leigh, and Atherton to Bolton, from Bolton to West Houghton, Hindley, Abram, Ashton in-Makerfield to Haydock, and then from Hindley, through Hindley Green, Atherton, and Tyldesley. The generating station would be erected at Leigh, and equipped with electrical plant sufficient to operate the whole of the system he had indicated, which covered 35 miles of track.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING.

The ordinary general meeting was held at Newcastle on Wednesday. The report stated that the gross earnings, in spite of the abnormally high cost of coal, had been £9,339, and a dividend of 5 per cent. was recommended, making 8½ per cent. for the year, carrying forward £311.

The **Chairman** (Mr. J. D. Milburn) said they had spent £18,000 during the year in the completion of their stations. They had also spent £1,700 more for coal. Nevertheless, the increase in the Company's business had been so great that they were able to maintain the dividend.

The Hon. C. A. Parsons seconded, and the report was adopted.

Colonel Wm. Angus and Mr. J. B. Simpson, retiring directors, were re-elected.

CITY OF OXFORD AND DISTRICT TRAMWAYS.

The nineteenth ordinary general meeting of this Company was held on Friday week, the Chairman (Alderman J. Saunders) presiding.

The **Chairman**, in moving the adoption of the report, said the accounts must be very satisfactory to the shareholders, for the directors were again able to recommend the payment of 3 per cent. for the last half-year, making with that which was paid in July, 5 per cent. for the year.

Colonel Webb seconded, and the resolution was carried unanimously.

CROMPTON AND CO.

At an extraordinary general meeting of this Company on Wednesday the following resolution was passed: "That the capital of the Company be increased to £300,000 by the issue of 46,000 new shares of £3 each, such shares to be numbered 54,001 to 100,000 inclusive, and to rank in all respects *pari passu* with the existing shares of the Company, and the directors are hereby authorised to issue these new shares at such times and on such terms as they may think fit."

SCARBOROUGH ELECTRIC SUPPLY.

The annual report of the directors of this Company, presented at the annual meeting at the Grand Hotel on 1st inst., gave the present position of the Company as follows: consumers, 592; equivalent 8-c.p. lamps connected, 33 343; Board of Trade units supplied, 331 266; total revenue, £7,788. 4s. 0½d. The accounts show that the balance to be disposed of is £3 721 2s. 5d., which the directors recommend should be dealt with as follows: placed to depreciation account, £529. 18s. 1d.; dividend at 6½ per cent. per annum, £3 088 10s. 6d.; carried forward to 1901, £102 13s. 11d. The capital expenditure stands at £52,193. 17s. 9d., being an increase of £9,120. 10s. 2d. during the year. The outlay has been mainly incurred in enlargement of buildings and additions to the plant at the generating station. The 5,000 additional shares mentioned in the last report have been created. Of these 1,000 have been issued, and £6 per share had been called up thereon up to Dec. 1, 1900. Further capital will, of course, be required from time to time as the operations of the Company extend. The retiring directors are Mr. John Bell Simpson, Mr. J. W. Woodall, and Mr. John Dale, who again offer themselves for re-election. The auditors, Messrs. Bradley, Davis, and Co., C.A.'s, also offer themselves for re-election.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

Directors: Alfred Sohier Bolton, Esq.; Sir Frederick J. Bramwell, Bart., F.R.S.; Sir Charles Grant, K.C.S.I.; Granville R. Ryder, Esq; R. W. Wallace, Esq., K.C.

Report of the directors (with abstract of accounts), to be presented at the fourteenth ordinary general meeting to be held at 1, Great George-street, Westminster, on Wednesday, Feb. 13, 1901, at 5 p.m.:

During the year the number of houses and shops connected with the system has increased from 2,110 on Dec. 31, 1899, to 2,324 on Dec 31, 1900, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 183,462 to 199,098. The directors have strengthened the renewal account by transferring to it £7,594. 10s. 9d., making the total amount placed to that account £37,974. 10s. 4d. After providing for the above amount and paying the dividends on the 6 per cent. first preference shares to June 30, 1900, on the 5 per cent. second preference shares to Sept. 30, 1900, and an interim dividend at the rate of 12 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1900 is £11,006. 12s. Of the above sum £1,425 has been appropriated to the payment of the first preference dividend to the end of the year, and £593. 15s. has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £8,987. 17s., out of which it is proposed to pay a further dividend on the ordinary shares of 6 per cent. for the past half-year, making, with the interim dividend paid on July 26, 12 per cent. for the year. This will leave a balance of £4,712. 17s. to be carried forward. The directors have to inform the shareholders that the issue of new ordinary capital has been fully subscribed by the shareholders, and the directors invite the shareholders to concur with them in the issue of shares to the staff as stated in the circular of Jan. 1. The directors have the pleasure to report that the new generating station, which has been constructed in conjunction with the Notting Hill Electric Lighting Company, Limited, was sufficiently advanced to enable the Company to obtain material assistance from it towards the end of last year, and we believe that it will be fully available for regular supply early in the spring. The capital for this undertaking has been obtained by the issue of 4 per cent. debenture stock, guaranteed jointly and severally by the two companies. A transformer station has been equipped, and is now in full working order on a site obtained from Her Majesty's Commissioners for the Exhibition of 1851, at the back of the Royal Albert Hall; this will render the accumulator station in Queen's-terrace-mews unnecessary, and it will shortly be discontinued. The sum of £1,656. 10s., received as premiums on the issue of second preference shares, has been appropriated to the reduction of the purchase of the Kensington Court Company account, and the sum of £818. 11s. 11d., received

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from Mr. Lane-Fox in payment of the amount agreed by the directors to be taken in settlement of the Company's claim for costs, has been transferred to the credit of the mains account. In accordance with the articles of association, Mr. A. S. Bolton and Sir Frederick J. Bramwell, Bart., F.R.S., retire from the directorship, and being eligible offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. S. Whiffin, and Dickinson, having dissolved partnership, and Mr. A. L. Dickinson, the remaining partner, having joined Messrs. Price, Waterhouse, and Co., the latter firm were appointed by the directors to audit the present accounts. Messrs. Price, Waterhouse, and Co. offer themselves for re-election.

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£	s.	d.
Coal or other fuel	£8,603 12 0			
Oil, waste, water, and engine-room stores	915 0 11			
Proportion of salaries of engineers, superintendents, and officers	765 12 5			
Wages and gratuities	2,468 12 1			
Electricity supplied from Wood-lane works	132 8 0			
Repairs, renewals, and maintenance	4,408 13 10			
		17,293	19	3
	Distribution of Electricity.			
Proportion of salaries of superintendents and officers	93 15 0			
Wages and gratuities	367 0 10			
Repairs, maintenance, and renewals of mains	1,160 4 0			
Repairs, maintenance, and renewals of meters	599 0 1			
Sundry expenses	14 11 4			
		2,234	11	3
	Rents, Rates, and Taxes.			
Rents payable	394 19 8			
Rates and taxes	4,288 8 10			
		4,683	8	6
	Management Expenses.			
Directors' remuneration	1,000 0 0			
Salaries of managing engineer, secretary, accountants, clerks, etc.	2,371 18 0			
Stationery and printing	332 14 3			
General establishment charges	376 9 6			
Auditors of Company	63 0 0			
Auditor appointed under the provisions of the order	60 0 0			
		4,204	1	9
Law and parliamentary charges		259	14	10
	Depreciation.			
Depreciation in respect of leasehold works, £290; renewal and maintenance of buildings, etc., £13,762. 8s. 8d.; less amount expended during the year, £6,167. 17s. 11d.	7,594 10 9			
	Special Charges.			
Insurances	356 13 4			
Cost of conversion to 200 volts	409 6 1			
		8,650	10	2
Total expenditure		£37,326	5	9
Balance carried to net revenue		17,590	5	4
		£54,916	11	1

Cr.	£	s.	d.
Sale of current per meter 5d., 6d. per B.T.U. less rebates and bad debts	51,766	14	3
Sale under contracts	834	2	9
(*Units*, 2,630,482.)			
	52 600	17	0
Rental of meters and other apparatus	1,712	0	6
Sale and repairs of lamps, etc.	8	2	9
Freehold and leasehold property—rents receivable, £888. 16s.; less repairs, £300. 5s. 2d., and transfer fees, £7	595	10	10
	£54,916	11	1

GENERAL BALANCE-SHEET.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		265,000	0	0
Temporary loan		4,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.		11,888	11	0
Balance at credit of net revenue account		11,006	12	0
Renewal fund account		37 974	10	4
Depreciation fund account works on leasehold property		2,520	8	6
		£332,390	1	10

Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		312 449	7	11
Stores on hand: coal, £428 18s.; oils, waste, etc., £201. 0s. 10d.; general, £1,072. 19s. 11d.		1 702	18	9
Sundry debtors for current supplied		16,362	7	5
Other debtors		193	3	11
Cash at bankers and in hand		1,682	3	10
		£332,390	1	10

CAMBRIDGE ELECTRIC SUPPLY.

Directors: D. Munsey, Esq. (chairman), Meadowcroft, Cambridge; A. A. Campbell Swinton, Esq., M.I.C.E., M.I.E.E. (managing director), 66, Victoria-street, S.W.; P. W. Latham, Esq., M.D., Trumpington-street, Cambridge; the Hon. C. A. Parsons, F.R.S., M.A., M.I.C.E., M.I.E.E. Wylam-on-Tyne; John B Simpson, Esq., M.I.C.E., Bradley Hall Wylam on-Tyne. Manager and engineer: John H. Barker, A.M.I.C.E., M.I.E.E.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Company, to be held at the Company's offices, Thompson's lane, Cambridge, on 15th inst. at 3 p.m.:

Your directors have pleasure in reporting that the progress of the Company continues to be satisfactory. During the year 1900 there has been added to the Company's mains the equivalent of 2,363 8-c.p. lamps, making the total 30 986. The number of units supplied has been 357,435, an increase of 59 043, or 19 per cent. In spite of the large increase in the price of coal the Company has been able to more than maintain its income without increasing the price of electricity. The Company, after paying all charges, placing £250 to the extinction of preliminary expenses, £448 14s. 10d. to the extinction of suspense account, and £750 to depreciation account, has a balance of £4,278. 10s. 11d., which added to £210 15s. 2d. brought forward from last year makes £4,489. 6s. 1d. An interim dividend of £1 413. 16s. 2d. and interest on temporary overdraft and loan £193. 18s. 9d. have already been paid, leaving a net balance of £2,881. 11s. 2d., out of which the directors recommend the payment of a dividend of 4½ per cent., making with 2½ per cent. already paid 7 per cent. for the year. This will absorb £2,843. 2s. 5d. leaving a balance to carry forward subject to fractional adjustment of income tax of £38. 8s. 9d. Mr. D. Munsey and Dr. Latham retire by rotation; both are eligible and offer themselves for re election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£	s.	d.
Coal, including dues, carriage, unloading, etc.		1 509	7	3
Oil, waste, water, and engine room stores		239	11	11
Proportion of salaries of engineers and officers		103	18	4
Wages at generating stations		695	7	6
Repairs and maintenance		339	18	1
	Distribution of Electricity.			
Proportion of salaries of officers		12	10	0
Wages to linesmen, fitters, labourers		70	13	9
	Rents, Rates, and Taxes.			
Rents, rates, and taxes		409	0	8
	Management Expenses.			
Directors' remuneration for year 1900		210	0	0
Salaries of managing engineers, secretary, etc.		282	16	8
Stationery, printing, etc.		151	13	1
Auditor of Company		10	10	0
Auditor appointed under the provisions of the order		22	0	10
	Law Charges.			
Law expenses		41	1	
	Depreciation, etc.			
Depreciation of leasehold works, buildings, etc.		750	0	0
Extinction of preliminary expenses		250	0	0
Extinction of suspense account		448	14	10
	Special Charges.			
Insurances, etc.		38	4	6
Total expenditure		5,535	9	0
Balance carried to net revenue		4 267	4	1
		£9 802	13	1

Cr.	£	s.	d.
Sale of current	8,798	10	3
Public lighting	23	0	4
Rental of meters	391	2	7
Transfer fees	11	5	0
Cash discounts and sundry receipts	569	6	5
Royalties	9	8	6
	£9 802	13	1

GENERAL BALANCE-SHEET.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		62,025	0	0
Sundry creditors		780	5	8
Net revenue account, £4 295. 7s. 4d.; less interim dividend paid, £1,413. 16s. 2d.		2 881	11	2
Depreciation fund account		2 500	0	0
Bankers		3 732	5	0
Loan		5,000	0	0
Workmen's deferred pay		329	14	0
Unpresented cheques		78	0	9
		£77,226	16	7

Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		68,571	2	6
Stores on hand: coal, £235; oils, waste, etc., £22. 6s. 1d.; general (lamps, etc.) £483. 13s. 10d.; stores on capital account, £3,703 7s.		4,444	6	11
Sundry debtors		4,272	12	4
Cash in hand		5	18	0
Work in progress		32	16	10
		£77,326	16	7

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BIRKDALE AND SOUTHPORT TRAMWAYS.

The directors' report for the year ending Dec. 31 last shows that the car receipts amount to £4,370. 7s. 1d., as against £4,572 0s. 4d. for the year 1899, being a decrease of £201. 13s. 3d. during the year. The profit on revenue account is £1,246. 9s., and the available balance on profit and loss account amounts to £782. 19s. 8d., which the shareholders are recommended to appropriate as follows: Depreciation—cars at 25 per cent., £245. 15s. 9d.; horses at 15 per cent., £162. 1s.; working plant, etc., at 10 per cent., £12. 2s. 5d. Dividend to shareholders at the rate of 6 per cent. per annum, £174. 6s.; transfer to reserve fund, £150; balance to be carried forward to year 1901, £38. 14s. 6d. From August to October last the working of the Company's traffic was seriously interfered with, owing to the relaying of lines and permanent way by the Southport Corporation for electric traction, the approximate loss of car receipts during that period being £300 (after accounting for a sum received from the Corporation as part compensation), and during the last five months of the year the competition of the electric cars has prejudicially affected the takings.

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The report of the directors for 1900, to be submitted to the meeting to be held on the 15th inst., states that the accounts now presented compare with those for the 15 months ended Dec. 31, 1899, and show a gross profit of £4 452, after allowing £500 for directors' fees. This result, having regard to the high prices of coal and other products prevailing throughout the year, may be considered satisfactory. The balance remaining to be carried forward, after writing off the deficit at the end of 1899, is £675. The business of the Company continues to make satisfactory progress, 57 new installations having been obtained during the year. The number of lamps installed at Dec. 31 was 23,239, an increase of 6,279 lamps of 8 c.p. A new boiler, engine, and dynamo, representing an additional 300 h.p, have been installed within the last few weeks to meet the increasing demand for electric light, the cost of which has been brought into the accounts. This expenditure has been provided for by the issue on Jan. 1 last of a further £3,800 of second debentures, making the total issue £8,000. It is not proposed to raise further capital at present.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

Directors: Eustace J. A. Balfour, Esq. (chairman); Walter Leaf, Esq. (vice-chairman); Sir John H. Morris, K.C.S.I.; Bennett Fitch, Esq., M.I.C.E.; Marlborough R. Pryor, Esq. General manager and secretary: Frederic J. Walker. Chief engineer: Sydney T. Dobson, M.I.C.E.

Report of the directors (with abstract of accounts) for the year ending Dec. 31, 1900, to be submitted to the shareholders at the ordinary general meeting to be held at the offices of the Company, Carnaby-street central station, Golden-square, W., on Feb. 12 at 12.30 p m.:

The supply to the Company's consumers has been fully maintained from the Carnaby-street and Mason's-yard stations. There has been an addition of 21,597 to the number of 8-c.p. lamps connected, and notwithstanding the high price of coal, the cost per unit has not increased. The large extensions of Carnaby-street station are being completed, and will be ready in good time to deal with the expected demand of next winter's season. The works of the Central Electric Supply Company, Limited, at Grove-road are being pushed on, and the directors are assured that all anticipated requirements from the winter of 1902-3 onwards will be duly provided for thereby. Three and a half per cent. debenture stock, amounting to £150,000, was issued in June last at 96 per cent., and the whole amount was taken up. The discount and expenses of this issue have been carried to the debit of capital reserve fund. In the net revenue account for 1899 credit was taken for a sum of £1,582. 5s. 9d., interest charged on advances made to the Central Electric Supply Company, Limited. The auditor of the Board of Trade having expressed an opinion that this amount should not at present be credited to revenue, the directors, while reserving their own opinion on the question, recommend that this and like sums chargeable in subsequent years should for the present be placed to a special interest suspense account. The net earnings of the Company for the year 1900 were £37,646. 4s. 1d., which, after payment of interim dividends of 7 per cent. on preference shares and 10 per cent. on ordinary shares, left an amount now to be dealt with of £24,801. 17s. 3d. The directors propose to divide this amount as follows: (*a*) by payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year, £3,500; (*b*) by payment of a dividend on the ordinary shares for the second half-year of 7s 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year, £19,000; (*c*) amount to be carried forward £1,801. 17s. 3d.—total, £24 301. 17s. 3d. The proposed alterations in the articles of association set out in the notice for the extraordinary general meeting are designed to bring the articles into conformity with the Companies' Act, 1900, and the present constitution of the capital. The vice-chairman, Mr. Walter Leaf, and Mr. Bennett Fitch, M.I.C.E., are the directors who retire by rotation under Clause 79 of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

Revenue Account.

Dr. Generation and Distribution of Electricity.	£	s.	d.	£	s.	d.
Coal, including dues, carriage, etc....	£15,044	17	9			
Oil, waste, water, engine-room stores	1,405	10	0			
Salaries of engineers and officers ...	2,478	10	1			
Wages at generating and distributing stations	4,677	5	8			
Repairs and maintenance: buildings, £506. 15s. 8d.; engines and boilers, £1,351. 0s. 2d.; dynamos, £186. 3s. 4d.; other machinery, instruments, and tools, £793. 10s. 1d.; accumulators, £77. 1s 1d.; lamps (at stations), £161. 17s. 3d.	3,076	7	7			
Attending and repairing public lamps.....	423	16	11			
Repairs and maintenance of mains..	2 610	9	5			
Miscellaneous expenses	142	1	6			
				29,858	18	11
Rents, Rates, and Taxes.						
Rents payable.....	106	7	6			
Rates and taxes	2,846	3	10			
				2,952	11	4
Management Expenses.						
Directors' remuneration	2,500	0	0			
Salaries of manager and secretary, engineer, clerks, canvasser, etc....	4,215	18	0			
Stationery, printing, and advertising.....	236	6	9			
General establishment charges	385	13	6			
Auditors of Company	157	10	0			
				7,495	8	3
Law expenses.....				74	10	11
Special Charges.						
Insurance.....	507	17	0			
Fees for testing meters.....	7	4	5			
Board of Trade audit	70	0	0			
Trustee for debenture stockholders	26	5	0			
Expenses of quotations of ordinary shares and debenture stock..	105	0	0			
Experts' fees *re* valuation for assessment	79	5	6			
				795	11	11
Depreciation.						
Depreciation on buildings	541	8	2			
Ditto plant, etc.....	11,982	8	3			
				12,523	16	5
				53 700	17	9
Net loss on sales of old plant, materials, etc.				467	2	3
Balance carried to net revenue account				39,020	10	0
				£93,188	10	0

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts (at 6d. per unit less rebates)	87,655	2	8
Ditto under contract	554	0	10
Public lighting	1 840	6	10
	90 049	10	4
Rental of meters on consumers' premises	2 295	3	11
Rents receivable.....	351	19	2
Transfer fees	55	0	0
Discounts on purchases	316	9	0
Sale of old materials, stores, etc.....	41	13	8
Sundry fees etc.	62	18	11
Sale of steam.....	15	15	0
	£93,188	10	0

General Balance Sheet.

Dr.	£	s.	d.
Capital account—amount received	450,000	0	0
Capital reserve fund.....	66,529	5	3
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	4,593	11	8
Sundry creditors on open accounts	4,183	6	7
Interest suspense account	2,694	11	2
Debenture stockholders, for interest accrued	2 066	5	0
Unclaimed dividends	44	5	5
Balance at credit of net revenue account, £37,801. 17s. 3d.; less interim dividends paid, £13,500...	24 301	17	3
	£554 413	2	4

Cr.	£	s.	d.
Capital account—amount expended for works	390,231	1	10
Central Electric Supply Company, Limited—expenditure on freehold site, etc.....	27,912	7	5
Amount paid on 10,000 £5 shares in Central Electric Supply Company, Limited	30,938	15	0
Stores on hand: coal, £1,991. 12s. 6d.; lamps, £36. 8s. 11d.; meters and switches, £2,137. 12s. 4d.; general, including oil, waste, etc., £1,596. 18s. 8d	5,762	12	5
Sundry debtors for current supplied, £20,404. 12s. 5d.; other debtors, £3,035. 5s. 4d.	23,439	17	9
Cash at bankers (including deposit of £70,000), £76,044. 12s. 4d.; cash in hand, £83. 15s. 7d. ...	76,128	7	11
	£554,413	2	4

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Board of Trade units generated			5 740 624
Quantity utilised	Private supply	4 984,748	5,207 276
	Public lighting	143 027	
	Used on works	79,501	
Quantity expended in distribution			533,348
Number of lamps on circuit, Dec 31, 1900			186 347

NEW COMPANIES.

The following companies have been registered since our last issue :

Allan Electrical Syndicate, Limited.—Capital, £1,000. Object: to acquire and turn to account electrical processes, machinery, apparatus, etc.

Anchor Cable Company, Limited.—Capital, £50,000. Object: to carry on a business of cablemakers for electrical and other purposes; to carry on the business of electricians, etc.

Cleveland and Durham County Electric Power Company, Limited.—Capital, £25,000. Object: to produce, store, and supply electrical energy and power and electricity for all purposes in the North Riding of Yorkshire and in Durham.

Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited.—Capital, £1,200,000. Object: to adopt an agreement between La Companhia Primitiva de Gas de Buenos Ayres of the one part and H. Ward of the other part to acquire gas or electric light works in the River Plate and other countries in South America, or elsewhere, and to carry on the business of manufacturers, generators, and suppliers of gas, electricity, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Bournemouth.—The Town Council invite tenders for 42 electric cars. Tenders by March 2. Details in our advertisement columns.

Mortlake.—The Barnes Urban District Council invite tenders for wiring their electricity works at Mortlake. Tenders by Feb. 11.

Edinburgh.—The Corporation invite tenders for engine and dynamo. Tenders by Feb. 9. Details in our advertisement columns.

Brighton.—The Council invite tenders for the overhead trolley construction and equipment on the whole of the tramway routes. Tenders by Feb. 14.

Glasgow.—The Corporation invite tenders for the supply of 100 car equipments and spare parts for same. Tenders by Feb. 22. Details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of storage battery for their electricity works. Tenders by Feb. 11. Details in our advertisement columns.

Brighton.—The Council invite tenders for continuous-current arc lamps and accessories for street lighting. Tenders by Feb. 25. Details in our advertisement columns.

Clyde Navigation.—The Trustees invite tenders for a three-ton electric wharf crane for Prince's Dock. Tenders by March 11. Details in our advertisement columns.

Aberdeen.—The Tramway Committee invite tenders for the electrical equipment of their bathing station route. Tenders by Feb. 13. Details in our advertisement columns.

Ploesti (Roumania).—The Municipality invite tenders for the construction and working of electric tramways in the city for 30 years. Tenders by April 3. A deposit of £2,000 is required.

Darwen.—The Corporation invite tenders for the supply and delivery of steel rails, fish and sole plates, tierods, bolts, etc., and copper bonds. Tenders by Feb. 25. Details in our advertisement columns.

Taunton.—The Corporation invite tenders for two 100-kw. tramway generators, one engine, and tramway switchboard and connections. Tenders by Feb. 25. Details in our advertisement columns.

Beckenham.—The Council invite tenders for boilers, steam alternator and combined engine dynamo and motor, pipework, batteries, and switchboard. Tenders by Feb. 25. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of boilers, with mountings, gangway, feed and drain pipes, etc., complete. Tenders by Feb. 15. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for the supply and installation of the complete motor and electrical plant of the central station of the town electrical works. Tenders by April 1. Details in our advertisement columns.

Long Eaton.—The Urban District Council invite tenders for producers, gas-engines, dynamos, switchboard, feeder and distribution cables, and conversion of street lamps. Tenders by Feb. 18. Details in our advertisement columns.

Canterbury.—The Lighting Committee invite tenders for the extension of the electricity works. Specification, etc., may be obtained at the City Surveyor's Office, Tudor-chambers, High-street, Canterbury. Tenders by Feb. 18.

Shoreditch.—The Borough Council invite tenders for erection of a generating station in Whiston-street, adjoining the Haggerston basin of the Regent's Canal. Specifications, etc., can be obtained at the Town Hall, Old-street, E.C. Tenders by Feb. 13.

Bermondsey.—The Council invite tenders for the construction, supply, and erection of (Section A) main switchboard and instruments; (Section B) battery of accumulators and accessories. Tenders by Feb. 25. Details in our advertisement columns.

Stirling.—The Town Council invite tenders for engines and dynamos (first extension), two sets each of about 350 h.p., and Lancashire boilers (first extension), 28ft. long and 8ft. diameter. Tenders by Feb. 15. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for coal conveyor and elevators and coal-discharging plant, including hoist, automatic weighing machine, tower, and bridge over roadway. Tenders by Feb. 21. Details in our advertisement columns.

Croydon.—The Town Council invite tenders for the supply, delivery, and erection of two dry-back boilers at their electric light station. Specifications, etc., may be obtained at the Borough Electrical Engineer's Office, Factory-lane, Croydon. Tenders by Feb. 16.

Wallasey.—The Urban District Council invite tenders for the erection and completion of car-sheds, stores, workshops, and dwellings at their tramway depôt, Seaview-road, Liscard, Wallasey. Tenders by Feb. 21. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for three miles of 21in. pipes. Specifications, etc., may be had on application to Mr. W. A. Chamen, engineer, 75, Waterloo-street, Glasgow. Tenders to be addressed to Sir James D. Marwick, town clerk, City Chambers, Glasgow, by Feb. 12.

Alcaraz (Spain).—The Local Authorities invite tenders for installation and working of electric lighting for 20 years. For the public lighting 120 10-c.p. lamps are required, for which a payment of 23 pesetas per annum each will be made; the deposit is 10 per cent. Tenders by Feb. 28.

Bromley (Middlesex).—Tenders are invited for sundry work in connection with the installation of electric light at the Poplar and Stepney Sick Asylum. Specifications, etc., may be obtained and plans inspected at the office of Mr. Robert Foskett, clerk to the managers, Bromley. Tenders by Feb. 12.

Wallasey.—The Urban District Council invite tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. Tenders by Feb. 21. Details in our advertisement columns.

Bournemouth.—The Corporation invite tenders for the supply of three steam dynamos and two steam-driven surface condensers, and other works in connection therewith. Specifications, etc., may be obtained of Mr. F. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by March 2.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the supply of 1,600 tons of steel rails, 70 tons of fishplates, 50 tons of tiebars, and 45 tons of soleplates. Specifications, etc., can be obtained from the engineer, Mr. W. H. Travers, Church-street, Egremont. Tenders by Feb. 19.

Luton.—The Town Council invite tenders for wiring for electric lighting purposes the Council-chamber, town hall, free library, corn exchange, and baths. Sketches of designs and full details of the proposed works to be given. Further information can be obtained of the Borough Engineer. Tenders by March 4.

Islington.—The Electric Lighting Committee invite tenders for the erection of a water-tower, tanks, and sundry additions to the central electric lighting station, Eden-grove, Holloway, N. Plans, etc., may be seen at the office of Mr. A. Hessell Tiltman, F.R.I.B.A., 51, Russell-square, W.C. Tenders by Feb. 12.

Wimbledon.—The Urban District Council invite tenders for the supply and erection of steam and exhaust pipes, etc., and the moving of two boilers, feed pumps, feed-water heater, and storage tank, an independent surface-condensing plant, and two water-tube boilers. Tenders by Feb. 18. Details in our advertisement columns.

Ballinasloe (Ireland).—Tenders are invited for supplying and erecting the necessary plant and fittings for an electric light installation in the new hospital block of the district lunatic asylum, Ballinasloe. Specification, etc., can be seen at the office of Mr. J. F. Fuller, F.S.A., 179, Great Brunswick-street, Dublin. Tenders by Feb. 9.

Southampton.—The Corporation invite tenders for the supply and the erection of the works included under the following contract: Contract No. 10—(Section A) car bodies and trucks; (Section B) motors and equipments. Specification, etc., may be obtained at the offices of the Borough Engineer, Southampton. Tenders by Feb. 11.

London, S.W.—The London County Council invite tenders for the supply of two blocks of water-tube boilers required for the electrical power generating station to be erected at the Camberwell depôt of their tramways. Full particulars may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Feb. 19

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Wolverhampton.—The Tramways Committee invite tenders for the supply and erection of a 10-ton electric travelling crane at the new car depôt, Cleveland-road, to operate on a 500 volt direct-current circuit. Specifications, etc., can be obtained from Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Feb. 11.

Southwark.—The Electric Light Committee invite tenders for the supply and erection of the following plant for their electric light station at Pearcse-street, Walworth-road, S.E.: (Section A) One 400-kw. high-speed engine and dynamo and accessories; (B) two water-tube boilers, fitted with mechanical stokers, and extension to the steam and water mains. Tenders by Feb. 18. Details in our advertisement columns.

Huelva (Spain).—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's ambassador at Madrid, stating that tenders are invited by the Spanish Government not later than Feb. 21 for the establishment of a telephone system in the city of Huelva. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Glasgow.—The Corporation invite tenders for the supply of the following material: (1) 1,000, 2,000, or 3,000 tons steel straight track rails, 100, 200, or 300 tons steel curved rails, 50, 100, or 150 tons steel fishplates; (2) 50 tons steel tiebars. The rails and fishplates will be a separate contract from the tiebars. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Feb. 22.

Valletta (Malta).—Tenders will be received at the office of the Receiver General and Director of Contracts, Valletta, until 11 a.m. on Feb. 15 for supply of 75,000 arc lamp carbons. Tenderers in England not having a representative in Malta are to deposit with the Crown Agents the sum of £50 as surety. The tenderer whose tender will be accepted may be compelled to carry out the obligations arising from his tender, notwithstanding that he may not have signed the contract. Particulars, specifications, etc., may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

RESULTS OF TENDERS.

Greenwich.—The Guardians have accepted the tender of Messrs. F. F. Joel and Co., at £5,485, for electric lighting at Grove Park Workhouse.

Aberdeen.—The Town Council have accepted the following tenders: Electrical Power Storage Company, Limited, for the supply and erection of storage batteries; P. Tawse, Clayhills, Aberdeen, at £7,765, for the supply of materials and the construction of works in connection with the laying down of the permanent way of new electric tramways in Great Western road and a passing place in Rosemount-place.

BUSINESS NOTES.

TRACTION.

Hastings.—The work of constructing the electric tramways is expected to be commenced at an early date.

Paisley.—The Town Council have passed a resolution refusing their consent to Mr. Murphy's Tramways Bill.

Cleator Moor.—The Urban District Council do not consent to the proposed West Cumberland electric tramway within their district.

Taunton.—The Town Council have confirmed their agreements with the tramways company and the British Electric Traction Company.

Richmond.—The District Council have approved the promotion of the London United Tramway Company's Bill subject to certain conditions.

Isleworth.—A meeting of tradesmen and residents has resolved to oppose the London United Tramways Bill unless a minimum 40ft. road were constructed.

Darwen.—At the last monthly meeting of the Town Council it was decided to proceed with the construction of a branch tramway to Hoddlesden at a cost of £13,000.

Luton.—The question of applying for a tramways provisional order was before the Town Council at their last meeting, when it was decided to discuss the matter in committee.

Burton.—A ratepayers' meeting last week passed a resolution consenting to the promotion of the Corporation's Bill to authorise the construction of electric tramways in the borough.

Paris Metropolitan Railway.—The strike is now over, owing to the intervention of M. Pierre Baudin, Minister of Public Works. The company have made several concessions.

Personal.—Mr. Thomas Bownass, of Keswick, has been appointed, out of 322 applicants, secretary and manager to the Lancaster and District Tramway Company at a salary of £200 a year.

The City (London).—The Common Council have decided to oppose the Tramways and Street-Widening Bill of the London County Council, whereby power is sought to lay down tramways in the City.

York.—The agreement for the purchase by the Corporation of the undertaking of the tramways company has been concluded, the latter having yielded every point upon which the Council refused to agree.

Nottingham.—The work in connection with the construction of the Basford and Bulwell section of the Corporation electric tramways has proceeded without any serious check, and the undertaking is in a forward stage.

Reddish.—Lieutenant-Colonel von Donop, R.E., has held an enquiry into the application of the Urban District Council for sanction to borrow the sum of £13,000 for the purpose of constructing a tramway from Reddish-road to Gorton-road.

"Tube" Vibration.—The recent two cases against the Central London Railway for damage to house property, reported in last week's issue, are understood not to affect the company financially, the responsibility in this respect resting with the contractors.

Leeds.—The Tramway Committee have expressed the strongest disapproval of the attitude taken up by the tramway men last Saturday, who left their work on the plea that the King had proclaimed a general day of mourning. An apology tendered by the men has been accepted.

Erdington.—The Tramways Committee have appointed Mr. Green, of Messrs. Pritchard and Co., the well-known Birmingham engineers, as consulting engineer to advise them generally on the proposed application for power to construct tramways in the district.

Warrington.—Application is to be made to the Board of Trade for their consent to the laying of double tramway lines in Liverpool road. The Corporation have refused at this stage to petition in favour of the Manchester and Liverpool Electric Express Railway Bill.

Tramway Accident.—On Tuesday Mr. Martin Fitzgerald, wholesale wine merchant, of Dublin, was awarded £1,000 damages against the Dublin United Tramways Company for injuries sustained by him owing, it was alleged, to the tramway track not being properly sanded.

Ashton.—A Local Government Board enquiry was held on Tuesday week by Lieutenant-Colonel von Donop, R.E., in respect of an application by the Ashton Town Council for sanction to borrow £26,570 for the construction and electrical equipment of the tramways and for other purposes.

Camberwell.—In their report to the Borough Council the Works and General Purposes Committee suggest that the Council's consent be given to the proposed tramways, but that a petition against the London County Council's Bill be lodged in order to obtain the insertion of protection clauses.

Metropolitan District Railway.—The directors announce a dividend at the rate of £2. 6s 8d. per cent. per annum on the 4 per cent. guaranteed stock for the past half-year. For the second half of 1899 £1. 7s. 6d. per cent. per annum was paid on the 5 per cent. preference stock.—*Financial News.*

West Cumberland.—A conference of local authorities in connection with the electric tramways scheme was held last week. The proceedings were conducted in private, but it is understood that the whole of the representatives, with the exception of Workington, expressed themselves as favourable to the scheme.

Leigh.—This town, which will form the centre of the South Lancashire Electric Tramways Company's extensive system, their generating station being there, is to have a new industry—viz., the making of electrical cables. The Anchor Cable Company, Limited, has this week been formed, with a capital of £50,000, to carry on business at Leigh, the directors including Councillor George Shaw (Mayor of Leigh), Messrs. R. A. Rumney, W. E. Rumney, and W. M. Henderson.

Leicester.—At the Town Council meeting last Tuesday the Tramways Committee presented a report recommending that steps be taken to purchase the tramways undertaking and to work the tramways by electric traction, and that parliamentary powers be sought to construct and equip extensions of the existing lines and a number of new lines within the borough, and to construct an electric power station depôts and buildings, etc. The committee advised the adoption of the overhead trolley system, and that the central power station should be on the Belgrave-road, where the heat from a refuse destructor could be used in the generation of power. A resolution was adopted that steps be taken to purchase the tramways undertaking from the company to be worked by the Corporation under their statutory powers, and the system be equipped for electric traction. The remainder of the report was referred back to the committee for them to obtain expert advice as to the proposals.

Manchester.—In view of the disastrous collapse of the overhead wires in Liverpool a few days back, a Councillor asked at the Manchester City Council meeting on Wednesday what precautions the Tramways Committee were going to take to prevent such an accident in the city. The Chairman of the committee admitted that under existing conditions it was quite possible for such a disaster to occur in Manchester. The committee was doing its utmost in the matter, however. Their engineer suggested that the only thing to be done, wherever a telephone or telegraph wire crossed a tramway route, was to insulate it with rubber. If there were several wires the Corporation should arrange with the owners to put them into one cable and cover it with rubber. He did not know whether the Corporation would be able to make such arrangements, but he trusted that the Telephones Committee would seriously consider what was to be done in regard to the telephone company's extension of wires, and not allow them, as far as was possible, to put them overhead.

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Scarborough.—A petition in favour of the proposed tramways has been signed by over 3,000 persons. The Corporation have been asked by the tramways company to give their consent to the passing of the Bill.

Hammersmith.—The report of the Law and Parliamentary Committee recommends that steps be taken to oppose the following Bills: Charing Cross, Hammersmith, and District Electric Railway, Central London Railway (to confer further powers), London County Council (relating to tramways), and London United Tramways Bills.

Perth.—The extension of the electric tramways from West Park-road to the western boundary of the burgh has now been completed. The trials on the new section were considered altogether satisfactory, both permanent way and overhead equipment working admirably. The permanent way on the Blackness road section is practically finished.

Hampstead Heath.—The fourth annual report of the Hampstead Heath Protection Society records that the society is in communication with the Commons' Preservation Society, the Metropolitan Public Gardens Association, and the Borough Council with a view of co-operating in opposition to any encroachment by the proposed extension of the Charing Cross, Euston, and Hampstead Railway.

Watford.—At last week's meeting of the Rural District Council a letter was read from the solicitors to the promoters of the proposed tramway scheme asking the Council to withdraw their opposition to the Bill. It was stated that the Council's opposition was simply with a view to certain protecting clauses being inserted. The County Council have decided to oppose the Watford and District Tramways Bill.

Huddersfield.—The official opening of the electric tramways took place yesterday. A large party left the town hall just after noon and travelled in special steam cars to Longroyd Bridge. Here the ceremony of formally opening the power station was gone through, after which the starting up of the engines was witnessed. The return journey to the town hall, where luncheon was served, was made on the new electric cars.

New Malden.—The District Council have passed a resolution that if the London United Tramway Company will agree to carry out the provisions of a report presented by the surveyor to the Council, and in consideration of the company paying the sum of £1,500 to the Council for public improvement purposes, the Council will waive the insertion of Clause 8, which refers to the widening of the railway bridge in Kingston-road, in the heads of agreement.

Birkenhead.—On Thursday week Lieutenant-Colonel P. G. von Donop, R.E., and Mr. Trotter inspected the permanent way and the overhead electrical equipment of the new tramways laid by the Birkenhead Corporation between Woodside and New Ferry. The inspection proved satisfactory, and the service of passenger cars was commenced on Monday last. The total length of the New Ferry route, which is the first section of the Corporation electric tramways to be inaugurated, is 2¾ miles. Fares have been fixed at 1d. stages, and 2d. for the full journey.

Aberdeen.—A joint meeting of the Tramways and Lighting Committees was held last week, when it was decided that the electric lighting department should proceed with their plans for the new station at Dee Village, leaving out any provision for the tramways in any way whatever. The larger question raised by the convener of the Tramways Committee, that there should be a special generating station for the tramways in a more central position, was deferred. The question of a repairing shed for the tramways at Dee Village station was departed from.

Crewe.—Last Wednesday week, Mr. Gerald A. F. Fitzgerald and Colonel Boughey, Light Railway Commissioners (with Viscount Emlyn as acting secretary), held an enquiry into an application by the Corporation for powers to construct a number of light railways or tramways in certain roads within the borough, and other roads outside. The London and North-Western Railway Company offered considerable opposition, on the ground that the scheme would not prove a financial success. The County Council also opposed, their objection relating principally to the roads not being sufficiently wide.

St. Helens.—The District Tramways Company have approached the Corporation with regard to the laying of a double track from Cropper's-hill to the toll bar. The electrical engineer is preparing a report as to the practicability of the suggestion and the probable cost involved. Sanction has been given to the Corporation's application to borrow £2,540 for the construction of tramways along Corporation-street and Parr-street. In the event of the tramway company requesting the Corporation to construct a line along Peeker's Hill-road and Junction-lane, the Tramways Committee have resolved that the line be made.

London United Tramways.—A trial trip was made on Wednesday on the system of the London United Tramways Company in London the conversion of which from horse to electric traction has been completed. The efficiency of the system is considered proved. The company has been unable up to now to commence passenger traffic in consequence of the absence of the Board of Trade's instructions as to regulations. The only serious disability in the way of the company is the opposition of the Kew Observatory authorities, who are concerned at the possibility of stray electric currents affecting the instruments at the observatory.

New York Elevated Railway.—The conversion of this railway from steam to electric power is expected to be completed by June next. The system adopted comprises eight 8,000-h.p. three-phase Westinghouse generators in a single power station, delivering power at 11,000 volts through three-conductor cables to step-down transformers located in seven sub stations. These sub stations are in convenient proximity to the railway lines, and contain 1,500 kw. Westinghouse rotary converters receiving current from the step down transformers at 390 volts and delivering continuous current through a single-conductor cable to the third rail at 625 volts.

Birmingham.—The Tramways Committee have considered the several Tramway Bills referred to them by the City Council—viz., the City of Birmingham, the King's Norton and Northfield, the Smethwick Corporation, and the Handsworth Urban District Council Bills. Reporting on the Birmingham Bill, the committee consider it very desirable that the lines within the city should be constructed by the Corporation and leased to the company; the lease to expire on Jan. 1, 1907, and the rent to be a sum equal to 10 per cent. on the actual cost to the Corporation of the construction of the new lines, connections to old lines, etc. As to the King's Norton and Northfield Bill, the committee recommend that the Corporation should consent to the authorisation of the proposed tramways within the city on certain conditions which have been agreed to by the King's Norton Council. The committee further recommend that the Handsworth and Smethwick Bills, although not directly affecting the city, should be watched during their progress through Parliament.

Tramways Return.—A parliamentary return has just been issued giving elaborate figures of the capital invested in tramways, the gross receipts, working expenses, etc. The return shows that the total capital paid up in England and Wales for tramways on June 30 last was almost £16 000,000, as compared with £14,000,000 in the previous year; while for the United Kingdom the total is given as £20,500 000, as compared with £18,000,000 in June, 1899. In England and Wales the length of line open for public traffic in June last was 933 miles, and in the United Kingdom it was 1,177 miles. There were 526 locomotive engines employed in England and Wales, as compared with 557 in 1898. The number of passengers carried in England and Wales was 817,000 000 in the year ending June last, as compared with 700,000,000 in the previous year. For the first time the net receipts last year were £1,030,552, as compared with £898,662 in 1899, and £623 338 in 1894. From the present return it appears that last year the total number of horses employed on tramways in the United Kingdom was 37,481, as compared with 44,171 in 1899, when the number was the highest on record. In 1878 only 9,222 horses were employed in working tramways. This is especially interesting, having regard to the increasing adoption of electric traction on tramways.

LIGHTING AND GENERAL.

Motherwell.—The formal inauguration of the electric lighting scheme took place last Friday.

Shipley.—It is expected that before the end of March the town will be supplied with the electric light.

Derby.—The Town Council intend to oppose the Derbyshire and Nottinghamshire Electric Power Bill.

Lincoln.—The electrical engineer having resigned, a successor at a salary of £300 a year is to be appointed.

Southampton.—The Electric Lighting Committee have decided to recommend the Council to borrow £24,478 for electric light works.

Barry.—The Public Works Committee have refused to allow the Post Office authorities to erect telegraph poles in Graving Dock-street.

St. Marylebone.—The Council have decided to present a formal petition against the Metropolitan Electric Supply Company's Bill in order to protect their interests.

Bromley.—The Urban District Council have appointed a committee to consider the desirability, or otherwise, of the Council establishing its own telephone system.

Cowes.—During the illness and pending the funeral of Queen Victoria upwards of 370,000 words of Press and thousands of ordinary telegrams were dispatched from Cowes.

Poplar.—The following gentlemen have been appointed members of the Electricity Committee: Messrs. Anderson, Barge, Barnes, Beaumont, Bugler, Morton, Randall, and Thurston.

Chelmsford.—The Lighting Committee have recommended the Town Council to seal the draft renewal contract with the electric lighting company for five years from March 25, 1901.

Lancaster.—The Town Council have confirmed the appointment of Mr. Wm. A. Tester as electrical engineer to take sole control of the whole of the electric lighting undertaking and the tramway scheme.

Warrington.—The Town Council have decided to take up a loan of £31,566, already sanctioned, for the purposes of electric lighting, and also a loan of £13,400 for the same object authorised in 1899.

New Works.—We understand that Messrs. Congdon and Powell, makers of electrical switch slabs, tanks, etc., have removed to new and very much larger works at Britannia Wharf, Pimlico, S.W.

Doncaster.—At a meeting of the Electricity Committee last week it was recommended that Mr. S. H. Thompson, of Glasgow, be engaged as assistant engineer, subject to the terms of the advertisement.

Bournemouth.—The Town Council and the Pokesdown Urban District Council have decided to oppose jointly the electric lighting

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order for which the Poole Electricity Supply Company, Limited, are applying.

Belfast.—The Electric Committee have prepared an interesting table giving a summary of the electric light rental for the year 1900, and which shows the use of electricity is increasing, both for lighting and for motor purposes.

Hammersmith.—During the quarter ended Dec. 31 there have been 716 consumers, an increase of 313 as compared with the corresponding period last year. The receipts amounted to £4,869. 11s. 9d., an increase of £1,427. 4s.

Wrexham.—The Town Council have sealed an indenture of mortgage for securing to the Alliance Assurance Company of £5,000, being the third equal instalment of the electric lighting loan of £20,000 authorised to be borrowed.

Scottish Electrical Contractors' Association.—We are informed that at a meeting of the General Committee of the Glasgow section, held Jan. 31, it was decided that the first business meeting of the Association should not be held until about the end of February.

New Cable Route.—The Eastern Telegraph Company announce that a cable between Porthcurnow, Cornwall, and St. Vincent, Cape Verde Islands, by way of Madeira, was opened for traffic on Wednesday last week, thus completing the new direct cable route between Great Britain and South Africa.

Rotherham.—The Electric Lighting Committee recommend that the price to be charged for the supply of electric current for motive power be 2½d. per unit. The committee further recommend that Mr. Ernest Cross (Aberdeen, be appointed electrical engineer to the Corporation at a salary of £200 per year.

Todmorden.—The electrical engineer has advised the Town Council that it would be economical to work the dust destructor in conjunction with the electric lighting works. The Town Council have decided to request the promoters of two Yorkshire Electric Lighting Bills to exclude Todmorden from the area of their Bills.

Calendar.—The Edison and Swan United Electric Light Company, Limited, have issued a useful and novel calendar for 1901. Handsomely designed, it is shaped to represent the "Ediswan" arc lamp, which has secured a lasting reputation throughout the kingdom among public bodies and in all engineering establishments.

Hampstead.—The Borough Council have adopted the recommendation of the Lighting Committee, that, in order to prolong the life of cables and to afford them better protection against mechanical injury, all electric mains should be laid upon the solid system in lieu of armoured cables as heretofore laid directly in the ground.

Kensington.—The plans of the scheme for lighting the workhouse and infirmary with electricity, and for the Guardians to lay down their own plant, have been sent back to the Local Government Board without the amendment suggested by the Local Government Board, that the supply should be obtained from outside sources.

Stepney.—The Electric Lighting Committee of the Borough of Stepney Council have decided upon a new tariff which will allow of a more equal distribution of the cost over the whole year, thus reducing the winter and increasing the summer accounts; the demand indicator readings will not be taken during the six summer months.

Formosa.—H.M. Consul for South Formosa reports that the following public works are now in progress or contemplated in the island: a railway from south to north; a cross railway from east to west in the south central district; harbour works at Takow; dredging works at Anping; waterworks at Takow; lighthouses (North Island, Pescadores); and telegraphs.

Personal.—We notice that Mr. T. H. Roberts-Wray has resigned his position as general manager to the Renewable Electric Lamp Company in order to start, in partnership with Mr. Alfred Baxter, the late London representative of the British Electric Works Company, Limited, a business as electrical engineers and suppliers of universal electric plant machinery.

Ormskirk.—On the question of the electrical engineer's report on the lighting of the workhouse premises with electricity being raised at the last meeting of the Board of Guardians, the Chairman said that 2d. per unit was the cost at which it was estimated they would use the electric power for pumping. He thought that if the scheme were carried out, there need be no fear of adverse criticism from the ratepayers.

Goole.—It is reported that the electric lighting order has passed through the preliminary stages. The Aire and Calder Navigation Company have opposed the order, and are asking for the insertion of a clause that the Urban District Council shall not have power to enter upon the Navigation's property to lay mains without the consent of the Navigation. The request of the Navigation Company is likely to be granted.

Fulham.—The opening ceremony at these works has been postponed until the 21st inst. We understand that the Mayoress will switch on the light, after which the company assembled will be entertained by the Council to afternoon tea. In the evening a dinner is to be given by the various contractors interested in the works, but this the Mayor and certain extreme Radical members of the Council have refused to attend.

Amazon Telegraph Co.—The directors report that for the year ended June 30 the revenue amounts to £14,427 and the expenses to £39,996. After adding £8,900 for debenture interest and sinking fund, there is a debit balance of £34,468, which, added to the debit of £29,300 brought forward, leaves a debit of £63,769 to carry forward. It is proposed to issue £150,000 debentures ranking in priority to the existing debentures.—*Financial News.*

National Telephone Co.—The directors, subject to final audit, recommend the following dividends for the half-year ended Dec. 31: at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares; at the rate of 5 per cent. per annum, less income tax, on the third preference shares; and at the rate of 5 per cent. per annum, less income tax, on the ordinary shares, carrying £85,000 to reserve and about £6,000 forward.—*Financial News.*

The City (London)—With regard to the notice of application to the Board of Trade for an alteration of the regulations in reference to the supply of electrical energy, the Court of Common Council have adopted the recommendation of the Streets Committee that the Board should be informed that the Corporation objected to the proposed alterations, and that they should be asked to afford the Corporation an opportunity of submitting their views on the subject before coming to a decision in the matter.

Stock Exchange. — The Stock Exchange committee have appointed Feb. 13 and 30 special settling days for the Metropolitan Electric Supply Company, Limited, further issue of 13,769 ordinary shares of £10 each, £5 paid, Nos. 85,001 to 98,769. Application has been made to the Stock Exchange Committee to allow the Electric Lighting and Traction Company of Australia, Limited 20 000 6 per cent. cumulative preference shares of £5 each, Nos. 1 to 20,000, to be quoted in the official list.

Llandudno.—On behalf of the Local Government Board Colonel C. H. Luard last week held an enquiry into an application by the Urban District Council for a loan of £1,500 for purposes of electric lighting. Mr. A. H. Preece, the consulting electrical engineer to the town, with whom was Mr. C. H. Morton, the resident engineer, stated that it was proposed to extend the steam-condenser at a cost of £1,126; building work was to be carried out at a cost of £87; and for engineering expenses and contingencies £287 was estimated.

Newark—At the monthly meeting of the Sanitary Authority it was stated that the proposed electric lighting station would be put on about 2ft. of concrete so as to raise the buildings quite out of the way of the floods, and they would be so constructed that they could be extended on the same lines as occasion required. Provision had been made for three engines of about 320 h.p. For condensing 18 000 gallons per hour would be required, which would be taken from the navigation, but would not reduce it, as the water would be returned to it.

Camberwell.—The Council have passed a resolution agreeing with the resolutions passed at last year's conference between representatives of the London County Council and of London local authorities with reference to certain proposals then before Parliament for the establishment of undertakings for the supply of electricity in bulk to local authorities or companies which might require it. The resolution sets forth that the Borough Council agrees with the principle laid down in the conference resolutions, and in its opinion no further conference is necessary, but if one be convened, the representatives will attend.

Glasgow Exhibition.—Electric motors, says the *Glasgow Herald*, will be a conspicuous feature at the exhibition, many of the exhibitors throughout the section showing machinery in motion driven by this means. In the machinery hall there will be over 60 motors, ranging from 1½ b.h p. to 200 b.h.p., and three each in the grand avenue and industrial hall. Electric cranes will be utilised in the handling of the exhibits, a five-ton one at the machinery hall loading bank and one of three tons at the goods yard at the industrial hall. Each crane is fixed, the electricity being supplied from the Corporation system.

Mile End.—At a recent meeting of the Guardians the Works Committee reported that they had gone carefully into the question of the electric light, and finding that the production was a very expensive affair, the result far from satisfactory, and that to effect an improvement would involve an outlay of several hundreds of pounds in the provision of new batteries and increased storage capacity, they recommended that no further outlay be incurred over the plant, and that the use of this means of lighting the premises be discontinued until the Borough Council have provided the neighbourhood with this means of public lighting. The matter was referred back to committee for further consideration and report.

Belfast Telephones.—At the last meeting of the Town Council it was reported that at a recent meeting of the Law and Improvement Committee the following resolution was adopted: "That the town clerk be authorised to accept the Postmaster-General's license for telephonic business as settled, and we recommend that a special meeting of Council be held to determine how far the undertaking be proceeded with, and that meanwhile no further facilities to erect poles or lay wires be given to the National Telephone Company." Considerable discussion ensued, after which it was agreed to delete the following words from the resolution: "And that meanwhile no further facilities to erect poles or lay wires be given to the National Telephone Company."

London Gazette.—A receiving order has been made out *re* T. A. Flather, 406, Meanwood-road, Leeds. The first meeting in the estate of the above will be held on Feb. 13 at 11.30 a.m. at official receiver's offices, 22, Park-row, Leeds, and the public examination on Feb. 26 at 11 a.m. at County Court House, Albion-place, Leeds.—The last day for receiving proofs in the estate of L. Francis, 13, Corporation-road, Southwold, Suffolk, is Feb. 16. Mr. H. P. Gould, official receiver, 8, King-street, Norwich, is trustee.—A first dividend of 3s. 6d. per pound has been declared *re* A. W. Hirst (trading as Hirst and Co.), St.

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Michael's-road, West Croydon, Surrey. Payable from Feb. 15 at official receiver's offices, 24, Railway-approach, London Bridge, S.E.

York.—The Electric Lighting Committee recommend that the basis of charges for lighting and power and for meters, as from Dec. 31 last, be as follows: For general lighting, the charge to be on the present rebate system of 7d. for the first hour's maximum demand, and 2d. per unit for all beyond that; for consumers who use more than 1,500 units per half-year, the sum of 7d. and 1½d. to be charged. Consumers, however, may at their option, to be declared in advance, be charged the following flat rates—viz., up to 400 units, 6d. per unit: above 400 to 600, 5d. per unit; above 600 to 2,000, 4½d. per unit; above 2,000 to 3,000, 4¼d. per unit; above 3,000 to 5,000, 4d. per unit. Above 5,000, special arrangement. For power and heating, the price of current to be at the rate of 1½d. per unit; churches, chapels, and other places of worship to be at the rate of 3d. per unit. Meter rents to be abolished as from Dec. 31 last.

Tunbridge Wells.—From a report of Wednesday's meeting of the Town Council which appeared in the *Sussex Daily News* we find that, in reply to complaints as to the occasional failure of the electric light in Tunbridge Wells lately, Councillor Robb, as chairman of the Lighting Committee, explained that the present system at the central station was in all ways inadequate to meet the increased demands of the town. As soon as possible the new machinery now being constructed would be in working order, and it was hoped there would be no repetition of the partial failures of the light. The speaker also detailed the additions to the works at the central station, and said it was estimated that a new chimney shaft would cost £5,000, and the lengthening of the present chimney would cost £175 this expenditure being required to meet the needs of the extended works. A well-known firm at Nottingham was being consulted in regard to the chimney shafts, and meanwhile the work in connection with the new machinery, extension of premises, etc., was being pushed forward. The Council accepted the explanation as satisfactory. It was stated that at an early date the Mayor would call a special meeting of the Council to discuss the question of a system of electric tramways for Tunbridge Wells and district.

Swindon.—A meeting of the Swindon Traders' Association was held on Thursday last week for the purpose of taking into consideration the proposal of the Corporation to seek parliamentary powers for the establishment of a system of electric lighting and traction for the borough. Alderman Skurray, the chairman of the committee which has charge of the matter, attended and explained at length the details of the scheme. The Corporation, he pointed out, were practically unanimous with the opinion that electric lighting and traction would be a great convenience and a valuable asset to the ratepayers, and the slight opposition which was shown outside the Corporation was due to the fact that the scheme was not properly understood. The Corporation had consulted Mr. Price, of Portsmouth, who gave it as his opinion that the scheme would undoubtedly pay. Acting under the advice of the consulting engineers, one of the most able firms in England, the Corporation had already purchased a centrally situated site for a generating station, and tenders for the necessary buildings, engines, and dynamos would shortly be considered. He pointed to the success which had attended electric traction in other places, and stated that under this scheme the Corporation would be able to light the town much better and much more cheaply than at present. The meeting decided, with only two dissentients, to intimate to the Corporation their approval of the scheme.

Stoke Newington.—The Electric Lighting and Sites Committee have reported on a letter from the London County Council with reference to the application of the North Metropolitan Electric Lighting Company, Limited, for an electric lighting order in respect of the area of the borough, enquiring whether the Council intends applying for an order for the South Hornsey portion of this borough, and whether they consider, having regard to the Hackney Order of 1893, the granting of the order now applied for should be opposed. The committee recommend that the Council do reply that the Council is of opinion that, by virtue of the Metropolis Management (Plumstead and Hackney) Act, 1893, Section 10, the London Government Act, 1899, and Section 3 of the South Hornsey Scheme, 1900, thereunder, the Council has powers, under the Hackney Order of 1893, applicable to the whole of the borough, including the South Hornsey portion, and that the Board of Trade has it in contemplation to introduce a Bill in the coming session of Parliament to ensure that electric lighting areas in London shall be co-terminus with the metropolitan boroughs, and that the Council desires that any provisional order which would confer powers on a private person or body to supply electricity in this borough, otherwise than by agreement with the Borough Council, should be opposed; and that the London County Council be requested to oppose the application accordingly.

Stockton.—The *Northern Echo* publishes an interview with the chairman of the Gas and Electricity Committees, Alderman Richard Hind, J.P. In reply to questions, Alderman Hind said: "The public lighting by electricity, in substitution for gas, has been so satisfactory that we shall extend it as occasion offers. We have 32 10-ampere Crompton arc lamps in the High street, part of Norton-road, and Bishopton-lane, and four five-ampere British Thomson-Houston enclosed arc lamps in the neighbourhood of the town hall, and it is suggested that we should proceed to erect arc lamps in Bridge-road and Yarm-lane. Since the electric lighting order empowering the borrowing of the necessary money was passed by the Local Government Board, we have already gone in for extensions of the mains to the West-villas, Richmond-road, and Yarm-lane to St. Peter's Church, and it is also proposed to extend the mains down Bridge-road to the railway crossing, and, if possible, to induce the Bridge Board to light the bridge with the electric light. The number of consumers already connected and the applications for connection that have been made will fully employ the whole of the present plant, without allowing much for reserve in case of accident. The committee have, therefore, no option but to ask the Corporation to authorise them to provide additional power. The engine-room is large enough to double or treble the present power, which is 300 kw. Consequently the proposed extensions only mean the cost of the new machinery, as the working expenses and standing charges will be practically the same. On this account the profit on the enlarged supply will be so much greater, which makes the extension all the more desirable. Enquiries have been made within the last few days for over 2,000 8-c.p. lights, and this alone, if the negotiations are concluded, would necessitate an extension of the works plant." At Tuesday's meeting of the Corporation it was decided to extend the mains for private lighting down Bridge-road and to make arrangements for the erection of eight arc lamps.

PROVISIONAL PATENTS, 1901.

JANUARY 28.

1872. **Improvements in current collectors and ploughs for electric tramway conduits.** Richard Mills, London and County Banking Company, Limited, Deptford, London.

1890. **Improvements in electric storage batteries or accumulaters.** Job Thomas Niblett, 4, Wellesley-mansions, West Kensington, London.

1894. **Improvements in electric meters.** James Hunter Gray, 141, Hopton-road, Streatham, London.

1900. **Improvements in telephone switching apparatus.** Joseph Davenport Finney Andrews, 75, Fulham Park-gardens, Fulham, London.

1917. **Improvements in electric railway systems.** Ed. Wilson Farnham, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1939. **An improved electric alarm.** Henry Felix Freed, Isaac Freed, and Sylvester Omer Spring, 40, Chancery-lane, London. (Complete specification.)

JANUARY 29.

1966. **Improvements in and connected with positive rods for secondary electric batteries.** Harry Rose, John Halifax, and Charles Henry Antrobus, 5, Hatton-garden, London. (Complete specification.)

1981. **Improvements in electric storage batteries or accumulators.** Job Thomas Niblett, 4, Wellesley-mansions, West Kensington, London.

1990. **Improvements in holders for incandescent lamps.** Joseph Davenport Finney Andrews 75, Fulham Park-gardens, Fulham, London.

1994. **Improvements in and relating to electrical meters.** Victor Isidore Feeny, 60 Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

JANUARY 30.

2089. **Improvements in trolley-controlling mechanism.** Charles William Gatward, 6, Lord-street, Liverpool.

2099. **Improvements in or relating to electric arc lamps.** William Fairburn-Hart, 50, Wellington-street, Leeds. (The General Electric Company, United States.) (Complete specification.)

2117. **Mechanism for actuating electrical igniters for internal-combustion engines.** Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Gasmotoren Fabrik Deutz, Germany.) (Complete specification.)

2118. **Improvements in systems of electrical distribution.** Bertram Hopkinson, 26 Victoria-street, Westminster, London. (Complete specification.)

JANUARY 31.

2127. **Improvements in or relating to electric fuse heads for blasting purposes.** William Albert Malson and Sidney Richard Malson, Bank-buildings, George-street, Sheffield.

2151. **Improved means for registering calls at telephone exchanges.** Edward Rowan, 4, Danes-inn, Strand, London.

FEBRUARY 1.

2223. **Improvements in portable plugs and wall sockets for electric circuits.** William Maxwell Stewart, 62, St. Vincent-street, Glasgow.

2233. **Improvements in electric arc lamps.** William Brown, 118, Fenchurch-street, London.

2238. **Improvements in toll apparatus for telephones.** Edward Payson Baird, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 2, 1900, being date of application in United States.) (Complete specification.)

2240. **Improvements in trolley rope holders.** John William Clayton, 52, Chancery-lane, London. (Complete specification.)

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2254. Improvements in or relating to maximum electric meters. Arthur William Brown, 11, Vere-street, Cavendish-square, London.

2272. Improvements in means and apparatus used for propelling boats by electricity. William Rowland Edwards, 65, Chancery-lane, London. (Complete specification.)

2285. Improvements in controlling mechanism for electric trolleys and the like current takers. Charles William Gatward, 6, Lord-street, Liverpool.

2293. Improvements in or connected with electrical switches. Albert Ernest Carter and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Feb. 28.

1899.

21964. Manufacture and repair of incandescent electric lamps. Fanta.'

1900.

1588. Manufacture of electric cables. Heyl-Dia.

2197. Magnetic holding table for metal-working machines specially adapted to hold flat articles down upon it. Lock and Barr.

2469. Electrolytic and like electrodes and electrical resistances. Kent.

4248. Switches or circuit breakers for high-potential electric circuits. British Thomson-Houston Company, Limited. (Rice.)

5382. Step-by-step printing telegraph instruments. Casella.

5393. Trolley poles and standards for electric traction. Strachan.

5841. Electricity meters. Clutterbuck.

8457. Means for electrically lighting lightships and other stationary vessels. Junge.

11107. Patterns or designs for electrically regulating the operating of card-punching machines, embroidery machines, and jacquard and other looms. Edwards. (Handwerck.)

20942. Systems of electric motor control. British Thomson-Houston Company, Limited. (Potter.)

21703. Systems of electrical distribution and arc lamps therefor. British Thomson-Houston Company, Limited. (Fleming.)

22516. Electrical interrupters for gas-engines. Bergmann.

22687. Apparatus for electrically operating keyed musical instruments. Reynolds.

23390. Electric controller casings. British Thomson-Houston Company, Limited. (Perry.)

23583. Supporting devices for electrically insulating telegraph and similar wires. Lake. (Renault.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Feb. 2	511	522	− 11	24,206	21,002
Birmingham Trams.	,, 2	3 707	3 877	− 170	18 882	—
Blackburn Corp'rat'n	Jan. 13	1 191	—	—	2 724	— *b*
Blackpool Corporatn.	,, 31	159	140	+ 19	29 046	21,361
Blackpool-Fleetwood	Feb. 2	142	167	− 25	674	740
Bolton Corporation..	,, 3	1.242	—	—	6 654	—
Bradford City Trams	,, 3	655	349	+ 306	3,589	1,720
Bristol Tramways Co.	,, 1	3,612	2 476	+1 136	—	—
Carlisle Tr'mw'ys Co	,, 2	106	—	—	558	—
Central London Ry.	,, 2	7,112	—	—	30 578	*a* —
City & South London	,, 3	1 955	1,119	+ 836	9 978	5,590
Cork E. T. and L. Co.	Jan. 31	322	297	+ 25	1,508	1 453
Dover Tramways ...	Feb. 2	139	149	− 9	775	756
Dublin & Lucan E.R	,, 2	64	48	+ 16	333	261
Dublin U.T., elec. cars	,, 1	3,109	2,789	+ 320	—	—
Dublin S.D. Electric	,, 1	612	569	+ 43	—	—
Dundee Tram Co. ...	Jan. 30	445	356	+ 89	—	—
Glasgow Corporation	Feb. 2	7,958	8,147	− 189	—	—
Halifax Corporation	,, 3	660	520	+ 140	33 665	26,633
Hull Corporat'n E.S.	Jan. 26	1 516	666	+ 850	38 355*b*	—
Liverpool Corporat'n	,, 26	8,143	6,598	+1,545	32 151	26 626
Liverpool Overhead	Feb. 3	1,404	1,527	− 123*	7,398	7,553
Portsmouth Corpn...	,, 2	667	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 3	2,500	—	—	—	—
Southampton Trams	Jan. 31	604	364	+ 240	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	Feb. 1	399	250	+ 149	1,698	1,104

a From July 30, 1900. *b* Since April 1, 1900. * Embarkation of troops.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	–	10½-11½
——— 40,001-70,000	5	–	10½-11½
——— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
——— 5 per cent. Mortgage Debentures	100	–	100-105
British Electric Works, Ordinary, 80,001-95,000	1	–	¼-½
——— 6 per cent. Cum. Pref., 1-60,000	1	–	¼-½
——— 4½ per cent. First Mortgage Debentures	108	–	96-97
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4½-4¾
Brush Electrical Engineering, Ordinary	2	–	1⅝-1¾
——— Non. Cum., 6 per cent. Pref.	2	–	2-2¼
——— 4½ per cent. Debenture Stock	100	..	105-110
——— 4½ per cent. 2nd Debenture Stock	100	–	101-106
Callender's Cable, Debentures	100	–	109-113
——— Ordinary	5	–	13-14
——— 5 per cent. Pref.	5	–	5½-5¾
Crompton and Co.	8	–	2½ 3½ xd
——— 5 per cent. Debentures	—	–	99-103
Edison and Swan United, Ordinary	8	–	13-13¼
——— 5 per cent. Debentures	5	–	2¼-2½
——— 4 per cent. Deb. Stock, Red.	100	–	95-90
——— 5 per cent. Second Deb. Stk., Prov. Certs.	—	–	98-100
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1⅝ 2¼ xd
——— 7 per cent. Cumulative Pref.	2	–	2¼-2
——— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
W. T. Henley's Telegraph Works, Ordinary	5	–	12½-14½
——— 4½ per cent. Preference	5	–	5¼-6
——— 4½ per cent. Debentures	100	–	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	20½-21½
——— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	12	–	39-43
——— 5 per cent. Bonds	100	–	101-104
Telegraph Manufacturing, Ordinary	5	–	10-11
——— 5 per cent. Cum. Pref.	5	–	5¼-6
Willans and Robinson, Ordinary, 1-80,000	5	–	10¾-11¼
——— 6 per cent. Cum. Pref., 80,001-60,000	5	–	6¾-7½
——— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	12½-13½
——— 4½ per cent. Cum. Pref.	10	–	10-11
——— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	–	7-8
——— 7 per cent. Preference	5	–	8¼-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-80,000	5	–	6¾-6¾
Charing Cross and Strand	5	..	9¾-10½
——— 4½ per cent. Cum. Pref.	5	–	5¾-5¾
Chelsea Electricity Supply	5	–	6¾-7
——— 4½ per cent. Debentures	100	–	109-112
City of London, Ordinary	10	..	7¾-8½
——— 6 per cent. Cumulative Pref.	10	–	13-14
——— 5 per cent. Debenture Stock	100	–	122-127
——— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (60 p.c. pd.) Red.	—	..	61-63
County of London and Brush Provincial, Ordinary	10	–	8¾-9½
——— 6 per cent. Cum. Pref.	10	–	11¼-12½
——— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	106 109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4¾-5½
——— 4½ per cent. First Mort. Deb.	100	..	102-105
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7¼-8¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10½
London Electric, Ordinary	8	–	1½ 2
——— 6 per cent. Pref.	5	–	4-5
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	12-13
——— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
——— 2½ per cent. Mortgage Debenture, Red	100	–	96 99
Notting Hill Electric Lighting	10	–	14½-15½
Oriental, 1879	1	–	1½-1¾
——— £5 Shares	5	–	7-7¼
——— £4½ Shares, New	4½	–	5¼-6
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	–	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	–	70-80
Royal Electrical Company of Montreal	$100	–	170-190
——— 4½ per cent. First Shares Mortgage Debentures	$100	–	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
——— 4 per cent. Debenture Stock	100	..	80-90 xd
South London, Ordinary	5	–	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	14¾-15½
——— 7 per cent. Pref.	5	–	8¾-9½
——— 2½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	–	11½-12½
——— 80,001-100,437	5	–	11-12
Electric Railways.—			
Central London, Ordinary	10	–	8¼-8¾
——— Pref. Half-Shares	5	–	4¾-5¼
——— ,, ,, deferred	5	–	3¼-3¾
City and South London, Consolidated Ordinary	100	–	50-54
——— Ordinary	10	–	4¾-5¼
——— 4 per cent. Debenture Stock	100	–	115-120
——— 5 per cent. Pref. Stock '91	100	–	128 143
——— ,, ,, ,, '96	100	–	130-135
Liverpool Overhead, 5 per cent. Pref.	—	–	12½-13½
Waterloo and City, Ordinary	100	–	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-16
Brisbane Tramway	100	–	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	–	9½-10½
British Electric Traction, Ordinary	10	–	13-14
——— 6 per cent. Cm. Pf. 80,001-60,000	10	–	12-13
——— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4¾-5¼
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4¾-4¾
——— 5 per cent. Deb. Stock, Red.	100	–	104-107
——— Prov. Cert., all paid	—	–	96-98
Kidderminster and District Lighting and Traction, Pref.	10	–	9¾-10½
New General Traction, Ordinary	5	–	3¾-4
——— 6 per cent. Cum. Pref.	5	–	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	16-17
——— 5 per cent. Cum. Pref.	10	..	10¼-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	–	11¼-12¼
——— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
——— 4½ per cent. Debenture Stock	100	–	102-105
Telephones.—			
National Telephone, Ordinary	5	–	4-4½
——— 6 per cent. Cum. First Pref.	10	–	13-14
——— 6 per cent. Cum. Second Pref.	10	–	11-12
——— 5 per cent. Non. Cum. Third Pref.	5	–	4¾-5¼
——— 4 per cent. Deb. Stock, Red.	100	–	97-100
——— 3½ per cent. Deb. Stock, Red.	100	–	94-97
Oriental Telephone and Electric Company	1	–	¾-1¼

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NOTES.

Pilot Voltmeters.—At the meeting of the Glasgow section of the Institution of Electrical Engineers, held on Wednesday last, Mr. Michael B. Field read an interesting paper on "A Method of Compensating Voltmeters for the Voltage Drop in Long Feeders."

Electro-Harmonic Society. — Mr. W. E. Lane having been elected honorary secretary (*pro tem.*) to this society, in succession to the late Mr. C. N. Grove, it is requested that subscriptions, applications for membership, and other communications be addressed to Mr. Lane at 14, Durley-road, Stamford Hill, N.

Long-Distance Wireless Telegraphy. — Dr. Fleming, during an address on wireless telegraphy as applied to lightships and lighthouses at Liverpool on Tuesday, announced that Mr. Marconi had just established direct communication with his system between St. Catherine's Point and the Lizard, a distance of 200 miles. Mr. Marconi is certainly to be congratulated on this new achievement.

An Early Automobile.—We notice in the columns of our French contemporary, *La Locomotion Automobile*, a statement to the effect that while delving in the records of the city of Hamburg a record has been discovered that in 1479 the communal treasurer was authorised by the magistrates of the town to pay a bonus of 24 livres d'Artois to a man named Gilles de Dom as an appreciation of his gift to the city of a "carriage set in motion by mechanical means only."

Electric Cranes.—At a recent meeting of the Yorkshire College Engineering Society, Mr. J. Hartley Wicksteed read a paper on the equipment of a foundry. In the discussion of this the relative advantages of electrical and steam cranes were considered. Certain speakers objected to the electrical equipment on the ground that it was liable to get out of order, but the President (Mr. J. Wilson Hartnell) explained that it was the question of design that influenced the upkeep of the crane. With a moderate amount of attention to details, dust could be kept out of the working parts, and then the electrical crane would be found much more easier worked and more cheaply maintained than the steam-driven crane.

Telegraphists' Good Work.—Sir Arthur Bigge has addressed a letter to the Press, on behalf of the King, expressing his Majesty's entire satisfaction with the manner in which the unprecedentedly heavy work in the telegraph office at Osborne and Windsor Castle was performed during the period of illness and since the lamented death of the Queen. The telegraphists on duty at Osborne and Windsor Castle at this time under Mr. Hiley, the Court telegraphist, were: Messrs. M. Daud (surveyor's staff), S. J. Jackson, P. W. H. Lander, J. Harnett, E. Long, W. G. Simmonds, R. Tubb, E. J. Eagle, G. A. Hounsell, F. W. Waller, W. G. Yeo, W. Muller, and Inspector W. Seggie (engineer's department, Newport, Isle of Wight). To this gratifying communication a letter was sent on behalf of the Postmaster-General, in reply, expressive of the great pleasure Lord Londonderry felt, and stating that the officials named would be proud to remember the gracious notice which had been taken of their services.

The Auroral Spectrum.—On the Danish expedition into Iceland, the spectrum of the aurora borealis was photographed and compared with the spectrum of the brush discharge from a metallic wire, but especially with the photographic spectrum of the light around the negative electrode of a discharge tube containing oxygen, a Scheiner spectrograph being employed. The auroral spectrum has a "principal ray" of wave-length about 556 tenth-metres, two strong bands at 428 and 392 tenth-metres, and numerous weaker bands extending into the violet as far as 337 tenth-metres. The spectrum of the brush discharge contained all of these bands save those at 428 tenth-metres and 392 tenth-metres; the cathode discharge in oxygen reproduced quite closely the entire auroral spectrum, though it showed also a number of foreign lines, due probably to the presence of oxides of C and N in the discharge tube. In estimating relative intensities of the auroral bands, says *Terrestrial Magnetism*, the arbitrary values 9 and 12 were given respectively to the bands of wave-length 428 and 392 tenth-metres. Many of the weaker bands, however, were sometimes absent altogether, making an accurate comparison with the intensities of the cathode discharge bands impossible.

The Queensland Post and Telegraph Department.—We have just received greetings for Christmas and the New Year from the officers of the Post and Telegraph Department at Queensland. We believe that the interesting memento on which the greetings are conveyed to us was sent by Mr. John Hesketh, electrical engineer to the department. It consists on the first page of the portraits of the postmasters-general who have held office since the department was first formed. These portraits are grouped round a table of statistics of the department, in which the financial results in 1870 and 1899 are compared. It is seen that the revenue of the Post and Telegraph Department has increased in that interval by about 10 times, while the number of letters newspapers, etc., dispatched has increased even more than that. Thus the telegraph messages in 1870 were only 89,368, whereas in 1899 they had increased to 1,641,096. On the next page are given the portraits of the eight principal officials of the department, amongst which our friend Mr. John Hesketh appears. On the other pages is given a reproduction of the original record of Queensland's first day's telegraph service, which was April 13, 1861. The receipts on that day amounted to the enormous sum of £2. 3s. 2d., while we notice that the least charge for any message was 2s. The design for the new general post office at Brisbane completes the memento.

The Electrical Engineer to the London County Council. — It will be remembered that in December last the London County Council advertised for an electrical engineer for the engineer's department, who should be directly responsible, under the chief engineer, for the work of construction or reconstruction for electric traction of the various tramways to the Council, other than those to be constructed under the supervision of Dr. A. B. W. Kennedy; the engineer also to be responsible for the working of the generating station plant and electrical equipment of the tramways after their construction. The salary named was £1,000 per annum. Twenty-five applications were received by the department, and these were reduced by the Highways Committee, who, after a personal interview with the applicants, selected three as being specially suitable for the position. These three names were submitted to the Council on Tuesday last. They were: Mr. Robert Percy Bransson, electrical engineer (under the Electrical Traction Company) for the construction of the Central London Railway; Mr. Charles Herbert Gadsby, consulting electrical engineer in private practice, specialising in electric traction; and Mr. John Hall Rider, chief consulting and resident engineer for electric tramways and electric lighting under the Plymouth Corporation. The committee recommended the Council to appoint Mr. Rider, as in their opinion he was the best

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fitted to discharge the duties which would devolve upon the candidate selected. We are pleased to note that the Council confirmed this decision on Tuesday, and now have the pleasure of congratulating Mr. Rider on his well-deserved promotion.

Civil Engineering Education.—Mr. P. M. Barnett recently gave his presidential address to the members of the newly-formed Aberdeen Association of Civil Engineers. He spoke of the demands made on the profession, in consequence of which it had been found necessary for civil engineers to restrict their attention and to devote their energies in a great measure to special branches of engineering. They had now harbour, railway, electrical, mining, sanitary, mechanical, and hydraulic engineers, and in each branch there was full scope for the best skill of the civil engineer. In Aberdeen they had civil engineers practising in nearly all the branches of the profession, and he anticipated that the association would prove a benefit, especially to the younger members. Mr. R. Gordon Nicol then gave some valuable notes on the education of a civil engineer, referring to the general qualities which were necessary in the ideal civil engineer. He spoke strongly on the necessity of adopting practical instead of the abstract methods so much in use at present, and also urged the necessity of young engineers having experience in the workshop, so that they might gain a real and intimate knowledge of the materials with which they had to deal in constructive work. No kind of theoretical teaching alone was considered fit to meet the intricate problems which the engineer had to deal with in his daily practice, and skilled judgment was acquired only from experience and observation.

Electrical Accessories.—We have received from Mr. C. H. Wordingham the revised list of electrical fittings which have been approved by the electric lighting department of the Manchester Corporation. It will be remembered that in December, 1898, Mr. Wordingham instituted a system of testing and registration which applied to all electrical accessories to be used in connection with the Manchester system of electrical supply. One argument which was brought forward at the time against this system was that the consumers would be restricted to a comparatively few articles which had been approved by the department, and that in consequence the cost of installing electric light would be very much increased. The contrary has been the case, however, as is shown in the list now before us. For practically every article required we find often a dozen names of electrical firms whose type of apparatus has been tested and approved. With this wide choice the consumer has also the advantage of knowing that the apparatus on his premises has been tried by an expert to see that it will reasonably fulfil its object. In looking through the list there are certain articles against which only a few names of makers are given. It will be seen, however, that these are the odd sizes, as, for instance, a switch to be used with sixtenths of an ampere of current at 200 volts. Against this only two names appear, whereas for the one-ampere switch for the same voltage no less than 16 various types by different manufacturers can be obtained. In a number of instances the catalogue prices are given opposite the makers' names. This, we think, should be done in every case, for it makes the list much more valuable to outside authorities, because they know the actual type of article which has satisfactorily passed through the stringent tests prescribed by Mr. Wordingham.

Independent Plants.—The Kensington Board of Guardians have a slight difference with the Local Government Board on the question of the provision of an independent electric lighting plant for the workhouse and infirmary. The Board of Guardians had included this independent plant in their scheme which was sent to the Local Government Board for approval. The plans were returned, with the request that the Guardians should reconsider them and obtain the supply of electricity from outside sources. At a recent meeting of the Board the question was discussed, and it was decided to stand by their original scheme, including the independent electric lighting plant. We have not the full facts of the case before us as to how many lights would be required in the workhouse and infirmary in question. We have noted, however, elsewhere that there is among local authorities a tendency to instal plant when the financial results arrived at cannot be expected to prove satisfactory compared with the cost of obtaining electrical energy from outside sources. The lighting of the Thames Embankment by the London County Council is a case in point. We remember at the time this was first projected, figures were given to show that it was cheaper for the Council to supply their own electric lighting. It would be exceedingly interesting to compare these forecasts with the actual figures, as, considering the small amount of plant required and the heavy cost of the site and buildings which have been erected, we think the estimates would be found to have been exceeded. Another point is the labour question, which in this case is an exceedingly serious one in view of the staff required compared with the comparatively small quantity of electrical energy which has to be generated. The Kensington Board of Guardians do not stand in such a favourable position as some, for such institutions have, as a rule, steam heating plant, and the one engineer can be placed in charge of the whole of the boiler plant, with a resultant economy in the labour charges for the electric lighting.

Deep-Level Electric Lines.—Amongst the advantages which the Great Northern and City Railway Company claim that they will realise over the Central London Railway is that arising from the use of a much larger tube. In this case the tube is to be of sufficient diameter to take the ordinary rolling-stock of the Great Northern Railway Company. With this large diameter there will be sufficient space at the side of the train to enable the doors of the present rolling-stock to be opened when the train is in the tunnel. This undoubtedly is a great advantage, but it can be unduly emphasised. The arrangement of the doors on the Central London Railway possesses extremely great facilities for the quick loading and unloading of the trains. The point, however, in which the new line will have an advantage is that they may distribute the weight of their electric motors throughout the train and do away, in consequence, with the exceedingly heavy electric locomotive. It is not, however, the weight of the locomotive on the Central London Railway which is giving the trouble in causing vibration, so much as the fact that a large proportion of this weight is carried on the wheels without the intervention of springs. In the locomotives in question the armatures are built directly on the axles, and half the weight of the field-magnet system also comes directly on the axles without the intervention of springs. In consequence of this a severe blow is caused every time the weight passes over a joint in the rails, as the dead-weight of each armature and half the field has to be accelerated upwards during the very short interval of time in which the wheel is passing from the low end of one rail and the projecting end of the rail of the next. This hammering action has damaged the track, particularly at the joints, while the small wheels on the ordinary rails give audible evidence of the defects so caused. We believe it is a fact, however, that the con-

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tractors for the plant advocated from the first the use of geared motors in order to avoid the great dead-weight on the axle, and that such geared motors are now being introduced as a means of overcoming the vibration trouble.

Central-Station Design. — Mr. R. A. Chattock, M.I.E.E, the Bradford city electrical engineer, gave a lecture to the members of the Bradford Scientific Association at the Mechanics' Institute on Friday last on "The Design of Central Electric Generating Stations." The president (Mr. E. Naylor) occupied the chair. In the course of his address Mr. Chattock remarked that his subject was of especial interest at the present time, in view of the large extensions that were now being carried out at the electricity works of the Bradford Corporation. If an area of supply was not large, and the population was fairly dense, the most suitable form of supply was by direct current. Direct current could be supplied economically on the three-wire system at a pressure of from 400 to 500 volts for a distance of about three miles, and this method lent itself to the supply of motive power more satisfactorily than the alternating current; the motors were more easily manipulated, and were cheaper in first cost than motors using alternating currents. If, however, the area was large and the population scattered, it was necessary to supply current at high pressure, of from 2,000 to 5,000 volts, or even higher, and to transform it down again at various points. If a direct-current supply was to be used, the site should be as central as possible within the area of supply in order to reduce the lengths of the various feeders and ensure efficient working. It might be laid down as a general rule that it was far more economical to put down one large central station rather than several small ones, and consequently the area of the site chosen should be large enough to provide for the total expected power required, with allowance for stores, workshops, and offices. In the early days of electric lighting a mistake was almost invariably made in not allowing sufficient space for extensions, and experience had proved that it was the best policy, if land could be obtained at a fairly reasonable rate, to buy even five or six times the amount required at the moment, and, if possible, to let it on short tenancies, so that it was always available when required. The arrangement of the various portions of the building was explained in detail, and various points were illustrated by means of lantern pictures. After a good discussion a vote of thanks was accorded to Mr. Chattock for his lecture.

London's Electric Power Supply.—At a meeting of the Institution of Junior Engineers held at the Westminster Palace Hotel on Friday last, a paper was read by Mr. L. F. Awde on "Electric Power Supply in the Metropolis." The author, in the first place, referred to the comparatively small amount of electric power at present used in London, and dealt with the difficulties attending the supply of electricity for power purposes from the existing stations in the Metropolis at a price that could really be considered as reasonable, and which would induce the manufacturing community to generally adopt this form of energy for machine driving, etc. The disadvantages attaching to the positions of most of the various stations, and their results upon the working costs, were dealt with at some length, and in this connection a curious fact was adduced—viz., that the average works costs for 1899 were exactly the same for both local authorities and companies, being 1·91d. per unit in both cases, the advantage resting with the local authority only in the matters of rates and management to the extent of 0·37d. per unit. The author spoke strongly upon the action of the colliery proprietors last year in cornering the coal market, the results of which were so severely felt by all the electrical undertakings, and hinted at some counteracting remedy that it might be necessary to find should their tactics be sustained or repeated. He expressed himself in favour of one large station down the river, generating for power purposes and street-lighting only, and submitted detailed estimates for such a station of a plant capacity of some 33,000 h.p., the whole scheme involving a capital expenditure of over one million sterling. The system proposed was a three-phase generation, and distribution at extra high pressure to transforming centres, the low-pressure distribution to consumers premises being at 500 volts from rotary converters and batteries. The costs of working were set out in detail, showing a total cost of under ½d. per unit, the maximum selling price being suggested at 1½d. per unit, or 1½d. per horse-power hour. In the case of factories in the immediate neighbourhood of the generating station, and with a view to encourage the erection of such factories, the special price for these was put at the low figure of 1½d. per unit, equivalent to very little more than ¾d. per horse-power hour.

Stepney Charges.—The Borough Council of Stepney has now taken the place of the Whitechapel Vestry, and hence has taken over what was known as the Whitechapel electric lighting undertaking. We have been recently informed by the resident engineer of these works that a new scale of charges is to be inaugurated on the 25th of this month. It will be remembered that in the old scale of charges great inducements were offered to the electric lighting consumers to increase their demand for electrical energy in summer months. The inducement was that all electricity supplied in the months from April to the beginning of October was charged for at the rate of 1d. per unit. We gather that complaints have been made that in consequence of this the charges during the winter months became unduly heavy. It has accordingly been decided to alter the rates and to do away entirely with the old 1d. per unit rate in the summer. Under the new system the consumers will have the option of paying under either of the two following scales: "(*a*) At the rate of 1d. per unit for all electricity consumed, and a monthly rental of 7d. for each demanded 8-c.p. lamp (or its equivalent) as shown by the maximum demand indicator, each such lamp consuming one unit in 30 hours. (*b*) At the rate of 8d. per unit for all electricity consumed up to the quantity required for 30 hours' use of the demanded number of 8-c.p. lamps (or their equivalent), as shown by the maximum demand indicator, each such lamp consuming one unit in 30 hours; all electricity consumed in excess of this quantity will be charged at rate of 1d. per unit." The last scale would be made rather more explicit if it were stated that the 30 hours' use was per month. The circular also states that the maximum demand indicators will be only read during the six winter months, so that in the summer months the demanded number of 8-c.p. lamps or their equivalent will be taken from the mean of the demand indicator readings for the March quarter. The usual clauses are also in evidence to the effect that if the consumer wishes to increase his supply for one night only in each month, he can have the maximum demand indicator disconnected on application. We had in the first instance considerable doubt as to the efficacy of the rates of charge in the summer months, and think that the new scale is much to be preferred, as it spreads the same standing charge which the Council has had to incur to supply the consumer equally over the four quarters.

The Berlin Visit.—The secretary of the Institution of Electrical Engineers informs us that the preliminary arrangements for the Institution visit to Berlin, on the

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initial invitation of the Allgemeine Elektricitäts-Gesellschaft and of Messrs. Siemens and Halske, are now being made. The German Reception Committee, of which Mr. Gisbert Kapp is secretary, and the Council of the Institution are anxious to form at once an approximate estimate of the number of members of all classes likely to take part in the visit. It is proposed that the whole party, starting on Saturday, June 22, should break the journey at Hanover for one night, visiting installations at that place, and should arrive in Berlin on Monday, June 24. In Berlin it is understood that visits will be made to the works (among others) of the Allgemeine Elektricitäts-Gesellschaft and of Messrs. Siemens and Halske, as well as to installations of special interest. An evening entertainment will probably be given by the two firms above mentioned. A ladies' committee will be formed in Germany to arrange for the entertainment of ladies accompanying members. The visit to the city of Berlin will terminate on Thursday, June 27. Members of the Institution are, however, invited to take part in the meetings and visits of the Verband Deutscher Elektrotechniker in Dresden from Thursday, June 27, to Sunday, June 30. Should, therefore, a sufficient number of members signify their intention of joining each group, special arrangements will be made with a tourist agency to supply to those who wish for them tickets and hotel coupons at a special rate for the following parties: (*a*) London - Hanover - Berlin - London; (*b*) London-Hanover-Berlin - Dresden - London; (*c*) London - Hanover - Berlin - Dresden-Nuremberg-Frankfurt-Cologne-London. The last-named group (*c*) has been arranged to enable members to see the works of Messrs. Schuckert and Co. at Nuremberg, and of Messrs. Lahmeyer and Co. at Frankfurt, to which it is hoped visits may be arranged. Those extending their visit in this way could arrive in London probably about July 5 or 6. It is anticipated that the cost of the visit, if the reduced rates are available (including railway fares and hotel expenses, but exclusive of wine and extras), need not exceed—for Group A, £12 first class and £10 second class; for Group B, £16 first class and £13 second class; and for Group C, £22 first class and £18 second class. The secretary asks that the forms he has sent out may be returned before the end of the month. The programme of the visit is a most attractive one, and we expect a large number will avail themselves of this exceptional opportunity to visit Germany's largest electrical works.

Cooper's Hill.—We have in previous issues referred to the proposed radical changes in the staff at Cooper's Hill College which will entail the retirement of seven of the members of the staff, including the professor in hydraulics and mechanism, the professor in chemistry, and also the professor in physics. The seven gentlemen referred to have all been given three months' notice to determine their engagements, and they consider that they have been exceedingly hardly dealt with. From what we can gather, the change has been made at the instance of the president of Cooper's Hill College, who has had large experience in the Public Works Department in India. His proposals for the reorganisation of the staff have been considered by the Visiting Board, which consists of the following gentlemen: Sir Charles Crosthwaite (chairman); Mr. James Mansergh, president of the Institute of Civil Engineers; Sir A. Rendel, consulting engineer to the Secretary of State for India; Mr. H. Leonard, late chief engineer, Bengal; Colonel G. F. Pearson, late Director-General of Forests, India; Colonel Sir W. Bisset, R.E., Government Director of Indian Railways; Sir C. Ilbert, late member of the Viceroy's Council; Sir J. Wolfe-Barry, F.R.S., past-president, Institute of Civil Engineers; Sir W. Preece, F.R.S., late engineer-in-chief, General Post Office. One would think, from these names, that all questions of a personal character would be far removed from the reasons which resulted in the change mentioned above, which, it is claimed by some, is to be made for economical reasons. Another view of the case is that in certain departments the instruction given at the college has not been up to date. The teaching staff's reply to this is that they have never been consulted as to the curriculum to be adopted, or as to any changes which they might think should be introduced in the course of studies with advantage. In order to ventilate the matter more thoroughly, a memorial was presented on Tuesday last to the Secretary of State for India, in which a dignified protest is made against the arbitrary and sudden dismissal of the teaching staff above mentioned. It is urged by those who signed the memorial that such a course should not be taken without an enquiry into the working of the college. The memorial was signed by such prominent men as Lord Kelvin, Lord Rosse, Lord Lister, Lord Acton, Lord Rayleigh, Sir Henry Roscoe, Sir Wm. Huggins, and Sir Joseph Hooker, and was personally supported by many leading men. In reply to the deputation, Lord George Hamilton made a long speech, in which he reviewed the financial difficulties of the college, extending over many years, and also the proposed changes in the course of study. He gave particulars of the gratuities and pensions which would be given to the seven members of the staff, and concluded by stating that the personal interests raised by them must be subservient to the general welfare of the college.

The Education and Training of Engineers.—"On the Training of Electrical Engineers" is the title of a most interesting paper read before the Manchester Section of the Institution of Electrical Engineers on Tuesday evening. The author, Dr. John T. Nicholson, M.I.C.E., gives it as his strong opinion that after leaving school the boy who intends to become an electrical engineer should first spend at least two years in the workshops of a mechanical engineer. In boys coming directly from school to the professional college, he had always found it extremely difficult to arouse a lively and intelligent interest in their subjects of study. Turning to other matters, the author referred to an announcement in *Elektrotechnische Mittheilungen* that Herr von Dolivo-Dobrowolski, chief electrician of the Allgemeine Electricitäts-Gesellschaft, is shortly going to Petersburg to take over the direction of the new Government electro-technical institute there. The same journal states that Herr Görges is giving up his position as engineer-in-chief of the firm of Siemens and Halske to fill a professorship at the Dresden Polytechnic. Remarking on this, Mr. Nicholson says he has yet to learn of any appointment in a college or technical school in Britain whose attractions could induce its acceptance by the engineer-in-chief of any of our great companies! In conclusion, the author would press upon the members of the Institution his strong conviction of the expediency of at once establishing some arrangement whereby the more eminent young employés of our manufacturing houses may be enabled and encouraged to return, for periods of months at a time, to the laboratories of their schools or colleges, for the purpose of spending their whole energies in the prosecution of industrial research for the benefit of the firms employing them. This system, he points out, is already partly in vogue in Germany and America, and has produced most gratifying results. If, however, the leaders of British industry do not realise the national significance of such higher scientific training, it is futile for the heads of our colleges

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and technical schools to seek to thrust forward their projects in their despite. On the question of the education of children employed by engineering firms, the Manchester Association of Engineers had a noteworthy discussion last Saturday. It appears that the Secretary of State for the Home Department and the President of the Board of Education are about to appoint a Departmental Committee to enquire into the employment of school children. This raises the question how far they ought to remain at school or to go to work before they are 14 years of age. One speaker pointed out that the fault of many electrical engineers was that they were not properly trained, and had "specialised' before they had got the general instruction. The advantage of passing a definite resolution in regard to the matter was urged upon the meeting, and eventually it was resolved that the age limit should be raised one year, but that the standard of education should be raised at the same time, and that the meeting was of opinion that the engineering employers would be prepared in this event to accept a shorter apprenticeship.

Electric Lighting Orders in London.—There are four applications for electric lighting orders to be considered by Parliament this session dealing with areas inside the boundaries of the London County Council. Two of these refer to the area of the St. Marylebone Borough Council. The third takes in the districts of Lewisham and Penge, while the fourth embraces the Stoke Newington area. With regard to the first two applications, one is made by the St. Marylebone Borough Council, and the other by the St. Marylebone Electric Supply Corporation. It is the third year in succession that the last-named corporation have applied for a provisional order. It will be remembered that last year they succeeded in passing the committee stage, but that the order was thrown out on the ground that the new Borough Council should have an opportunity of undertaking the supply. The question is, however, complicated by the fact that the Metropolitan Electric Supply Company are already in the district, and that up to the present Parliament has not granted any provisional order to a local authority to enable them to compete with a private company. In fact, the old Vestry of St. Marylebone entered into negotiations with the Metropolitan Company for the purchase of that part of their undertaking which lies within the area in question. The negotiations did not come to business, owing to the great difference between the values put upon this portion of the undertaking by the experts engaged on either side. It would seem, therefore, that of the two competitors the Metropolitan Supply Corporation comes before Parliament with the bigger chance of success. The four applications have been considered by the Highways Committee of the London County Council, who naturally report in favour of the local authority's title to the orders concerned. They also suggest that in the event of any of the three companies having their applications for orders granted, that a repurchase clause should be inserted in the same, similar to that which was contained in the 1896 order for Camberwell. The clause in question provides that the local authority can repurchase at any time without the first 21 years upon the payment of $1\frac{1}{2}$ times the capital outlay of the undertakers, together with the sum necessary to make up the dividends to an average of 5 per cent. per annum from the commencement. The London County Council also suggest that the ordinary date of purchase should be 42 years from Aug. 26, 1889, in order that these should end at the same date as the other provisional orders within the county of London. With respect to the application of the St. Marylebone Borough Council, the only proposal made by the London County Council is that there should be no provision made in the order by which the Council should have the right to transfer. The transfer of the Lambeth order to the South London Electric Supply Corporation still rankles in the minds of the Highways Committee, in that in the transfer no provision was made for the London County Council's consent being requested before any plans were passed. This has prevented the Highways Committee of the London County Council having any jurisdiction over the company in question.

The Equipment of the Inner Circle.—Information continues to leak out concerning the various proposals for the electrical equipment of the Inner Circle of the Metropolitan District Railway Company. Thus we find that the outlines of the offer of Messrs. Dick, Kerr, and Co. have been communicated to our American contemporaries, who are enabled to publish actual drawings of the various details which this firm would adopt were the contract placed with them. We gather from these drawings that the firm would propose to use motors of a geared type on the axles of the passenger carriages. These would be controlled from either end of the train on the multiple-unit system. The ordinary train would be made up of six coaches, three of which would be motorcars and the other three trailing cars, so that at any time it would be easy to split a train up into small units. It is suggested that this could be done when the traffic was light, and then one motorcar and one trailer would form the unit. It is stated in the offer that it would be much preferable to work with an earthed return, having only one insulated conductor. If, however, the Board of Trade require an insulated return in order to protect magnetic observatories, the firm propose to run the two insulated conductors on the outside of the tracks. The one conductor would have its centre line $10\frac{1}{2}$in. above the sleeper, while the other, which would be vertically over the first, would be $11\frac{1}{2}$in. higher up. The castings, which would be secured to the sleepers by coach screws, and which would support the insulators carrying these conductors, would be provided with a projecting tongue between the two conductors. Wooden boards would be placed longitudinally from one of these projecting tongues to the next, and secured to the same by means of bolts. These boards would then form an insulated division between the two conductors. The main advantage claimed by the company for the introduction of electric traction on these lines is the greatly increased acceleration. For instance, with the motors fixed on every alternate carriage, as suggested in the offer, the train would have, when fully loaded, 63 per cent. of its entire weight on the driving wheels, whereas if even the trailing cars were filled and the motorcars empty, which would give the worst possible condition of things, 57 per cent. of the entire weight of the train would be on the driving wheels. The total weight of the loaded train, consisting of three trailing cars and three motorcars, is estimated at 129 tons. The trailing cars weigh $13\frac{1}{3}$ tons each, and the motorcars $22\frac{2}{3}$ tons each. The firm estimate that with the distribution of weight and motors they could obtain an acceleration of nearly $2\frac{1}{2}$ft. per second per second. The proposal is that the motorcars should be for third-class passengers while the first and second class passengers would be on the trailing cars. The firm proposes to employ three-phase currents, and to transmit at 5,000 volts to distributing stations, where transformers and motor-generators would be placed. The frequency proposed is 25 cycles per second. The whole of the motors and generators would be designed by Prof. Short, and it is suggested to use Willans engines to drive the generators. It remains to be seen whether this firm's offer will be accepted.

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HUDDERSFIELD ELECTRIC TRAMWAYS.

Huddersfield has taken a prominent lead amongst municipal authorities as being one of the first in all movements towards municipal ownership. The borough can claim to be the first of all towns to own and work a municipal tramway system. Thus it was in 1877 that tramways were first proposed for Huddersfield. The Bill brought forward in that year was introduced by the London Tramways and General Works Company, but was not proceeded with owing to the opposition of the Corporation. In 1879 the Corporation promoted a Bill, and obtained powers in the from time to time with girder rails weighing 98lb. per yard, resting on a concrete bed, the space between the rails being paved with granite. It appears that the Corporation made the tramways with an idea that they would be able to lease them, but as no company could be found to take over the working, it was decided in 1882 to purchase engines and cars and to run the line themselves. In doing so they worked under a license from the Board of Trade. Full powers for working the tramways were, however, obtained from Parliament in 1897. The history of the

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CHAIRMAN, TRAMWAY COMMITTEE.

THE MAYOR OF HUDDERSFIELD,
ALDERMAN R. M. SHAW.

COUNCILLOR T. A. COCKIN,
DEPUTY CHAIRMAN, TRAMWAY COMMITTEE.

MR. J. POGSON, M.I.M.E.,
GENERAL MANAGER
OF TRAMWAYS.

MR. K. T. CAMPBELL, M.I.C.E.,
BOROUGH ENGINEER OF HUDDERSFIELD, RESPONSIBLE
FOR THE ELECTRICAL SYSTEM OF TRAMWAYS.

MR. H. N. THOMAS,
RESIDENT ELECTRICAL ENGINEER AND CLERK
OF WORKS DURING CONSTRUCTION.

next year to enable them to construct tramways along certain routes. It was then decided to use the 4ft. 8½in. gauge, and to make the track of sufficient strength to enable it to carry locomotives. It will be seen that this was necessary owing to the severe grades which are found in the Huddersfield streets. This will be gathered from the fact that the altitude of the Huddersfield streets along which lines are constructed varies from 200ft. to 800ft. above the sea-level. The first system of rails used consisted of 43lb. rails spiked to metal chairs placed 3ft. apart, the chairs weighing 80lb. each. These chairs were supported on continuous beds of concrete. Some 10 miles of track were laid on this system, which was found, however, to be too light for the traffic which had to be carried. The extensions have consequently been made undertaking from 1882, when the cars were first run, up to the present time is too long for us to give in our columns. The department has had the financial difficulties which all pioneer undertakings are subject to, as the whole of the rails, rolling-stock, and car-sheds have had to be renewed during that period owing to two serious accidents, for which heavy compensation had to be paid, the undertaking was still further handicapped. It is satisfactory, however, to know that for the last five years the system has been entirely self-supporting, in spite of the fact that good wages were paid to the conductors and drivers, and that they worked comparatively short hours per day. From the figures given us by Mr. J. Pogson, who has for years had charge as general manager of the tramways, we learn that the mileage per annum of the steam trams has reached

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600,000 car miles, while over 6,000,000 passengers were carried during the past year. Leaving now the history of the undertaking, we come to the period when it was decided to equip the same for electrical working.

It may be said that from the date upon which the Huddersfield Corporation took into serious consideration the advisability of substituting electricity for steam as the motive power in connection with its extensive system of tramways, very little time has been lost in the carrying out of such work as has enabled the Tramways Committee to place at the disposal of the public an installation of electric traction comprising nearly one-half of the tramways within the borough, while the power station and car-sheds have been erected on a scale sufficient to meet the requirements

MR. F. C. LLOYD, TOWN CLERK.

of the whole of the tramways undertaking both within and without the municipal boundary. Under the Act of 1899 1900 powers were obtained for the construction of 19½ miles outside the borough and 3½ miles inside the borough, which, added to the 28 miles already laid inside the borough, make in the aggregate 52 miles of single track. The Corporation also have running powers over three miles and one furlong in the Linthwaite district.

If we look at the history of Huddersfield as regards its tramway enterprise from the beginning, it may fairly be said that, notwithstanding the many difficulties to contend with, more particularly in the initiatory stages of the undertaking, the Corporation has persevered from time to time, until we now find that, so far as the scheme of conversion has been completed or is in contemplation for the near future, the town may claim to have escaped the limitations which have come down to it as a legacy from the *régime* of the horse car and steam tram, and that we have a thoroughly equipped and up-to-date street railway with spacious cars, frequent service, and high speeds—conditions which have made tramways such important and necessary acquisitions in the economy of time, so essential to business people. These conditions are for the first time realised in Huddersfield to the fullest extent by the opening of the electric tramways, and the public have now an opportunity of seeing how great are the advantages of a tramway service embodying the very latest improvements in street locomotion. The new undertaking will, we hope, perform a twofold service. Not only will it add immensely to the convenience of the town, but will give an impetus to those adjacent centres of industry which at present suffer from inadequate means of transport.

Dealing with the Huddersfield Corporation electric tramways from their inception, and having regard to many difficulties which presented themselves at first, notably that of doing away with an efficient system of steam cars, which would be of no practical value in the new undertaking, the Tramways Committee may be congratulated upon the persistent manner in which it has adhered to the determination to convert the lines from steam to electric traction. It was in September, 1898, that the borough engineer, Mr. K. F. Campbell, M.I.C.E., A.I.E.E., was instructed to prepare a full report upon the proposed undertaking. The engineer's report was presented to the committee on Dec. 12, 1898, and, after a long and exhaustive investigation, was adopted by the committee on Feb. 24, 1899, and it was resolved to proceed forthwith to electrically equip the Lindley and Outlane routes. It had previously been suggested that these routes should be equipped as an experiment, but Mr. Campbell very strongly recommended that they should be merely considered as a part of the whole scheme of electric traction on the ground that in the equipment of a small section of the tramways the cost, *pro rata*, of providing buildings and plant, if they were to be of service as part of the entire scheme thereafter, must exceed the cost which would be incurred if the question of applying electricity as the motive power were confined to such a small section. This important decision on the part of the Council enabled the Tramways Committee to authorise the preparation of the necessary plans and specifications for the equipment of some 14 miles of single track. Before, however, committing the Corporation to so large an expenditure as was involved by the works

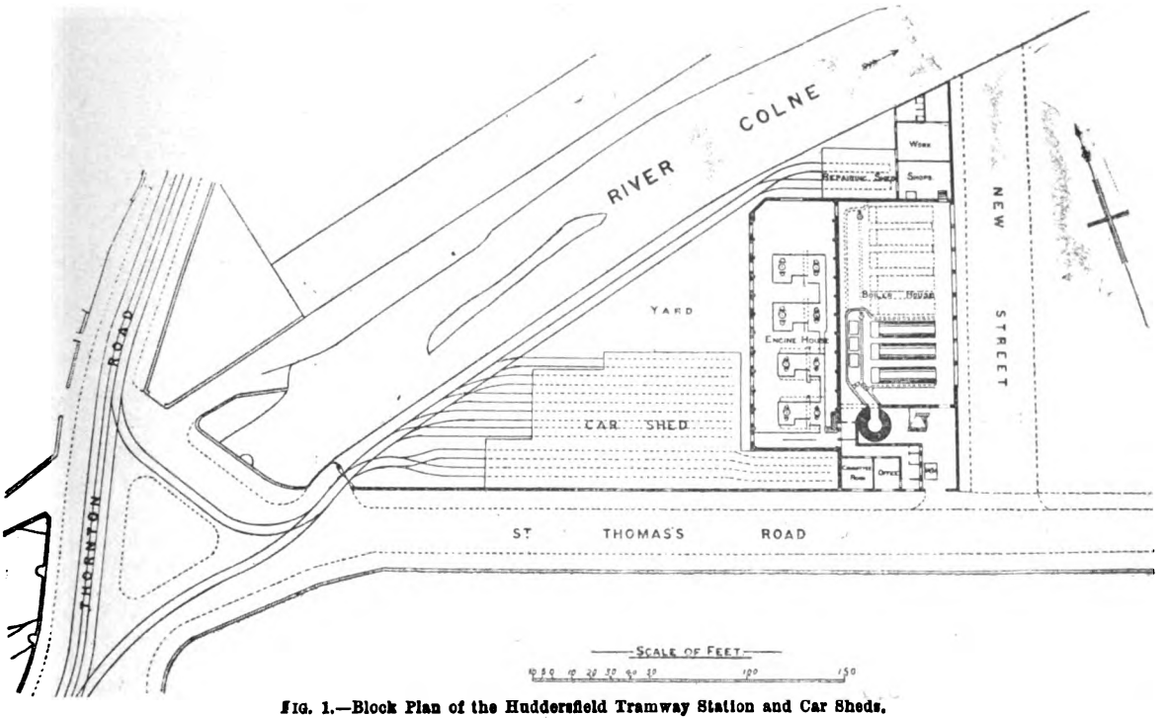

FIG. 1.—Block Plan of the Huddersfield Tramway Station and Car Sheds.

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contemplated, it was deemed advisable to refer the engineer's plans and specifications to a consulting engineer for his further advice, and Mr. Horace Field Parshall, M.I.C.E., of London, was therefore called in, with the result that the plans and specifications as submitted were approved by him. We should here note that in the preparation of the plans and specifications for carrying out the work the committee and the borough engineer have had the assistance of their able and experienced tramways manager, Mr. J. Pogson, M.I.M.E., who for a long time back had advised the committee to convert their extensive system of tramways from steam to electric traction, and had presented many valuable reports in favour of the conversion. In the carrying out of the work Mr. H. N. Thomas, late of the Isle of Man tramways, has acted as resident engineer and clerk of works. Mr. Thomas is now taking full charge of the running and upkeep of the electrical equipment.

Power Station Site.

In the matter of the selection of an advantageous site for a power station the Corporation has been exceedingly fortunate in its choice. Thus it has been able to command a position by which the whole of the current required in connection with the entire scheme can be supplied from one station with direct current at 500 volts, thus avoiding the additional expense of sub-stations and transforming gear. It has also been able to utilise a site which, already the property of the Council, has been for some time back unremunerative. The site, which is about one acre in extent, stands on the River Colne, from which an adequate supply of good water is always at hand for condensing purposes and for boiler feeding as well. In relation not only to the electric traction undertaking, but to the town's interests, it may be said that the position is an ideal one for the generation of power for tramway purposes at a minimum cost, and it must be admitted from the plan (Fig. 1) that the borough engineer has used the space available to the best advantage.

Buildings.

The buildings, which have been erected from the designs of the borough engineer, are all constructed in Yorkshire stone, with ashlar facings, and, although free from any attempt at embellishment, possess all the advantages in appearance and usefulness of a station of the first class. The roofs are of Welsh slates, with sufficient glazing to thoroughly light every part of the buildings. The boiler-

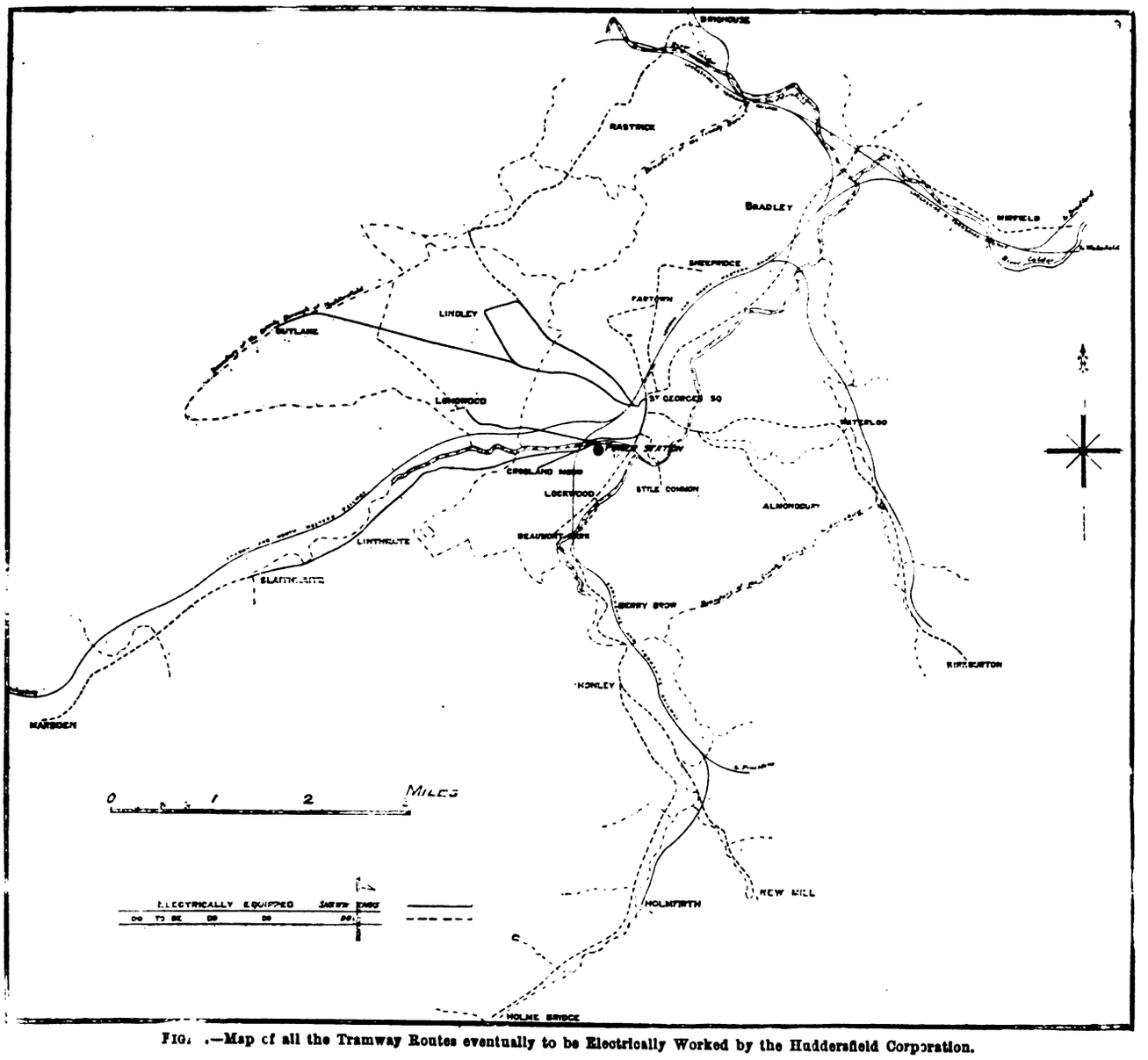

FIG. 1.—Map of all the Tramway Routes eventually to be Electrically Worked by the Huddersfield Corporation.

house has its entire frontage to a new street constructed between St. Thomas's-road and the River Colne; it is 107ft. in length, 59ft. wide, and 23ft. high to the square, and provides accommodation for eight Lancashire boilers. Opposite to each boiler is an arched opening in ashlar, with wrought label mould over, and formed of sufficient width to permit of additional boilers being introduced without interference with the structure; the circular portion above the doors is filled in with glass. The inside is lined throughout with double pressed bricks. The roof is slated in two bays, with skylights 6ft. wide on both sides of each bay. The apex of each roof is finished with continuous louvred openings for ventilation. The flues, etc., are lined with firebrick, and the front of the boilers is walled in white glazed brickwork. At the end and outside the building a coal hopper and elevator have been constructed in connection with the mechanical stokers

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supplied by Messrs. T. and T. Vicars. The flooring to the front of the boilers is finished in cement with polished granite face. The chimney shaft into which the boiler flues are carried is a graceful structure, circular in plan, and 225ft. in height, built in brickwork, and finished at the top with neat moulded stone cornice, supported by shaped and moulded corbels. The chimney is the sole relic of the dust destructor plant previously erected on the site, but which was not a success.

The engine-house is built alongside of and parallel with the boiler-house, and is 130ft. long, 42ft. 6in. wide, and 35ft. high to the square. It is abundantly lighted by 12 windows, each 5ft. wide and 15ft. high, the top portion of each window being made to open for ventilation. The building is faced inside with white glazed bricks, and the projecting buttresses and arches which support the moulded stone string carrying the travelling crane have bull-nosed angles, and a pleasing effect is obtained by carrying round at dado height three courses of chocolate-coloured bricks. At the end of the engine-house nearest the river an opening has been provided sufficient to allow all intended plant to enter the generating station without any interference with the buildings. This opening is filled in with doors and framing, with glazed sides and arch, all constructed so as to be readily taken down for the purpose mentioned. The roof is of steel construction in one span, with a skylight running along each side for the full length of the building, and three ventilators are fixed in the ridge with sufficient

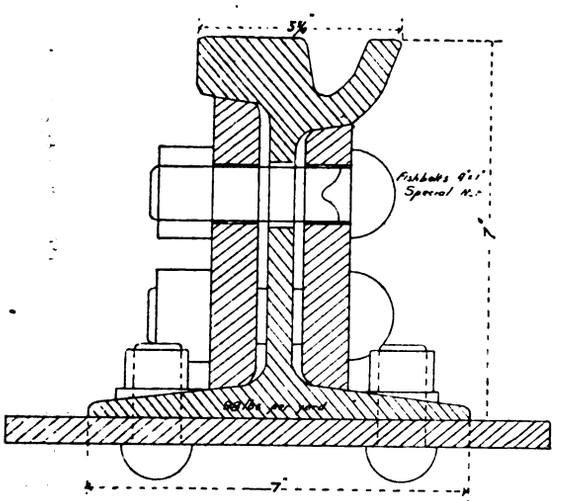

FIG. 3.—Section of the New Rails, showing Sole-Plate at Point.

extracting power to keep the atmosphere of the room agreeable. The roof is covered on the inside with dressed boards, with mouldings planted round to form panels between the principals, and being painted and picked out in colours has a very cheerful appearance. The switch-board gallery is situated 12ft. 9in. above the engine-room floor level, and is approached by an iron staircase, which also gives access to the platforms round the engines. A committee-room and suitable offices for the staff have also been provided.

The car-sheds, which practically occupy the remainder of the site, provide accommodation for some 25 cars, and are constructed entirely of steel, the roof being in four bays supported on wrought-iron posts and neat lattice girders. They are entirely lighted from the roofs by means of skylights, and the ceilings are boarded. An inspection pit has been formed between each set of rails to allow for a thorough examination of the cars when necessary. Standpipes and connections have been arranged at convenient points to facilitate the washing and cleaning of cars, and the whole of the sheds and yard has been paved with 8in. local stone setts laid to proper falls and connected with a perfect system of drainage.

The whole of the work in connection with the erection of the buildings has been performed by the following well-known local firms—viz: excavation and masonry, Messrs. Abm. Graham and Sons; joiners' work, Messrs. J. Walker Sykes and Son; ironwork, Messrs. W. C. Holmes and Co; plumbing, Messrs. Crossley and Bould; slating and plastering, Messrs. T. Longbottom and Sons; painting, Messrs. W. and P. Holroyd; cement flooring, Mr. John Cooke.

ROUTES.

The total length of tramways now electrically equipped is equivalent to 15 miles 7 furlongs 8 chains of single track, and comprises the following sections, which can be followed from the map (Fig. 2): From the generating station at Longroyd Bridge to the boundary between the townships of Slaithwaite and Linthwaite; the Crosland Moor section; the Paddock and Longwood route, terminating at Quarmby Clough; from Longroyd Bridge to St. George's-square *vid* Manchester-road, Buxton-road, New-street, and John William-street; Lindley *vid* New North-

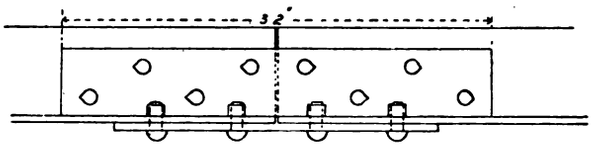

FIG 4.—Details of Fishplate.

road, Elgerton, Holly Bank-road, thence along Lidget-street and Acre-street, returning to St. George's-square by way of New Hey-road, Westbourne-road, West-hill, and Trinity-street, thus making a circular route between The Square and the Lindley and Marsh districts; also the Outlane route, which joins the last-named section at the Bay Horse, Lindley. Of the total length of lines, amounting to about 16 miles (single track), 10¼ miles of new lines have been constructed by the Corporation's own workmen under the direction of the borough engineer. Considering the fact that so much of the permanent way has been constructed without stoppage of the usual service of steam-car traffic, it will be realised that good progress, under circumstances of considerable difficulty, has been made.

The permanent way is divided into two sections, that laid between 1893 and 1898 for steam traffic, and that which has been since put down from the design of the borough engineer. It will be seen from the plans (Figs. 3, 4, and 5) showing the section of rail the great improvement made in the design of the latter. In the case of the old section of rail, weighing 98lb. per yard run, provision is only made for a groove of $\frac{7}{8}$in. in depth, and as a consequence the useful life of the rail on account of the limited depth of groove is materially reduced. In fact, the wheels wear away the tread so that they run on their flanges before the period of the loan (15 years) out of which they were paid for expired. The new section of rail has a depth of groove of $1\frac{1}{16}$in., and by the design so adopted gives greater rigidity, whilst the life of the rail is estimated to be several years longer than the old section, notwithstanding that the weight of the new rail is not increased. Another substantial advantage is attained in the new form of fishplate introduced. As is well known, the weakest part of the rail is that at the joint, and at Huddersfield, as well as other places, trouble has been

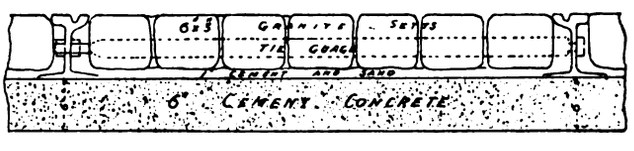

FIG. 5.—Section of Track.

caused by the almost constant springing of the rail at the joints. To overcome this difficulty the fishplate has been extended, as shown on the drawing, to a total length of 2ft. 6in., with the result that the joints are found to be sufficiently rigid to prevent any possible chance of springing. Each joint is bonded with double 0000 copper bonds of the Columbia type, carefully fitted by hydraulic pressure in holes drilled in each rail, and cross bonds of the same pattern are inserted at intervals of 120ft.

POWER STATION PLANT.

With the exception of the electrical equipment of the Paddock and Crosland Moor routes, which has been carried out by Messrs. R. W. Blackwell and Co., Limited, of London, the complete equipment contract was placed with

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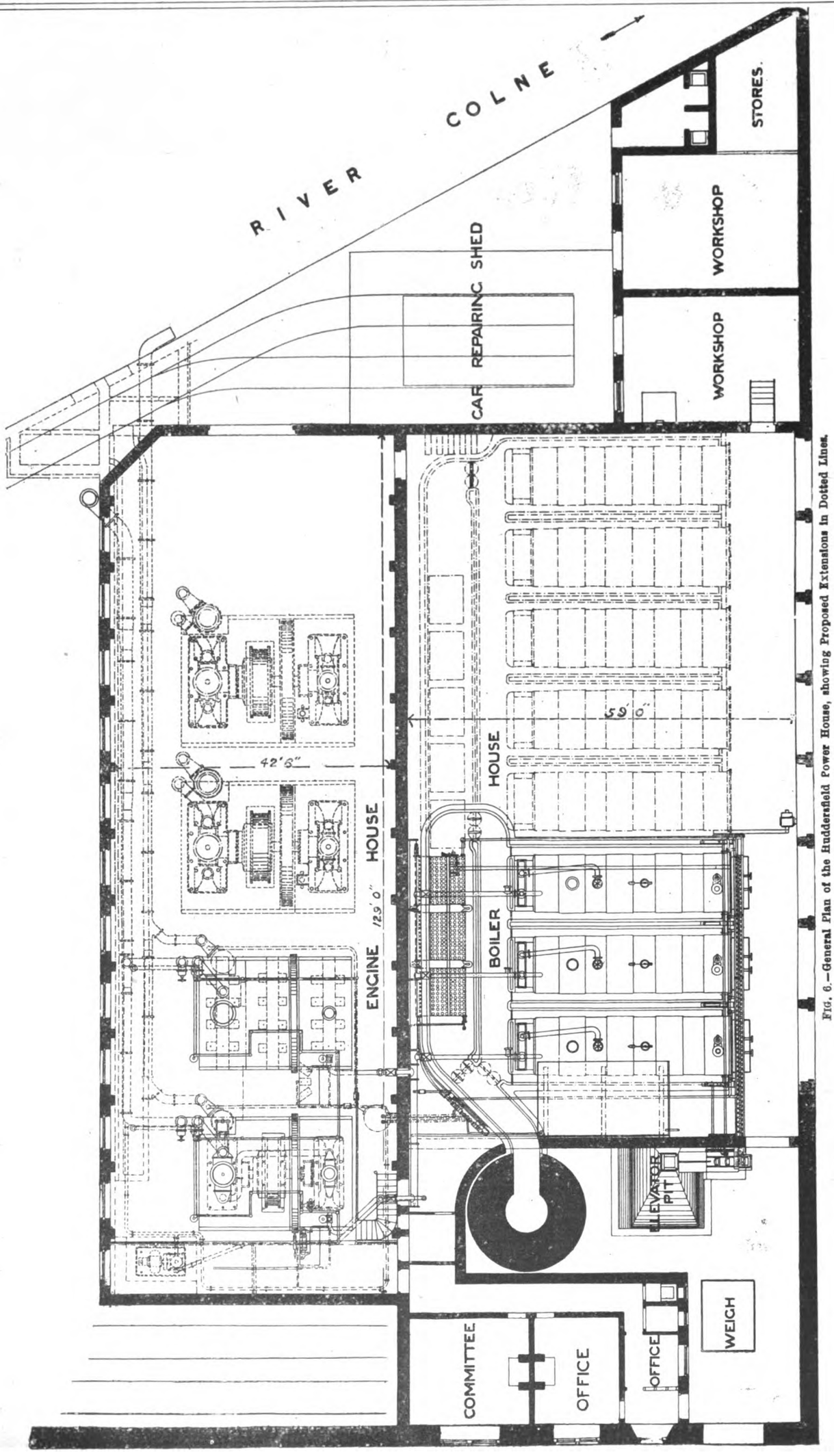

FIG. 6.—General Plan of the Huddersfield Power House, showing Proposed Extensions in Dotted Lines.

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Messrs. Greenwood and Batley, Limited, of Leeds, whose sub-contractors in every branch are also firms of great repute. The boilers, supplied by Messrs. Taylor and Co., Marsden, are three in number, of the Lancashire type, 8ft. 6in. internal diameter, 30ft. long, and constructed for a working pressure of 180lb. on the square inch. The plates comprising the outside shell are $\frac{15}{16}$in. thick. The flues are 3ft. 5in. diameter, and made up of 18 rings, the longitudinal seams being welded and the ends flanged for attachment to each other and a solid ring plate for caulking. Each flue is fitted with five Galloway tubes. These boilers are each guaranteed to evaporate 10,000lb. of water per hour. The furnaces are fitted with Messrs. Vicars's mechanical stokers, with special clinkering nozzles to allow the clinker to be broken while the furnaces are working. As the coal is carted to the power station it is tipped into the elevator pit (shown in the plan, Fig. 6), from which it is raised by an elevator of steel buckets mounted on an endless chain, which deposits the coal in the conveyor,

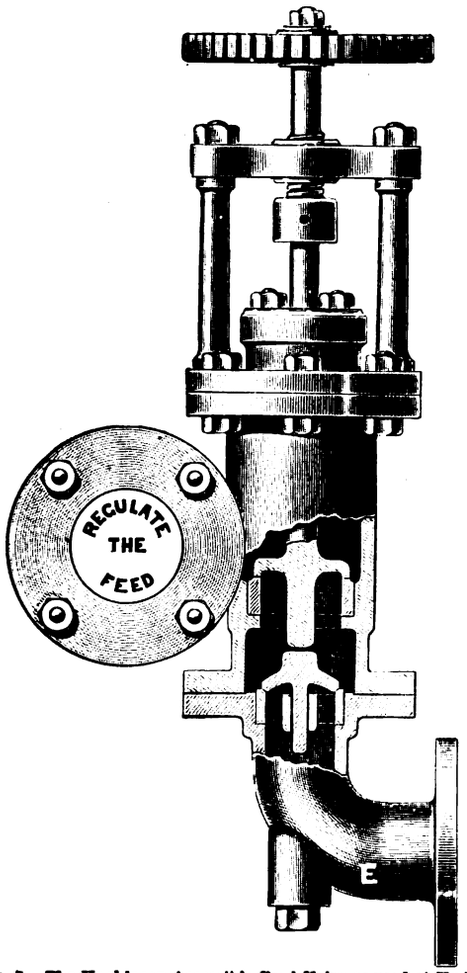

FIG. 7.—The Hopkinson Accessible Feed Valve as used at Huddersfield.

along which it is moved by a large screw to the row of furnaces in use. Each boiler is fitted with a hopper, from which the furnaces are fed, an automatic gear being employed to regulate the supply. A 10-b.h.p. electric motor drives the coal elevator and conveyor, and also the economiser, and is arranged to be driven either from the 'bus bars of the main generators or from the station lighting set. The elevator, conveyor, and gear were also supplied by Messrs. T. and T. Vicars, Limited.

The whole of the boiler mountings are Messrs. Hopkinson's own make, and include their patent quadruple safety valves, patent triad junction valves, patent accessible check feed valves, patent parallel slide blow-off valves, and patent absolute water-gauges with patent shields mounted on polished gunmetal columns. The Hopkinson's patent accessible feed valve (Fig. 7) is a novel arrangement of back pressure check feed valve, which has been designed to obviate a number of inconveniences and dangers incidental to the working of steam-boilers. A trouble common to many feed valves is that grit and other matter collect on the seat of the valve and prevent it from closing. When an ordinary valve is used, this prevents the stoppage of the boiler in order to remove the foreign matter, and a serious waste of time ensues. The main advantage of the valve under review, and one which will appeal to all users of steam power, is that the engineer is able to examine, clean, or repair it whilst the boiler is under steam. The mechanism by means of which this is made possible is quite simple. The engineer has only to close the upper valve by means of the wheel, and remove the elbow which contains both the valve and the valve seat. No other parts of the valve need be disturbed. The screwed portion of the spindle is outside the valve, and therefore not subject to fluid pressure or the action of water. It is fitted with Hopkinson's composite gland, and the spindle acts as an indicator to show the lift of the valve. It is made of gunmetal, or a cast-iron body with gunmetal working parts. A large number of these valves are already in use both in this country and abroad, and have given such satisfaction that the makers have found it necessary to put down a new labour-saving plant to turn them out rapidly. The boiler feed pumps are by Baylis and Thomas, of their usual direct-acting twin-cylinder type, and are in duplicate, as is the whole boiler feed piping, which is so arranged as to permit of one range being cut out in case of accident without inconveniencing the working of the boilers. From the pumps the feed water is passed through three Green's economisers of 96 tubes each, the tubes being 9ft. long by $4\frac{7}{16}$in. external diameter, which raise the feed water up to the temperature of the water in the boiler under pressure. The economisers are fitted with the usual scrapers and driving gear, and constructed to withstand a pressure of 350lb. on the square inch. The total heating surface of these economisers is 2,880 square feet.

The whole of the steam-piping is in duplicate, and is constructed of mild steel; the main branches are lap-welded, and the flanges are screwed on and the pipes expanded into them to ensure a sound joint. From the stop valve of each boiler the pipes are 7in. internal diameter, the main range being 10in. In addition to the main stop valve on boilers, steam stop valves in duplicate are fitted close up to the main range, which allows of any part of the steam range being cut out in case of accident or repairs without it being necessary to shut down the boiler. The connections between the boilers and the two main steam-pipes can well be seen in Fig. 8. All valves supplied are of Hopkinson's well-known type, the main valves having cast-steel bodies of a special pattern. The flanges on the pipes and valves are drilled to one standard in proportion to size, and are interchangeable, rendering repairs an easy matter. Steam-traps are fixed on the main range. A superheater of the Musgrave type, with 38 tubes, through which the steam passes from each boiler to the main range, is placed at the back of the boiler, in the hottest part of the flue, in order to ensure dry steam at the engine stop valve. The design of pipes is such that a by-pass pipe can be put on to cut out any superheater should it be required to do so. The whole of the steam-piping and boiler feed piping from the economisers is lagged with magnesia fixed on in sections with a steel or brass band, which allows any part of the pipes to be inspected without permanently destroying the insulation.

The engines driving the main generators are vertical inverted-cylinder compound-condensing engines, and have been built by Messrs. Musgrave and Sons, of Bolton. They can be seen in plan and elevation in Figs. 6 and 9, while Fig. 10 gives a general view of them. They are fitted with Musgrave's patent automatic cut-off gear, connected direct to the governor, thereby dispensing with an equilibrium throttle valve and attaining greater regularity in the speed of the engine, which is normally 90 revolutions per minute. The high-pressure cylinder is $17\frac{1}{2}$in. diameter, and the low-pressure 35in. diameter, with a 3ft. stroke. The air-pump is 24in. diameter, 14in. stroke, the pump bucket having a series of small indiarubber valves, also delivery grid with valves of best indiarubber. This arrangement is found to work well, and greatly reduces the shock on closing. The condenser is of the jet type, with the usual water regulator valves, etc. The injection water is taken from the River Colne and conveyed by an

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open culvert in the basement of the engine-house, into which the suction pipe of the air-pump is placed. The crankshafts of the engines are of Siemens-Martin steel, the crank discs being firmly shrunk on and accurately balanced. The crankshaft pedestals are cast with the base, and are fitted with bell metal steps lined with white anti-friction metal, and the bearings are on the swivel principle. The flywheel is of cast iron, 18ft. in diameter, having 10 tons of weight in the rim alone, in which is cast a suitable rack for gearing with the barring engine. The engines are provided with forced lubrication to all the parts, supplied by two ram pumps on each side of engine. One pump is coupled to the neck and eccentric rings only, the other pump supplies oil to the crank pin, cross-head pin, and slide block, but, if necessary, both pumps can be coupled so that they pump oil to one main pipe, which supplies all the parts under pressure. The individual feed can then be regulated by means of valves. The steam and exhaust valves are all of the Corliss type, double-ported, side, being carried through to the river and discharging below the intakes of the condensing water culvert. Provision has been made in these pipes and culvert for the enlarging of the power station up to its full limit. Suitable penstocks are provided to cut off the condensing water if required, and settling tanks have been put down to permit of the settlement of deposit. The total volume of flow when completed will be equal to 3,000 gallons per minute.

The generators, manufactured by Messrs. Greenwood and Batley, are of the multipolar type, each designed to have a capacity of 375 kw. at 550 volts when running at 90 revolutions per minute. The armature is of the slotted core type, and is keyed on to the engine main shaft between the cylinders, and also bolted to the boss of the flywheel. The magnet yokes are circular with inwardly projecting poles, which are removable without disturbing the field frame. The field is compound wound, and so designed that the potential shall be 500 volts at no load and 530 volts at full load. The commutator is built up of hard-

FIG 8.—Section of the Huddersfield Tramway Power House, showing Pipework but not the Engines.

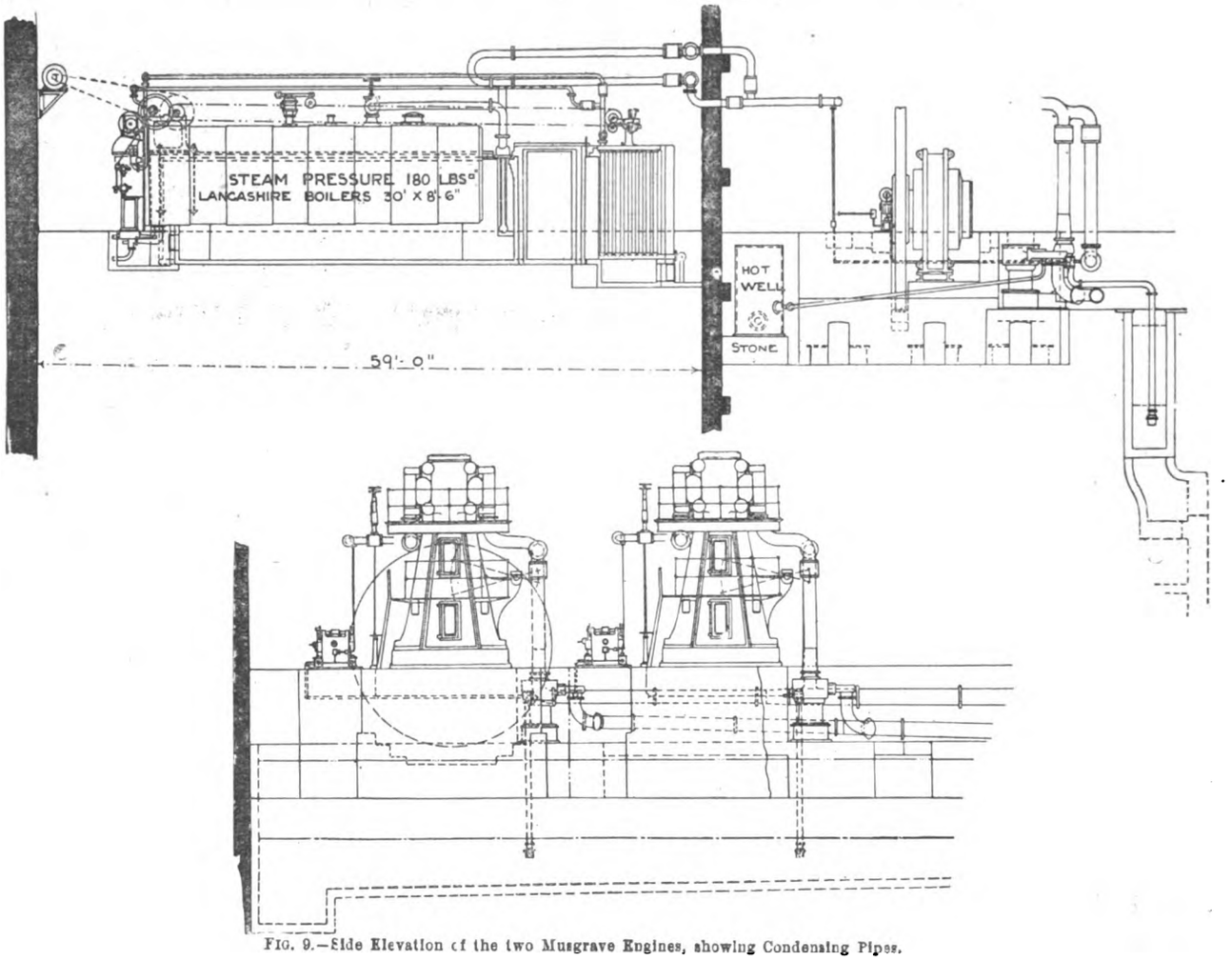

FIG. 9.—Side Elevation of the two Musgrave Engines, showing Condensing Pipes.

actuated by Musgrave's tripping motion for the steam side. The high-pressure valves only are coupled to the governor, which can be regulated to vary the speed whilst running. An auxiliary engine is employed to barr the main engines round, and is arranged to gear with the toothed rack in the rim of the flywheel. The barring engine, which makes 1,055 revolutions to one of the main engines, is Musgrave's patent, and is fitted with their well-known automatic releasing gear for throwing itself out of action as the engine gathers way.

Each of the main engines is capable of developing 520 i.h.p., or a maximum of 650 i.h.p., at 90 revolutions per minute, and 160.b. steam pressure. They are designed to be worked either as condensing or non-condensing. A large exhaust pipe to atmosphere is provided, which is carried over the injection water culvert in the basement and thence through the wall and up the outside of the building and wall above the roof of the engine-house. These pipes are fitted with suitable expansion joints and drain connections. The condensing water return pipes are laid along-

drawn copper insulated by mica strips, the bars being so mounted as to give the maximum wearing depth, and wide enough to permit adjustment of the brush-holders, so as to avoid ridges and to give uniform wear. The brush-holders are so constructed that the pressure of the brushes on the commutator may be adjusted as desired. The brushes are of carbon and provided with flexible copper connections to the brush-holders. The magnet coils are wound separately to admit of easy removal. All materials used are of the best quality. The insulation of the various electrical circuits to frame was tested with an alternating potential of 3,500 volts, and successfully withstood this severe test. The main cables from the connecting ring are highly insulated, and are carried up to the switchboard in suitable ducts.

A smaller steam dynamo is provided for the lighting of the station, the working of the cars in the shed, and the driving of the conveyors, economisers, and workshop motors. This consists of a 25-kw. dynamo, supplied and fixed by the British Thomson-Houston Company, Limited, and running at a speed of 400 revolutions per minute.

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This is direct-coupled to a Reavell engine of equal capacity, the generator being mounted on the bed-plate of the engine. The advantage of this small set is that it can be used for all station work when the larger generators are not required for traction purposes, and therefore the cost of running is very much reduced as compared with the working of the larger generators for shunting and repairing purposes. It also provides for the lighting of 100 16-c.p. incandescent lamps and five arc lamps on the station premises, and is capable of producing additional power when required. This Reavell engine is compounded in such a way that the steam, after the first stage of expansion on the top of the piston, is exhausted to the under-side, where the second stage of expansion is performed during the up-stroke, before exhausting to the atmosphere.

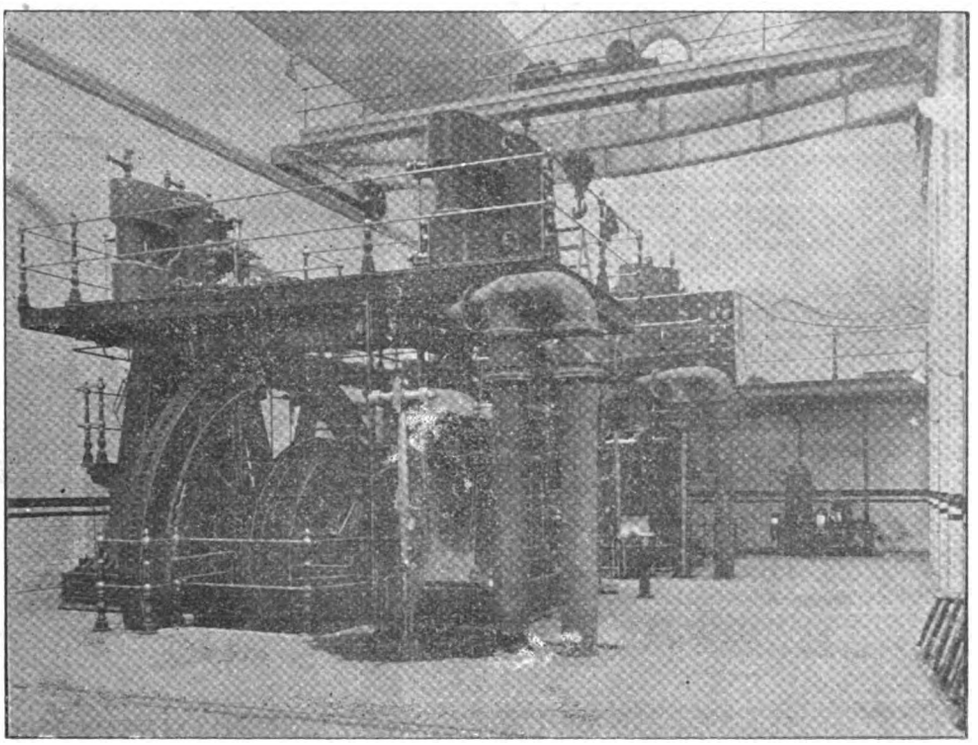

FIG. 10.—View o the Huddersfield Tramway Engine-Room, showing the Musgrave Engines and Greenwood and Batley Dynamos.

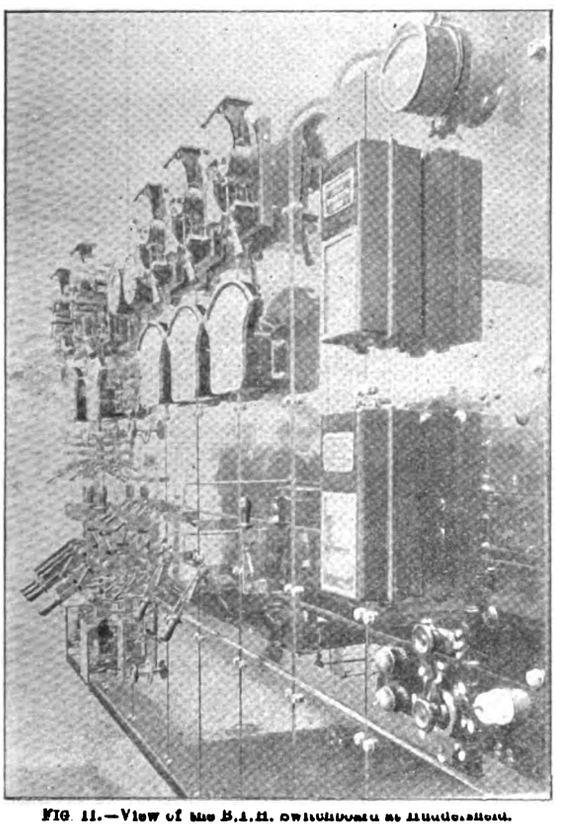

FIG. 11.—View of the B.T.H. Switchboard at Huddersfield.

The special feature of this system is that only a portion of the steam is transferred from the top to the under-side of the piston; that portion of the steam which is left being compressed up to initial pressure on the top of the piston, so as to serve the same purpose as an independent air-buffer, as used in other single-acting engines to overcome inertia during the up-stroke.

When steam is admitted for each succeeding stroke there is, therefore, after the point of cut-off, both the admitted steam and that which is compressed into the clearance space from the previous stroke, and this total quantity of steam is expanded above the piston; then, when transference takes place to the under-side of the piston, only that portion of the steam which was

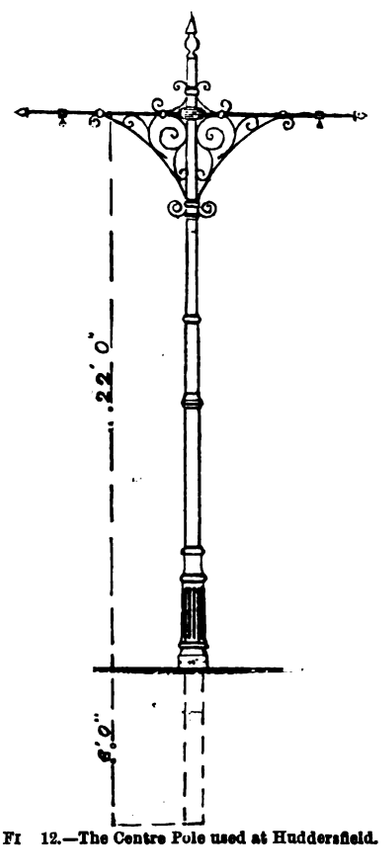

FIG. 12.—The Centre Pole used at Huddersfield.

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admitted during the previous stroke is transferred to the under-side, expanded again, and exhausted. The net result is that, although a single cylinder and piston is employed, two distinct stages of expansion are obtained, and the same economy results as would be obtained in other compound engines having two cylinders and two pistons. The engine has a central valve, and thus the valve gear is radial, operated from a point in the connecting rod through a bell crank, and so disposed that considerable variation in cut-off may be obtained with very little variation in lead. The engine is governed by varying the point of cut-off—in other words, it is an "automatic, variable-expansion engine." The cylinder is surrounded by live steam on its way from the boiler to the top of the central valve, and is thoroughly jacketed in this way.

The engine-house is spanned by an overhead crane capable of lifting 25 tons, manufactured by Messrs. Thomas Broadbent and Sons, Limited, of Huddersfield. It is provided with the necessary gears for longitudinal and cross transverse motions respectively, operated by hand from an overhead platform. The end carriages are made of steel plates and angles, and mounted on cast-iron wheels bushed with gunmetal. The hoisting motion has two speeds, one for heavy and the other for lighter weights, and there is a powerful brake for holding and lowering the weights, controlled by a screw handwheel. The crane is 27ft. above the engine-house floor, and travels the whole length of the building on iron girders supported by buttresses forming part of the walls.

The switchboard (Fig. 11) has been supplied and erected by the British Thomson-Houston Company, Limited, and consists of two generator panels, one station-lighting panel, three traction feeder panels, and one Board of Trade panel. The material of which the switchboard is made is slate of the best quality, enamelled on the face and sides, with edges neatly bevelled. The dimensions of the generator, station-lighting, and Board of Trade panels are: 62in. high by 24in. wide and 2in. thick, with a sub-base 28in. high by 24in. wide, also 2in. thick; traction feeder panels: 52in. high by 16in. wide by 2in. thick, with sub-base 28in. high by 16in. wide by 2in. thick. On each of the generator panels there are mounted a Thomson-Houston automatic circuit breaker of type M.K., an ammeter, a field switch, pilot lamp, lighting switch, field rheostat, and three main switches. The standard Board of Trade panel is of the usual type, with instruments mounted thereon for recording the amount of drop in the return circuit, etc., as per Board of Trade regulations, with the exception that the instruments recording the current returning by the earth are removed to the earth-plate box on the system as explained later. Mounted on the hinged bracket at the end of the board is an illuminated dial voltmeter for the generators, and another for the 'bus bars, which can be seen and read from any part of the switchboard and readily swung into different positions. The arrangement of the instruments is such that each panel is self-contained for the generator or feeder for which it is intended, and allows of changes for extensions to the board being made with a minimum of trouble.

Overhead Line Equipment.

This important branch of the contract has also been placed in the hands of Messrs. the British Thomson-Houston Company, whose design in overhead line material is the result of many years' experience and careful study. By using high-grade materials and carefully-prepared designs the firm has become noted for combining lightness and elegance of design with great strength and ability to resist wear. The trolley wire is of hard-drawn copper, No. 00 B. & S. gauge, carried on tubular steel poles in selected designs (Figs. 12 and 13), and suspension poles, side and double brackets being adopted where necessary, according to the varying widths of the different routes equipped. The poles are placed at an average distance apart of 120ft. They are neat in design, and are each made in one piece. They were manufactured by Messrs. Russell and Co., Wednesbury, and erected by Messrs. Greenwood and Batley. The brackets have ornamental scrolls in wrought iron, special insulators and hangers being used to support the trolley wires.

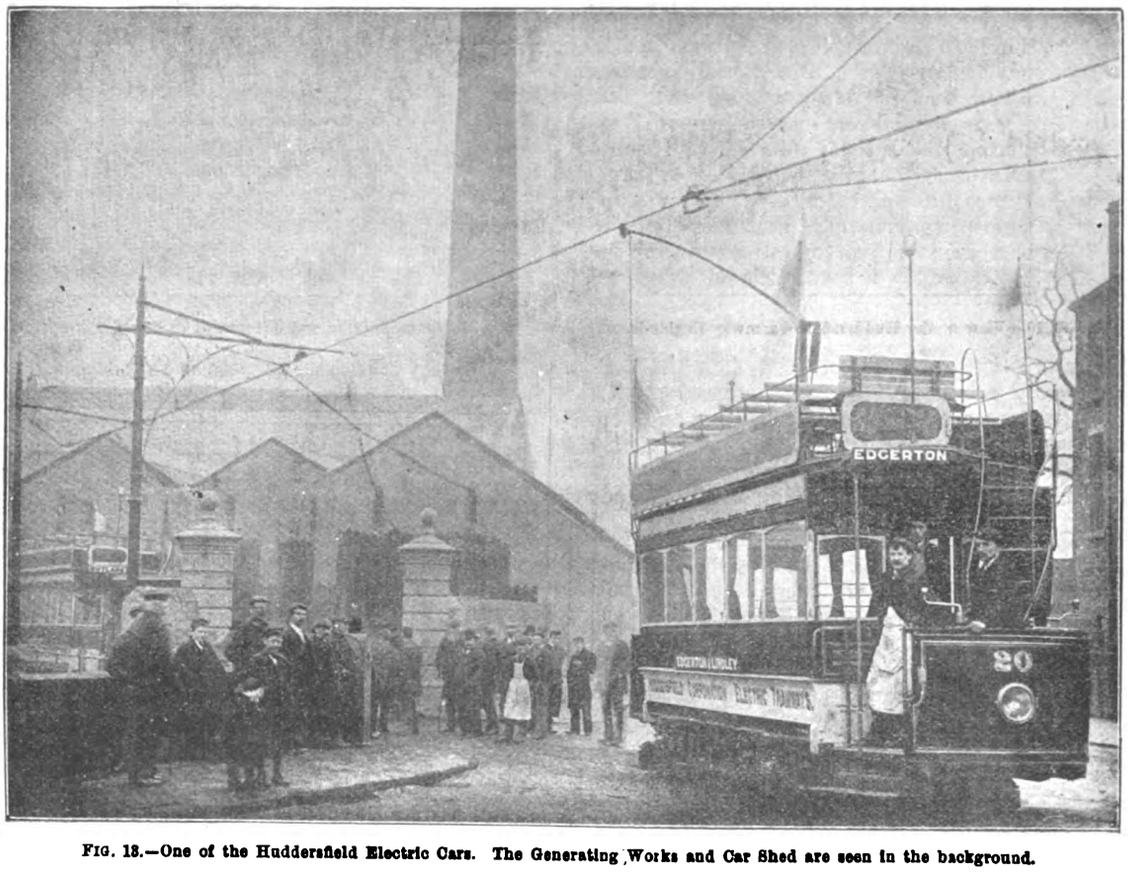

Fig. 13.—One of the Huddersfield Electric Cars. The Generating Works and Car Shed are seen in the background.

Feeder System.

The basis upon which the feeders are laid is somewhat novel. For distributing the maximum loads along the different routes, and making due allowance for the exceptionally heavy grades, the following scheme was adopted as being the most economical consistent with good regulation and voltage distribution, and by which it was found necessary to feed both line and rail at three separate points: (1) Manchester-road, at about 11,000ft. from the

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power station; (2) junction of Upperhead-row and New North road; (3) at Oaks, New Hey-road. At these three points the average potential of the line will be approximately 500 volts. By this arrangement the maximum drop of volts between any two points of the trolley line is on the average only about 16 to 17 volts, while on the outlying routes the maximum drop is about 20, and this latter condition will occur only under the worst circumstances, and then only for a short time when the car is running up the steep grade at the end. Even under these severe conditions the maximum drop on the rails in the town is only about 3½ volts, and on the outlying routes barely five volts, the latter being an extreme case already referred to, as against seven volts allowed by the Board of Trade regulations. In Huddersfield the return conductors are not earthed at the central station, but at a central point on the routes where recording ammeters are placed. The section and feeder boxes are of cast iron, and are placed approximately half a mile apart. By means of switches fixed in these boxes it is possible to cut out any section of the trolley wire without interfering with the rest of the system. At the feeding points these boxes carry, in addition to the above, two main switches for connection to the line and rail feeder. By this arrangement should a fault occur on the line feeder, it can be disconnected and used as the return, the other being used as a feeder for the line. Telephone cables are brought up into every box, making it possible to have communication with the power station from any part of the system. Test cables are also run along the whole route and suitably connected up to the rails and instruments on the Board of Trade panel to show the drop on various sections of the lines as required by the Board of Trade. The feeder and return cables were all supplied by Messrs. W. T. Henley's Telegraph Works Company, Limited, and are single paper-insulated lead-covered cables drawn into the firm's patent three and four way conduits, laid in cement. The design of the earthenware conduits is shown in section in Fig. 15, as is also the method of laying. The feeders at the station end are connected directly on to the station 'bus bars after being sealed in the Henley patent sealing ends. They are connected to the switchboard in the feeding pillars by means of rubber-insulated lead-covered cables, which are jointed to the paper cables in a disconnecting joint-box placed in a brick pit at the termination of the conduits. The pilot and telephone cables, also supplied by the same firm, are three and four cored, with fibrous insulation laid up and lead-covered, the four-cored being drawn into the conduits from the generating station to the feeding points. From the feeding points to the end of the route the three-core is armoured and laid direct in the ground. The pilot core at the termini of the armoured cable is connected to the rail, and the telephone cores are connected to the section boxes, which are placed about half a mile apart along the different routes. The following are the lengths and sectional areas of the various feeders: the Linthwaite feeder is 2·15 miles long, with a sectional area of ·350 in the lead and ·250 square inch in the return; the Outlane route is supplied through a feeder ·450 square inch, while the return is ·400, the total lengths being 1·94 miles; the Manchester-road feeder is ·859 of a mile long, and in this case cable of ·400 square inch area is used for both lead and return. The total length of cable used is over 20 miles, and in addition about 8,000 yards of three and four way conduits have been supplied and laid by Messrs. Henley and Co.

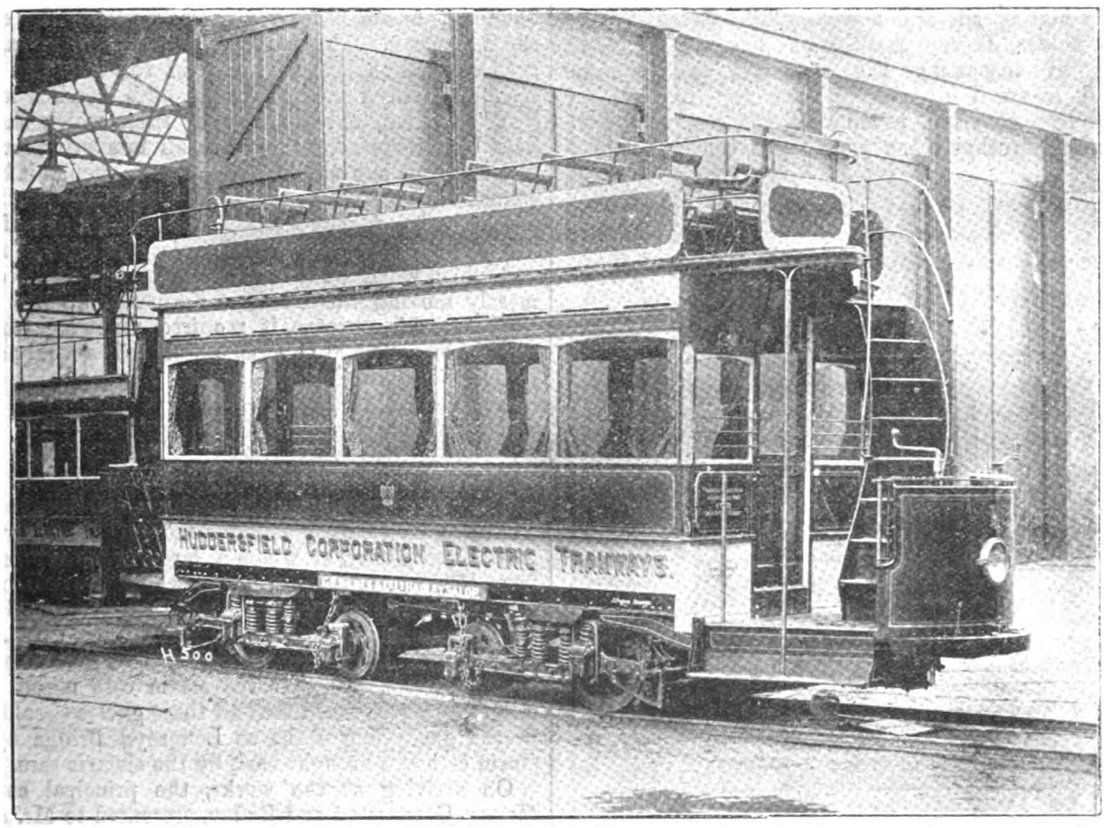

FIG. 14.—The Present Type of Electric Car used at Huddersfield. Car bodies by Milnes and Co., Brill maximum traction trucks, and British Thomson-Houston Company motors and equipments.

ROLLING STOCK.

The cars, of which there are 25, were built by Messrs. G. F. Milnes and Co., of Hadley, and are mounted upon Brill maximum traction trucks, for which it is claimed they can negotiate smaller curves than trucks having wheels all of a like size. The length of car bodies outside is 18ft. 7in.; the length over end platform is 29ft. 1in.; the height inside (clear) is 6ft. 8in. These cars have a total carrying capacity of 57 passengers—*i.e.*, 24 passengers inside and 33 outside. The cars (one of which is shown in Fig. 14) are very handsome in appearance, having vermilion waist panels, and cream-coloured rocker panels, emblazoned with the Corporation arms, the lettering also being tastefully painted on. The interior is very neat, the roof having sycamore veneer panels, from which hang the incandescent lights. The pillars are of ash, and the doors have curved oak moulding. The inside seats have stuffed cushions trimmed with crimson Utrecht velvet; the top deck seats are Callender's patent rainproof type. The cars are heated electrically by four heaters of the Consolidated Company's

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make, placed beneath the seats, with perforated grids through the kicking-board. It is worthy of note that all the tramcars used in Huddersfield since the old lines were first laid down up to the present time have, with only one exception, been supplied by Messrs. G. F. Milnes and Co. The solitary exception did not survive its trial run.

The electrical equipment of each car consists of two Thomson-Houston G.E.-58 electric motors of approximately 27 b.h.p., two B-18 controllers, circuit breakers, and lightning arresters. The motors are of special soft steel cast into two bowl-shaped halves, known as the "top" and "bottom" frames. The frame is thus divided into a horizontal plane, and the two parts bolted together, completely encasing and protecting the armature, commutator, brush-holders, and field coils. The motor is supported in the rear on the car axles, which latter revolve in special large bearings of the motor. Motion is transmitted to the axles from the armature by means of cut-steel gearing, working in a practically watertight iron case, and they run constantly in an oil bath, which reduces friction, noise, and wear. The G.E.-58 motor is intended for comparatively heavy service. It is especially desirable where the requirements call for moderately high speeds and heavy traffic. Being divided into two halves, it can readily be lowered or raised to admit of inspecting the armature and commutator, and a small opening in the top, covered by a clamped iron covering, permits of the ready removal of the carbon brushes when worn. All bearings on the

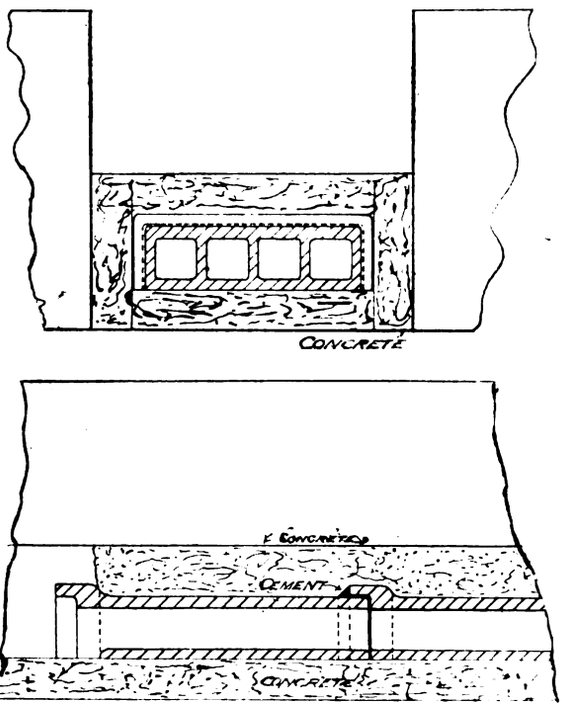

FIG. 15.—Sections of the Henley System of Earthenware Ducts for Cables.

motor are provided with grease boxes and oil cellars of sufficient capacity to warrant thorough lubrication. The grease boxes are cast with the upper frame, and covered with a flange lid held down by a spring, so as to exclude the dust and dirt. The armature is of the well-known Thomson-Houston iron-clad type, the core being built up of well-annealed laminations, and assembled directly on the shaft. The insulation of the armature is very high, and is impervious to moisture. Each coil, before being placed on the armature, is severely tested, so as to ensure the armature being perfect when completed. The coils are held in place in the slots, and on the ends by tinned steel wire bands, held together by clips, and securely soldered, and cannot vibrate and become loose. The weight of the motor, without gear or gear case, is approximately 1,685lb. The B-18 controller, mounted on the platforms of each car, is for the purpose of regulating the speed of the motors, and for changing the directions of rotation of same. It consists of a practically weatherproof frame, in which is enclosed an insulated cylinder, with metallic fingers fastened in various graduated positions thereon, which by being revolved changes the electrical connections of the motors in various ways. These fingers, in making and breaking contact, would in a very short time be roughened and burned so as to make them absolutely useless were it not for a protecting device known as the magnetic blow-out, the fundamental patents of which, for the United Kingdom, are owned exclusively by the British Thomson-Houston Company, which, as its name implies, magnetically "blows out" or extinguishes the arc at the moment of its formation. Controllers equipped with this device have operated on tramcars for thousands of miles, and have broken circuits hundreds of thousands of times without showing any serious wear of the contact fingers. Besides the above, the controllers are also used for the operation of the rheostatic brake, a most effective method of bringing a tramcar to an easy and gradual stop, which is secured by connecting the motors in such a manner as to convert them, for the time being, into generators, and thus transforming the kinetic energy stored up in the car by virtue of its rapid motion into electric energy, which is dissipated in suitable resistances in the motor circuit. This transformation of energy is so rapid that an exceedingly effective retardation of the car is obtained, the amount being entirely within the control of the motorman. This brake is of great service in the long grades found on the Huddersfield routes. The reversing handle is only removable when both handles are in the "off" position, and a controller from which the handles have been removed is safe from all tampering, and can in no case allow any current to pass, even though it be directly connected to a live wire. The M.Q. automatic circuit breaker, placed conveniently under the hood of the car, is an instrument that takes the place of the old time fuse, and which when "blown" open can be readily closed by merely moving the handle. Formerly, when a fuse was used for this purpose, it required renewing whenever it would blow. The M.Q. circuit breaker is entirely automatic in its action, and is also equipped with the magnetic blow-out, which prevents burning of the contacts previously mentioned as applied on the controllers.

Opening Ceremony.

These tramways, after being inspected by the Board of Trade, were officially inaugurated on Thursday, the 7th inst. The guests, of whom a large number were invited from the surrounding districts which the tramways will supply, were asked to assemble at the town hall at noon. They were there received by the Mayor (Mr. Alderman R. M. Shaw, J.P.). In order that the great improvement of the electric cars over the steam cars might be appreciated, it was arranged that all these guests should be taken to the generating works at Longroyd Bridge by the old steam cars and brought back by the electric cars.

On arriving at the works, the principal contractors, Messrs. Greenwood and Batley, presented to Mr. Alderman Haigh a gold key, with which he opened the doors of the power-house. In an apt speech, the Managing Director of the firm expressed the belief that the solid gold of the key would be an emblem of the financial results to Huddersfield of their electric tramway undertaking. When the whole party had assembled in the engine-room Mr. Alderman Haigh invited the Mayor to start the No. 1 engine, which he christened "Victoria." Mr. Councillor T. A. Cockin, the deputy chairman of the Tramway Committee, then started the second engine, which was christened "Alexandra." As a memento of the occasion, the borough engineer presented each of these gentlemen with a silver tray on which a perspective view of the power station plant was engraved. The works were then inspected by the visitors, who expressed satisfaction with the general arrangement and appearance of the works. In Fig. 16 will be seen the line of electric tramcars, drawn up outside the car-sheds, in which the guests were conveyed back to the town hall. This was done without the slightest hitch, but we noticed that preference was shown for the inside seats. This was in consequence of the Liverpool accident. The efficacy of the guard wires at Huddersfield was, however, made clear by the fact that there was a telephone wire lying across the route and resting on the guard wires while the procession of decorated cars conveyed the guests to the town hall.

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The luncheon was served in the town hall, which was so largely used for similar festivities last year when the Municipal Association visited Huddersfield. As a compliment to the Mayor, who presided, and who is a staunch teetotaler, alcoholic beverages were barred. After a well-served lunch of six courses, the toast of "The King and Queen" was honoured in coffee. A long toast list followed, commencing with "The Town and Trade of Huddersfield," proposed by Sir Thomas Brooke, J.P. Mr. J. Crowther, in reply, alluded to the municipal enterprise of the town, which, he remarked, could be appreciated by anyone, considering the large amount of the town debt. He believed that the citizens had exceedingly good assets to put against their indebtedness, and that the system of electric tramways was not the least valuable of these assets.

The Mayor of Brighouse proposed the toast of "The Huddersfield Corporation Tramways." In doing so he referred to the fight which had taken place in Brighouse over the question as to who should supply the district with trams. As a result, Huddersfield and Halifax had shared the honour, but the difference in the gauges used by these towns would prevent intercommunication between the two systems. He was pleased to see the progress made in Huddersfield, as they were quite ready in Brighouse for the electric trams, which he hoped the Corporation of Huddersfield would proceed to construct at once. The next toast was that of "The Town Clerk," proposed by Alderman Calvert, and replied to, of course, by Mr. Lloyd. The toast of "The Engineer" was proposed by the Deputy-Chairman of the Tramway Committee (Mr. Councillor Cockin), who bore testimony to the energy of that gentleman in all matters connected with the town's welfare. Mr. Campbell, in reply, modestly passed all the credit on to the various contractors who had been responsible for the construction of the power-house, the supply of the plant and cars, and also the equipment of the overhead line.

The tramway manager, Mr. Pogson, who has been for so many years responsible for the running of the steam cars, was honoured by the next toast, proposed by Mr. Councillor Broadbent. In reply, Mr. Pogson stated that next to Mr. Alderman Haigh he had the longest period of service of anyone in connection with the Huddersfield tramways. He had found, however, that their drivers and conductors were remarkable for their long period of service, which for the whole of the men now employed averaged $10\frac{3}{4}$ years. In consequence of their well-trained staff they had succeeded in reducing the yearly outlay in compensation for accidents to a very low figure, which for the last five years averaged only £165 per annum. This was equal to 7d. per car per day, whereas insurance companies asked for a yearly premium equal to $10\frac{1}{2}$d. per car per day. The Corporation had a considerable reserve to meet future accidents.

The toast to "The Contractors" was proposed by Mr. J. Lee Walker, J.P., and replied to by Mr. Wurtzburg on behalf of the main contractors, Messrs. Greenwood and Batley, who said that although there had been a little delay in the completion of the works due to certain sub-contractors, he thought the town had now a thoroughly good and efficient system. Mr. A. H. Walton, replying on behalf of the British Thomson-Houston Company, referred to the late regrettable accident at Liverpool. He characterised it as one of those unexpected accidents which it was difficult to foresee and prevent in new undertakings. It was, however, to be looked upon rather as an "act of God" than as a class of accident which would frequently occur. Telephone wires and telegraph wires in falling had often caused most serious and fatal accidents before the days of electric tramways. He therefore thought that such wires should be placed underground. Mr. Musgrave, replying on behalf of the engine builders, remarked on the very large demand which had arisen for large engines for tramway purposes. He thought that electric trams had a good opening in Huddersfield. Mr. Hopkinson also replied. The remaining two toasts were "The Visitors" and "The Chairman," which last toast was received with musical honours.

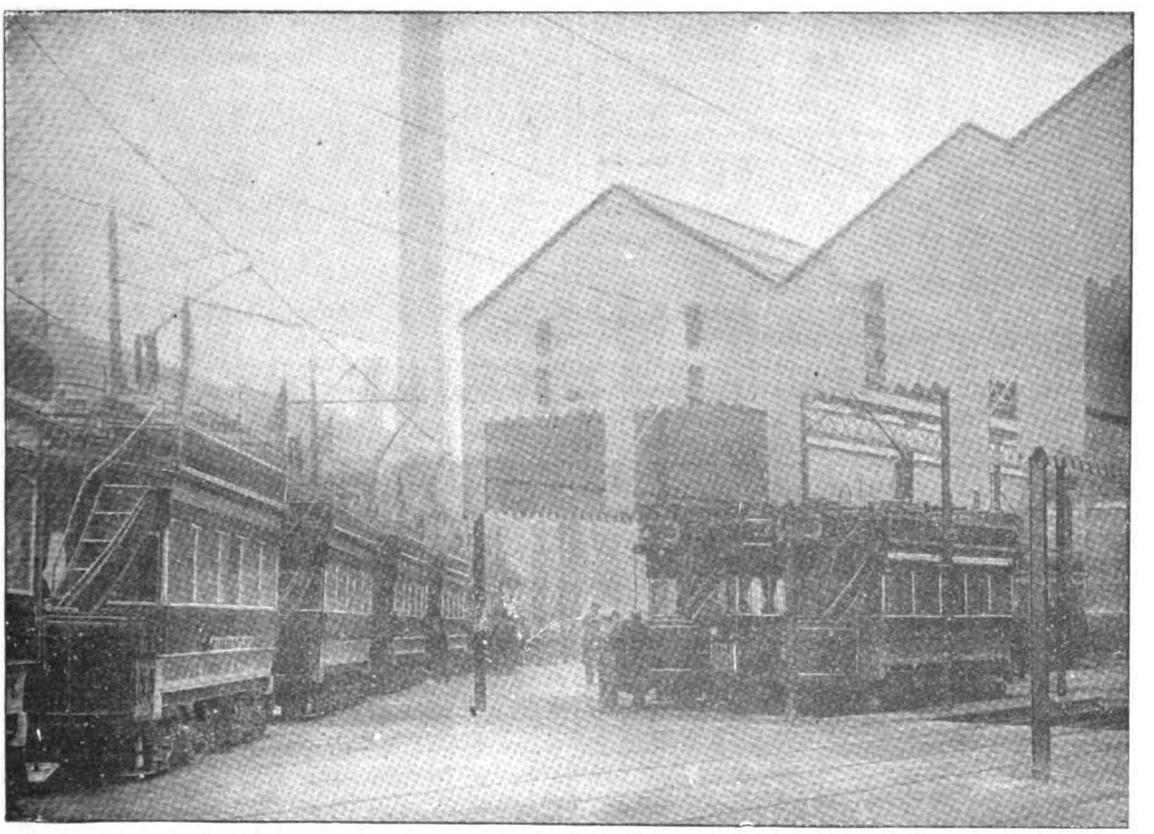

FIG. 16.—The Electric Cars at Huddersfield, as arranged to take the Guests on the Opening Day.

In conclusion, we have to express our thanks to Mr. K. F. Campbell, the borough engineer, for his kindness in placing plans and full particulars of the plant before us, and also to congratulate the Huddersfield Corporation on its electrical system of tramways. We understand that it is proposed to proceed at once to construct the other sections of line for which powers have already been obtained. A commendable feature in the design of the power-house is that due provision has been made for the reception of the additional plant as required, and there should, in consequence, be no hitch in carrying out the extensions.

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CABLE MAKERS v. BRIGHTON CORPORATION.

We are not in a position to correctly judge the case between the Cable Makers and the Brighton Corporation, in that we have not been able to obtain the exact clauses in the specification which have led to all the bother. Perhaps, however, it may be found that a particular specification is not the cause but the culmination of a dispute. The *Pall Mall Gazette*, in its issue of Feb. 13, states that the Brighton Lighting Committee "are having a report upon the subject prepared." It also says: "It is quite true that in several cases the tenders of the British manufacturers were lower than the tenders of the Union Company; but the Union Company was the only one that complied with the conditions stipulated for by the Brighton Corporation." The conditions given by the *Pall Mall* are three: (1) the British companies limited the quantity of cable to be supplied at the prices quoted; (2) they objected to the engineer's decision being final; and (3) the British tenders were to charge for drums, and allow in full if returned within three months, or otherwise allow a proportional return. If these are the real points, we must say that the Cable Makers have a strong case. It is common in many businesses to give a price, and allow that price to stand for repeat orders within a limited time. As regards the second objection, it is a very common clause in a specification that the engineer's decision be final, and we cannot think this an insuperable objection. As regards the charging for drums and allowing full price upon return within a limited time, we fail to see what objection there can be to so common a transaction, and one so just to buyer and seller. The remark in the *Pall Mall* that the price charged for the drums, added to that of the cables, would raise the total of the otherwise lower tenders of British firms above that of the Union Company is puerile. The charging for drums has nothing to do with cost of cables, and if the British tenders were lower than that of the Union Company without considering the drums, they were still lower when the drums were considered, as the amount of charge was to be allowed in full. It is impossible to conceive that these are the true facts of the case, and we venture to suggest that the objectionable clauses of the specification be published in full when the report of the committee of the Brighton Corporation is ready.

LOWESTOFT.

On Tuesday last we witnessed the formal opening of the electrical works at Lowestoft. This station belongs to the Corporation. The light was switched on by the Mayoress (Mrs. J. Beckett), and the whole proceedings were eminently satisfactory. A detailed description will be given in an early issue.

HOLBORN.—On Wednesday evening, at the meeting of the Holborn Borough Council, on the motion of Councillor A. Chapman, the Town Clerk was instructed to submit to the Council a statement showing what monopoly or monopolies for the supply of electrical energy in the borough now exist, when the same expire, and what steps will be necessary to ensure that every monopoly for such supply should be ultimately vested in the borough.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SOUTH YORKSHIRE ELECTRIC POWER BILL.

SIR,—Our attention has been called to a paragraph in your issue of Feb. 8 stating that this Bill has been rejected by the Standing Order Examiner. As this statement is wholly inaccurate and is calculated seriously to prejudice the position of the promoters of the Bill, we are instructed, as parliamentary agents for the Bill, to request that you will correct it in your next issue. The report of the Standing Orders Examiner deals only with a point of minor importance, and does not involve the rejection of the Bill, which will be duly presented to Parliament at its meeting.—Yours, etc., TAHOURDINS AND HITCHCOCK.

Westminster, S.W., Feb. 11, 1901.

FOREIGN COMPETITION.

SIR,—The enclosed copy of a letter which has been forwarded to the Mayor of Brighton may be of interest to your readers, as the question of foreign competition is now attracting so much attention. The letter explains generally the circumstances of this particular case, and shows how competition may extend beyond the simple question of price, to the acceptance or rejection of harsh and oppressive conditions, which might be accepted on the chance of their not being enforced, but really leave the contractor at the mercy of some official of the purchasers.—Yours, etc., A. H. HOWARD.

Cable Makers' Association, 2, Queen Anne's-gate,
Westminster, S.W., Feb. 8, 1901.

[COPY.]

Cable Makers' Association, 2, Queen Anne's-gate,
Westminster, S.W., Feb. 8, 1901.

To the Mayor and Corporation of Brighton, Town Hall,
Brighton.

Dear Sirs,—I am requested to call your attention to the circumstances under which the contract for electrical cables for Brighton has been placed with the Union Cable Company, a firm which has no works in Great Britain, and proposes to obtain its cables from Germany. This company was registered in August, 1900, with a nominal capital of £25,000 in £1 shares, of which 10,000 shares have been issued and 10s. per share paid up on them, so that the actual capital of the company is £10,000, of which £5,000 is uncalled. The shares are principally held by the Deutscher Kabelwerke, of Berlin.

In several cases the prices in the tenders sent in to the Brighton Corporation for these cables by responsible British manufacturers were substantially lower than the tender of the Union Cable Company, but in spite of this fact the contract has been placed with a German firm for cables which will certainly be manufactured in Germany. The reason for not accepting the lower tenders is stated to be that the British houses did not comply with the conditions upon which the tenders were invited. An examination of the conditions proposed by the British firms (which are those of the Cable Makers' Association, as accepted by the leading consulting engineers of Great Britain), in comparison with the conditions of the specification, does not seem to justify the action of the Corporation in subjecting the ratepayers of Brighton to an increased expenditure by placing the order with a foreign firm at a higher price than that obtainable from responsible British manufacturers.

The above circumstances seem to call for some investigation, and I should be pleased to afford any explanation of the general conditions adopted by the Cable Makers' Association, in order to show that these are perfectly fair to the purchaser as well as to the manufacturer, and that they do not necessitate any additional expenditure by the Corporation, as has been suggested. As matters stand at present, it is practically certain that no responsible British manufacturer will tender for any further supply of cables to the Brighton Corporation under the same conditions.

The importance of this matter is accentuated by the fact that tenders are now being invited by the Tramway Committee for considerable quantities of cables. If the conditions as printed in the specification are again insisted upon, it seems almost certain that the order will again be placed in foreign hands at enhanced prices, and work will leave England for abroad.—I am, dear sirs, yours faithfully,

A. H. HOWARD, Hon. Secretary.

On behalf of the following firms: British Insulated Wire Company, Limited; Callender's Cable and Construction Company, Limited; Connolly Bros., Limited; Henley's Telegraph Works, Limited; India Rubber, Gutta Percha, and Telegraph Works, Limited; Johnson and Phillips; London Electric Wire Company, Limited; Siemens Bros. and Co., Limited; Telegraph Manufacturing Company, Limited; Western Electric Company; W. T. Glover and Co, Limited.

The following paragraphs appeared in the *Pall Mall Gazette* of Feb. 13 referring to this subject:

"BRIGHTON CORPORATION AND THE CABLE MAKERS.

"Some little concern has been aroused among the members of the Brighton Town Council by the letter from the Cable Makers' Association respecting the Brighton Corporation having placed a contract for electric cables with a firm which obtains its supplies from Germany. The Lighting Committee, on whose recommendation the Council adopted the tender of the Union Cable Company, are having a report upon the subject prepared.

"It is quite true that in several cases the tenders of the British manufacturers were lower than the tender of the Union Company; but the Union Company was the only one that complied with the conditions stipulated for by the Brighton Corporation, and it seems that their electrical engineer advised the Lighting Committee that the non-compliance with these conditions on the part of the British tenderers was tantamount to making the lowest British tender above that of the Union Company. Three points in the conditions were in dispute—namely: (1) the British companies imposed marginal limits as to the quantity of cable to be supplied at the prices named in the tender; (2) they objected to the decision of the Brighton engineer being final in the case of dispute; and (3) they stipulated that the drums on which the cables are wound should be charged for in the first instance, the full amount being allowed if the drums were returned within three months, and a proportionate amount being charged if they were kept for over three months. It is thought that disputes 1 and 2 might have been arranged; but on the third point the engineer advised the committee that the charge for the drums would make the lowest British tender in excess of the Cable Company, who imposed no conditions as to the return of the drums, and who did not demur to the other conditions of the contract. It seems to be conceded that the amount at risk over and above the lowest British tenders was very small; but the committee, so far as can be gathered, decided in favour of the Union Company under the impression that the British Cable Makers had formed themselves into a ring for the purpose of enforcing conditions that were unacceptable. There seems reason, however, for believing that the Council generally were not quite alive to all the bearings of the case, and the matter is likely to be thoroughly investigated. In some quarters it is felt that the contracts ought not to have been sent out of England unless substantial reasons existed against the acceptance of the British contracts. It is most desirable that the Corporation should be placed in full possession of the facts, and should be enabled to arrive at a decision as to the reasonableness of the British companies' conditions, inasmuch as a larger contract is pending, for some £80,000 worth of cables."

INSTITUTION OF ELECTRICAL ENGINEERS.

At a special meeting of Council of the Institution of Electrical Engineers, held on the 7th inst, the following resolution was carried unanimously: "That the Council of

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the Institution of Electrical Engineers, in special meeting assembled, hereby records its deep sense of the irreparable loss which the British Empire has sustained through the lamentable death of her Majesty Queen Victoria, and its sorrow, in which each member shares, that one who spent her life for the good of her people, and to whom her subjects were affectionately devoted, has been removed from the scene of her unremitting labours, and that a reign marked by unparalleled social, scientific, and industrial progress has thus been brought to a close. The Council humbly begs permission to express to his Majesty King Edward, and to the members of the Royal family, its most sincere condolence and sympathy, and further to lay before his Majesty the assurance of its unswerving loyalty and devotion, and its earnest wishes that he may, with her Majesty Queen Alexandra, long be spared to reign in happiness and peace over a loving and united people. It therefore directs that a sealed copy of this resolution, with copies of resolutions of condolence passed by local sections of the Institution, be forwarded to the Home Secretary for transmission to his Majesty."

Copies of the following resolutions have also been received from the local sections of the Institution in Calcutta, Cape Town, Dublin, Glasgow, and Manchester, and the whole are to be forwarded to the Home Secretary on receipt of resolutions expected from other sections of the parent Institution:

Calcutta Local Section (by telegram)—"The members of the Calcutta Local Section send respectful condolences to his Majesty the King on the occasion of the national bereavement, and beg to assure his Majesty of their heartfelt loyalty."

Cape Town Local Section (by telegram).—"The Cape electrical engineers desire to join with the Institution in expressing their heartfelt sympathy with his Majesty the King and with the Royal Family in their great bereavement."

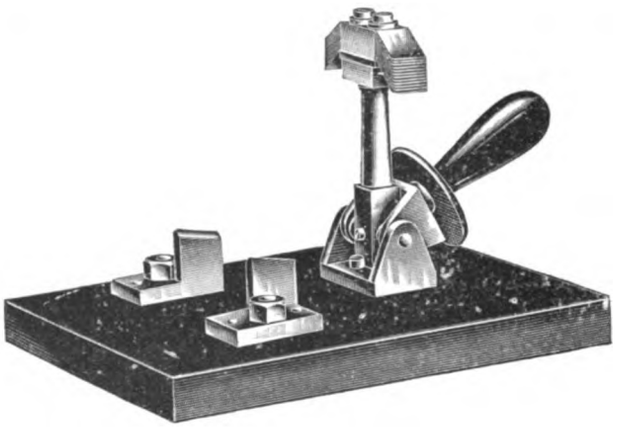
Dublin Local Section.—"That we, the Dublin Local Section of the Institution of Electrical Engineers, desire to record the deep grief with which we have received the news of the death of our late beloved sovereign, Queen Victoria; that this meeting do forthwith adjourn as a mark of our sorrow; and that if the Institution of Electrical Engineers propose to present a vote of condolence with the Royal Family, it is the desire of this section heartily to endorse the same."

Glasgow Local Section.—(1) "That this special meeting of the committee on behalf of the Glasgow Local Section of the Institution of Electrical Engineers desires to express its deep sense of the loss sustained by the death of their late beloved sovereign, Queen Victoria, whose long and beneficent reign has been marked by such social and scientific progress." (2) "That an expression of confidence and loyalty be sent to his Most Gracious Majesty King Edward, with the hope that he may long be spared to reign over his attached people."

Manchester Local Section.—"That we, the Manchester Section of the Institution of Electrical Engineers, desire to record the deep grief with which we have received the news of the death of our late beloved sovereign, Queen Victoria."

THE "ADELPHI" SWITCH

The General Electric Company have just put on the market a new and efficient form of 500-volt switch under the above title. It is intended to keep time with the continued increase in the use of high voltages for electric tramway and railway systems, as well as for private power and lighting plants. The chief properties claimed for the new switch (the design of which will be seen from the accompanying illustration) are quick break action, wide double break, laminated brush with consequent good contact, effective insulation, and great mechanical strength. The contact brush is built up of hard-rolled springy copper strips, as shown, and suitably spaced in the centre to give great elasticity. This is insulated from a powerful contact arm mounted on a spindle and held "off" by a mouse-trap spring; an insulating handle with shield works loosely on the same spindle. It will thus be seen that the handle is doubly insulated from the live contacts. The latter are of massive phosphor-copper with copper bolts, and the whole of the current-carrying parts are designed for a current density equivalent to copper at 800 amperes per square inch. The switch is made in many sizes from 20 to 800 amperes capacity, both single and double pole, and is provided with back connections; in addition, carbon breaks are fitted when desired. It is confidently expected that



the "Adelphi" switch will fill a much-needed want in high-tension work.

FORTHCOMING EVENTS.

FRIDAY, FEB. 15.

Institution of Mechanical Engineers.—At 8 p.m. meeting.

SATURDAY, FEB. 16.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the Willesden generating station of the Metropolitan Electric Supply Company.

Glasgow and West of Scotland Scientific Society.—At 7 30 p.m., social meeting.

Incorporated Association of Municipal and County Engineers. Council meeting.

MONDAY, FEB. 18.

Society of Arts.—At 8 p.m., lecture by Mr. W. J. Pope on "The Bearings of Geometry on the Chemistry of Fermentation" (Lecture II.).

TUESDAY, FEB. 19.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "The Nilgiri Mountain Railway," by Mr. W. J. Weightman.

Royal Institution.—At 3 p.m., Prof. J. A. Ewing on "Practical Mechanics" (Lecture V.).

WEDNESDAY, FEB. 20.

Society of Arts.—At 8 p.m., ordinary meeting. "Some Features of Railway Travelling Past and Present," by Mr. Fredk. McDermott.

Royal Meteorological Society.—At 7 30 p.m., ordinary meeting. The following paper will be read: "Report on the Phenological Observations for 1900," by Mr. E. Mawley.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. "Works Management," by Mr. A. H. Barker (Lecture II.).

THURSDAY, FEB. 21.

Institution of Electrical Engineers.—At 8 p.m., extra meeting. Paper on "The Electrical Power Bill of 1900: Before and After," by Mr. W. L. Madgen.

FRIDAY, FEB. 22.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "How Air subjected to X Rays Loses its Discharging Property, and how it Discharges Electricity," by Prof. Emilio Villari; "On the Propagation of Cusped Waves and their Relation to the Primary and Secondary Focal Lines," and "On Cyanine Prisms, and a New Method of Exhibiting Anomalous Dispersion," by Prof. R. W. Wood. Council meeting at 4 p.m.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Automatic Coupling," by Mr. J. L. Cridlan.

Electro-Harmonic Society.—Concert at St. James's Hall Restaurant (ladies' night).

Royal Institution.—At 9 p.m., discourse by Sir W. Roberts-Austen on "Metals as Fuel."

SATURDAY, FEB. 23.

Institution of Electrical Engineers.—Students' visit to the Bankside works of the City of London Electric Lighting Company, Limited.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Sound and Vibrations" (Lecture I).

Institution of Junior Engineers.—At 2.30 p.m., students' visit to the Willesden station of the Metropolitan Electric Supply Company.

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "Mond Gas, its Production and Use," by Mr. A. Rollason.

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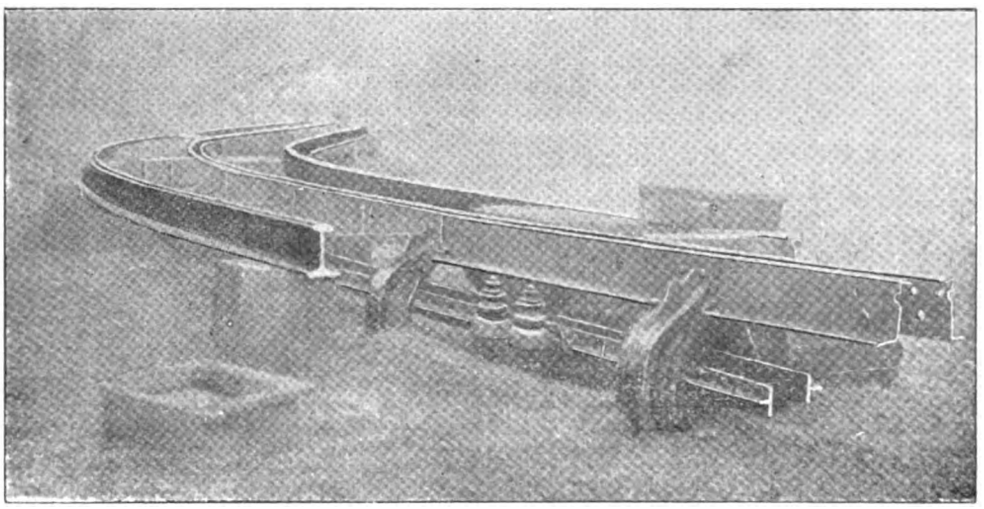
THE LONDON COUNTY COUNCIL ELECTRIC TRAMWAYS.

Yesterday afternoon, at three o'clock, we were permitted, in common with a number of others, to visit the London depôt of the London County Council in order to view a section of the conduit line which the London County Council propose to use. The details of this conduit system have been got out by Dr. A. B. W. Kennedy, who is advising the Council as consulting engineer. It is proposed to use this system on the first three routes of the London County Council tramways which are being converted for electrical working. These routes are respectively (*a*) that between Westminster Bridge and Tooting, (*b*) that between Kennington Gate and Blackfriars-road, and (*c*) that between St. George's-circus and Waterloo-road. In accordance with the Council's Tramway Act of 1900, the Council has deposited a description and drawings of the proposed conduit system with the Councils of the metropolitan boroughs of Lambeth, Southwark, and Wandsworth. The Wandsworth Council have approved of the same subject to some slight modifications, and it is expected that the other two Councils will signify their approval to the Board of Trade shortly. The illustration herewith gives a general view of the arrangements of the conduit with its two insulated conductor rails, but we hope to give more detailed drawings in our next issue. In the tramways of double track, each of which is 4ft. 8½in. gauge throughout, the position of the rails in the roadway will remain exactly as at present. The rails are to be of steel and of the girder type, weighing 102 lb. per yard run. The slot rails will also be made of steel, and each rail is to weigh 50lb. per yard. The opening between the slot rails forming the slot through which the plough works, will be ¾in. wide. The conductors carrying the electric current for working the motors on the tramcars will be soft-steel tees, carried within a concrete conduit, which has yet to be formed in the case of the illustration. The weight of these conductors is to be 23lb. per yard run. They are to be carried by insulated supports spaced 15ft. apart. These insulators are carried on independent stems from cast-iron feet, which are embedded in the concrete about midway between two yokes. The insulators on this vertical stem are secured by means of nuts on the top of the stem, and these again will be protected by an inverted bell insulator, which will prevent moisture dropping on to the surface of the smaller insulators, which are seen in the illustration. The arm which supports the conducting rail is clamped between the two lower insulators. The slot rails shown in the illustration are wider at the road surface than the rails actually to be used. The width across the surface of these two rails is to be 4½in. The same remark applies to the conductor rails, which had for the trial lines to be made of standard sections. In the real article the depth of these conductor rails will be considerably less, thus giving more clearance at the yokes. The current is collected from the conductor tees and transmitted to the motors in the car by rubbing contacts on a plough carried by the car and passing down through the ¾in. slot. The cast-iron yokes carry the slot rails, which are bolted to the yoke jaws, and further fixed by wooden wedges. These yokes are spaced 5ft. apart as measured along the centre line of the track. The normal depth from the top of the slot rail to the bottom of the conduit is 1ft. 9½in., and the base of the yoke (which bears upon a concrete foundation) is 4in. lower, or 2ft. 1½in. from the surface of the road. The normal section of the concrete conduit itself between the yokes will be the same as the opening in these yokes. Access from the street to every insulator will be given by cast-iron insulator boxes, consisting of frame and cover, giving an opening 1ft. square. These covers will be filled with the same material as the paving of the space between the rails. Wherever the conduit is drained, a larger box, with opening 19in. by 12in. and provided with a similarly filled cover, gives access to both insulator and drain pit, and the same sized box will be employed wherever a section insulator is used. The concrete used for the walls of the conduit will be made with the best Portland cement (5 to 1), and will have a thickness of 8in. under the track rails.

The conductor tees will be divided by section insulators into sections not exceeding half a mile in length. Each section of the conductor tees will consist of a positive and negative length in each conduit. Normally each of the two conduits will be electrically separate from the other, and will be supplied from feeders having a branch for each section. Automatic cut-outs and cross-over switches will be provided for each section, and so arranged that in the event of a fault occurring and persisting on the positive of any section, the polarity of the two conductors in that section can be reversed, so as to throw the fault on to the negative, where it can remain until the stoppage of traffic at night allows it to be located and rectified. The normal difference of potential of the conductors will be 500 volts, and insulated feeders for each conduit will be laid solid in troughs filled in with bitumen under the margins immediately outside the track rails. The Blackfriars and Kennington line and the Waterloo and St. George's-circus line for their entire length, and the Westminster and Tooting line from Westminster as far as the south-east corner of Clapham Common, will be fed direct from the generating station at Camberwell-green at 500 volts. The remainder of the Westminster and Tooting line will be fed at 500 volts from a sub-station, to be placed at the Balham depôt. It is intended to work chiefly with double-decked cars on bogies. The total length of the cars over all will be about 31ft. or 32ft. Each car will hold about 26 or 28 passengers seated inside and about 38 or 42 passengers seated on the roof, or 64 to 70 seats in all, and each car will carry its own motorman and conductor. Each car will carry two independent motors of the geared type, one on each bogie, both motors being started and controlled in the usual way from



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the front platform of the car. The power of the motors is to be sufficient to give the car a speed of 12 miles an hour, and it is proposed that within a circle of four miles radius or thereabouts, as may be decided, from Charing Cross this speed shall not exceed 10 miles an hour. The cars will be electrically lighted.

It is intended that the whole of the Council's tramways south of the Thames, both those already acquired and those to be hereafter acquired, and also new tramways which may be constructed under powers to be obtained from Parliament, shall be supplied with electrical energy generated at a station at the Camberwell depôt, and distributed, where necessary, from sub-stations to be established at various places along the different routes. This station and plant are now being designed, and the Council hope that the first electric lines will be at work in 18 months' time. This period would have been considerably shortened if the electric current could have been obtained from an outside source.

A very large number of representatives of local authorities were at the public view of the above-mentioned conduit yesterday, and appreciated the short trips which were given them on the electric car. We doubt, however, if they realised that this car was running in a different conduit to that which could be seen in skeleton form; in fact, the working model was that exhibited by the Westinghouse Company at the Tramway Exhibition last year, and the arrangement of the various parts differs considerably from the conduit which the County Council are adopting. Speeches were made to those present at the view by Mr. W. H. Dickinson, the chairman of the London County Council; Mr. J. William Benn, the chairman of the Highways Committee, and several other prominent men, including the mayors of two of the districts through which the first electric lines are to be constructed.

With the short time at our disposal before going to press, we cannot go fully into the details of the new conduit. The points, however, which seem to us to require discussion are the mechanical design of the yoke pieces, which are not made to carry the running rails, and the method of supporting and insulating the conductors. With the exceedingly limited space between the live conductors and the bottom of the conduits, there seems at the first glance to be little room for cleaning *débris* out of the duct without causing it to accumulate round the stems of the insulators, filling up the space between these stems and the gun-metal arms carrying the conductor rails. Any such accumulation would seriously affect the insulation of the system. It leads one to question whether a deeper conduit with insulators supported from above would not give less trouble in maintenance in the London streets.

ELECTRICAL TRADES UNION.

The following are the proposed rules for wiremen, cable jointers, and assistants employed in the London district, to which we referred in our last issue:

1. That 53 hours constitute a week's work, but when members are working on jobs where the hours are less, the money shall be made up to equal the 53-hour week.

2. That 9½ hours constitute a day's work for five days in the week, and 5½ hours on Saturday, finishing work on that day at 1 p.m. Overtime on Saturdays, from 1 p.m. till 4 p.m. to be paid for at the rate of time and a half, after 4 p.m. double time. Overtime worked during the first five days in the week to be paid for at the rate of not less than time and a quarter for the first two hours, time and a half for the next two hours, and after that double time. Each day to stand by itself; night shifts to be paid for at the rate of not less than time and a half.

3. That the rate of pay for wiremen and cable jointers shall be not less than 9½d. per hour, chargemen not less than 10½d. per hour. Apprentices, assistants, and jointers' mates shall be not less than 17 years of age when entering the society, and shall serve three years at the trade as apprentice, assistant, or jointers' mate, and one year as probationary member. The rate of pay during the probationary period to be not less than 7½d. per hour. No one shall be allowed to join as assistant, apprentice, or jointers' mate who is above the age of 21 years.

4. Members working over one and less than 12 miles from shop to be allowed travelling time and expenses. Country expenses to be not less than 10s. 6d. per week. Travelling time and expenses to be paid for the journey from London to job, and from job to London.

5. All members working on boats, under floors, in roofs, on accumulators, oil vessels, waterside premises, and other dirty jobs, must receive not less than 6d. per day dirty money.

6. District holidays to be Easter Monday, Whit Monday, August Bank Holiday, Christmas Day, and Boxing Day. That no holiday shall entail more than two days' loss of time. The rate of pay for bank holidays shall be not less than time and a half, Christmas Day and Sundays not less than double time.

7. That no member in the London district be allowed to work more than one night in succession—namely, that after working all night our members must cease work at the usual time of leaving work the next day.

8. One hour's notice to be given on either side. Weekly wage employés to give and receive one week's notice. Members running casing to receive one hour's grinding money.

9. That on all jobs requiring four or more men, not more than one assistant or apprentice to four men shall be employed.

10. That no member be allowed to work overtime, unless absolutely necessary, when members in the district are unemployed.

11. That on all jobs a lock-up for tools and materials be provided, and on building jobs, and, where circumstances require, a messroom shall be provided.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

351. In running alternators in parallel it is possible to obtain two kinds of motor current between them, one caused by any irregularity in the turning moment of the engines, and which is shown by a violent swinging of the ammeter needles, and the other due to the strengths of the alternator fields being in the wrong proportion. This results in a current passing between the machines which is quite steady, and has the appearance of an increased load. The writer has run two machines in parallel, one of which would not maintain full voltage on full load when running alone, but in parallel would give its full amperage, the other machine maintaining the voltage on the 'bus bar at full pressure. Can any reader explain this apparent boosting up of the volts, and if it is an armature reaction, how it is the field is not weakened instead of strengthened? F. T. C.

352. What advantages are obtained by the adoption of electrical coal-cutting machinery? Describe shortly, with the aid of sketches, what you consider to be the best types of electrical coal-cutters.—G. S.

ANSWERS.

Question No. 345.—Explain, with diagrams, the method usually adopted in combined lighting and traction stations for connecting the generators to either switchboard.

Best Answer to No. 345 *(awarded* 10s.*)*—It is not always the case in combined lighting and traction stations that two distinct switchboards are erected when the same generators are used for both purposes—in fact, it is seldom that such a practice is carried out, especially if the station was originally designed to supply current for lighting and traction. In stations of this sort the lighting current is delivered to the consumers by the three-wire system at a pressure of 400, 440, or 460 volts between the outer conductors, preferably 460 volts, as it is nearest to the voltage required for traction, and will not require the speed of the

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generator altered or its field weakened too much to obtain this lower voltage. Fig. 1 shows a very usual method of connecting the generators to lighting or traction feeders at will, all shunt connections being left out, as they are not important and possess no special feature. As will be seen in Fig. 1, the two leads from each generator are connected to a double-pole main switch, the other side of the positive pole of which is connected through a maximum-current circuit breaker (marked C B) and an ammeter to a separate horizontal plug bar, which is situated on the upper half of the plug panel, as the section of the switchboard is called that carries these bars. The other side of the negative pole of the main switch is connected direct to a plug bar (horizontal) on the lower or negative half of the panel There is, as a rule, some auxiliary machinery which will also be connected to horizontal plug bars, such as a battery of accumulators or a motor-generator, which can be run off the traction machine to take light lighting loads or to charge the accumulators if they are used. This motor-generator is very useful, as it obviates the necessity of installing a large set of accumulators, for with it the accumulators need only be used during the time the

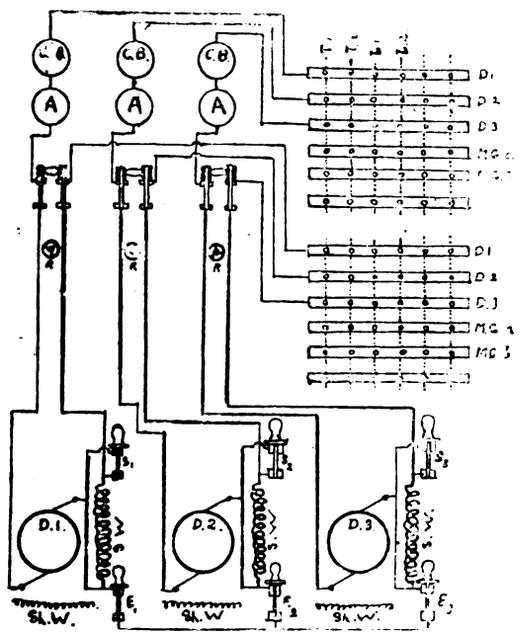

FIG. 1.—C B, automatic circuit breaker; A, ammeter: Sh W, shunt field winding (connections not shown); S W, series field winding; R, hand regulator of shunt resistance; S_1 S_2 S_3, switches to short-circuit series winding; E_1 E_2 E_3, switches for equaliser.

traction set is shut down, which means from three to six hours a day. The two leads from the two machines comprising the motor-generator are connected through suitable meters, switches, and starting arrangements to the bars marked M G *a* and M G *b*, the two positive leads going to the upper two bars and the two negative to the lower. The remaining bar is fitted in case of extensions. Behind these horizontal plug bars, but insulated from them by being placed at the back of the slate or marble panel, are fitted vertical bars, represented by the dotted lines in Fig. 1, which have holes drilled and screwed in each that come opposite to slightly larger holes in the panel and horizontal bars. The (in this case) two traction feeders are connected to the upper two of this vertical bars, marked T_1 and T_2, of course first going to a switch, meter, and automatic circuit breaker; the lower two, T_1 and T_2, are connected together and to the rails of the traction system. The positive lighting feeders are connected through suitable apparatus to the upper or positive vertical bars, marked L_1 and L_2, and the negative lighting feeders are connected to the lower or negative bars, marked L_1 and L_2 (Fig. 1). Brass plugs are made with a thread on one end, that screws into the vertical bars, and with a large head at the other, which makes contact with the horizontal bars, so that by screwing in a plug in a line horizontally with, say, D_1, and vertically with, say, T_1 on both halves of the plug panel, generator No. 1 is connected up to No. 1 traction feeder, or it can be connected to any other feeder by putting the plug in opposite to it and the desired feeder. Care must be taken, however, never to break circuit with a plug; the switches should always be opened before the plug is unscrewed. The generators are generally compound-wound, sometimes over-compounded 5 or 10 per cent., so as, when used for traction, to keep the voltage fairly constant on the line, but to increase at the station slightly with the load; but when put on lighting, the series winding is cut out or short-circuited, and the shunt winding only is used by means of a switch (marked S_1, S_2, and S_3), which is bolted on to the machine, or to a pillar beside it that also carries the equaliser switch (marked E_1, E_2, and E_3) for running two or more machines in parallel on traction.

Fig. 2 shows another method of switchboard arrangements which is more simple and less liable to accident. In this case the two generator leads, together with the equalising lead of each generator, is brought to a triple-pole throw-over switch and connected to the hinge or centre contacts of it, shown on the dotted line, *h*. When a machine is required to be put on traction this switch is closed *upwards*, which makes connection direct to the traction 'bus bars,

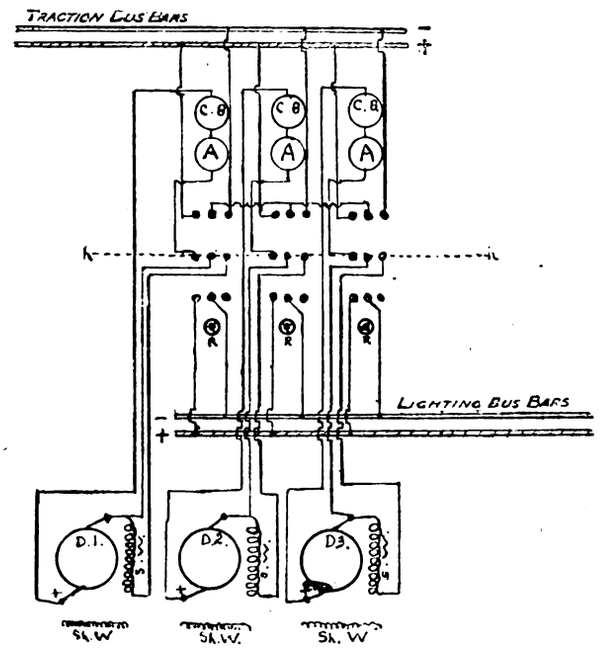

FIG. 2.—C B, automatic circuit breaker; A, ammeter; Sh W, shunt winding (connections not shown); S W, series field winding; R, hand regulator of shunt resistance (connections not shown).

leaving it working compound-wound and connected to the equalising bar. If the machine is wanted on lighting, the triple-pole switch is closed *downwards*; it will then be running as a shunt machine and connected to the lighting 'bus bars, as will be seen by looking at Fig. 2, the bottom right-hand contact of the switch being blank. If a motor-generator is used, or a set of accumulators, they are connected to the 'bus bars by switches. With a switchboard of this kind a generator can be changed from lighting to traction or *vice versâ* in a very short time, and there is no danger of putting in wrong plugs, or forgetting the equaliser, or to short-circuit the series winding.—A. J., SWANSEA.

Answer to No. 345 (*awarded* 5*s.*).—The accompanying diagram shows the connections which have been adopted for connecting generators to either the lighting and tramway switchboards. This is the arrangement for two generators, but the same holds good for any number. D_1 D_2 are the two generators with shunt coils, F, and series coil, S. H is a non-inductive resistance, used when breaking the shunt circuit by means of switch W. The current from the machine passes through double-pole automatic magnetic switch cut-outs, D D, through ammeters on one pole, A A, to three-way throw-over switches, B B^1 (one for each machine), constructed so that when switch is on positions as in diagrams, dynamo No. 1 is feeding the traction switchboard, and dynamo No. 2 is feeding the lighting switchboard. M M are ampere-hour meters on the lighting

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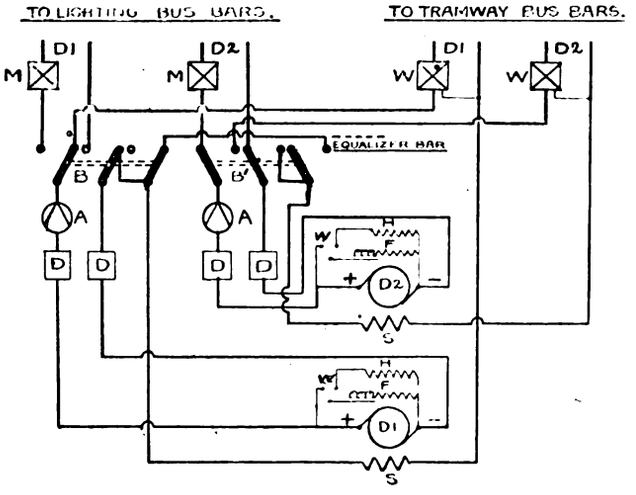
circuits, and W W are watt-hour meters on the tramway circuits. The generators are generally wound to give from 460 volts to 500 volts when running as shunt machines (D_2), and over-compounded to give 500 volts to 550 volts as compound machines (D_1). If the connections from D_1 are traced, it will be seen that the series coil is in action, and the generator is working as a compound machine; in the connections for D_2, the series coil is idle, and the generator is working as a simple shunt machine. If it is required to run D_2 in parallel with D_1 on the traction load, the switch B^1 is thrown over to the other set of contacts, when the – sides of the two armatures are connected together by means of the equalising bar, the two series coils are put in



parallel, and the machines, if identical, take equal shares of the load. To run both machines for lighting, switch B is thrown over. Care should be taken to see that the shunt coils are sufficiently excited before using switch B or B^1. It would be a better arrangement if these switches were interlocked with their respective shunt switches.—W. A. J.

Question No. 346.—The dynamos used in an electrolytic bleach works are sparkless under normal conditions, but when fumes of chlorine gas are present the commutators exhibit continuous rings of sparks. Why is this?

Best Answer to No. 346 (*awarded* 10*s.*).—The fact that under normal circumstances the dynamos run sparklessly shows that they are properly built, and it is also well known that the presence of rings of sparks around a commutator is due to the burning of metallic dust, which may arise from a loosely-made brush, or from solder or copper dust which has collected between the various commutator segments. These rings often occur in an intermittent manner when a new dynamo is first tested, but upon running soon cease owing to the dust being burnt out, as it is technically called, in the testing-room. Now, the fact that in this case these rings are continuous shows that the chlorine has some action upon the copper of either the brushes or the commutator—probably the former—as the copper is here more finely divided, and there are frequently loose ends to get hot.

Every chemist knows that chlorine has a great affinity for copper, and this knowledge is made use of in Hunt and Douglas's process for the extraction of copper from its ore, which is treated, after roasting, with a solution of 112 parts of calcium chloride, 280 parts of sulphate of iron, dissolved in 1,000 parts of water, and then adding 200 parts of common salt. If cuprous oxide is present, metallic copper is at once precipitated. The formula is $3Cu_2O + 2FeCl_2 = Cu_2 + 2Cu_2Cl_2 + Fe_2O_3$, but it will be seen that double the amount of copper remains combined with chlorine. In the case under consideration most probably cupric chloride ($CuCl_2$) is formed. This compound occurs when metallic copper is burnt in an excess of chlorine. It is a dark liver-coloured powder, which would fly over the commutator and bridge across the mica from section to section, and burning out would give rise to continuous rings of sparks. In burning out it might lose some chlorine and so form cuprous chloride (Cu_2Cl), a substance which turns green upon exposure to air,

If there are any loose ends to the brushes these will get hot, and chlorine gas being present we have all the conditions fulfilled for the formation of cupric chloride, and the writer thinks this will be found to be the correct explanation; and if carbon brushes be substituted for gauze ones, provided there is ample brush area, the sparks will considerably diminish in number, even if they do not entirely cease—at any rate, the alteration is worth trying. Cuprous chloride readily absorbs ammonia and forms a blue product, and as the chlorine gas is not pure, the writer would like some of the dust which is gathered from under the commutator for analysis to see what product is formed. This investigation would be very interesting, even if it did not yield any tangible result in the way of giving a definite solution to the question of how best to overcome the difficulty.—M.

Answer to No. 346 (*awarded* 5*s.*).—The ring of light which is often visible round the commutator of a dynamo working in an atmosphere containing a great deal of chlorine is in no way to be confounded with the sparking, properly so called, due to electrical actions. It results from the mechanical wearing off of particles from the commutator and brushes by their mutual friction. These particles of copper dust, being heated by the mechanical work expended in their abrasion, combine chemically with the chlorine in their neighbourhood, forming copper chloride ($CuCl_2$). As the affinity between copper, or, indeed, most metals, and chlorine is very great, sufficient energy is liberated during the combination to raise the gases in proximity to incandescence. This copper dust near the commutator surface is swept round with it, so that the region in which combination occurs is a more or less complete ring. The combination may be easily demonstrated by dropping warm filings into a jar of chlorine gas, or, in "T. A.'s" case, more simply by filing a piece of brass in the chlorine-laden air of the works. This apparent sparking has no particularly prejudicial effect on the machine or commutator beyond a possible lowering of the insulation between adjoining segments, due to a film of the chloride being deposited on the surface of the insulation between them. With even tolerable care, however, in wiping the surface occasionally, this should not occur. In one way, indeed, the action is an advantage, as it prevents copper dust getting in the armature. It is sad, nevertheless, to think of a machine condemned to stifle in chlorine, for with the moisture also present, hydrochloric acid is formed, and this must sooner or later tell on the dynamo.—ZERO.

Answer to No. 346 (*awarded* 5*s.*).—The question states that the dynamos run sparklessly in the absence of chlorine. I should imagine, however, that there is a little sparking, and that the brushes are scoring the commutator considerably. When a dynamo has been running some time under these conditions, the brush gear and the bedplate under the commutator are found to be covered with a fine copper dust worn off the commutator and the brushes. Now, copper in a finely-divided state will fire spontaneously in chlorine gas, and although the atmosphere is very very far from being of pure chlorine, it is yet sufficiently rich in it to cause the copper dust to ignite, coming, as it does, hot from the brush tips. The questioner will no doubt have noticed that very soon after the chlorine becomes perceptible the commutators lose their bright coppery look, and become a dull yellowish colour: this is caused by a film of copper chloride, and illustrates the great affinity of copper for chlorine. This sparking in rings does not injure the commutator at all, as it is simply the combustion of the dust, and not actually on the surface of the commutator. If the voltage is high, however, there is a possibility of it causing flashing from brush to brush all round the commutator. It can be prevented by the use of a brush made up of thin sheet white metal, such as the Boudreaux brush, which does not wear the commutator, and does not itself wear into dust.—J. W.

ADVANTAGES OF ELECTRIC LIGHTING.—These, as well as the intricacies of the maximum-demand system of charging, formed the two chief items of an essay read at the Croydon Debating Society, on Feb. 13, by Mr. W. Perren-Maycock, M.I.E.E.

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COMPANIES' MEETINGS AND REPORTS.

ST. JAMESS AND PALL MALL ELECTRIC LIGHT.

The annual meeting of the Company was held on Tuesday at the offices Golden square, W., Mr. Eustace J. A. Balfour (chairman) presiding.

The **Chairman**, in moving the adoption of the report, congratulated the shareholders on the position of the Company and on the results which had been arrived at during this year's work. It was proposed that a distribution amounting to 14½ per cent. should be made on the ordinary shares, so that the dividend would have been maintained steadily at this rate for the past four years. During the period under review they had added to their service the equivalent of 21,597 8-c.p. lamps, making the total lamps at the end of 1900 183,347. As had been explained on previous occasions, the policy of the directors had been to make periodical reductions in the charges to consumers, and the large reduction made two years ago had already borne good fruit, for the value of the return per 8 c.p. lamp, which fell from 9s. 6d. in 1898 to 9s. 2d. in 1899, had in the past year risen again to 9s. 8d., which proved that the extra amount of electricity consumed at a lower price would more than make up for the actual loss incurred in making such reductions. Similarly, the larger output, together with economies which were from time to time effected in the Company's methods, enabled the directors, in spite of the large increase in the cost of coal, not only to prevent an increase in the cost to them of their supply, but even to effect a small reduction. This, thought they would agree, was an altogether healthy sign. Unfortunately, the advance in the price of coal would be felt in equal measure in the current year, for although hand to mouth supplies might now, perhaps, be obtained at a lower figure, it was necessary for this Company, having important public responsibilities, to safeguard the continuity of their fuel supply by regular contract. They had, too, on the current year to face a very serious addition to their rates—in fact the increase in the amount to be paid was from £2,829 to £5 700. In view of the extra expenditure on these two items it had been decided to make no further alteration in the charges for the present, but to devote the current year to strengthening and consolidating their resources, and in pushing on with the important extensions which they had in hand, so that everything might be ready for undertaking the large increase in their business which they confidently expected to have. The extensions at Carnaby-street would be finished in ample time for the next winter's supply. They consisted of a second chimney shaft, a large boiler-house and engine-room with a yard for coaling, workshops, and other conveniences which had been very much needed. The whole of the floor space above the boiler-house and engine-room was prepared for the plant to be used in connection with the supply from the Central Electric Supply Company. The St. James's Company, in combination with the Westminster Electric Supply Corporation, took a half share in the construction and equipment of the new works of the Central Company at Grove road, which would be employed for the service of the two companies after their present resources within their respective districts had been exhausted. The site for these works, which had now been secured, gave direct access to the sidings of the railway company and to the canal. The first section of the works was in process of erection, and orders had been placed for the engines and boilers and the necessary electric plant.

Mr. Walter Leaf seconded the motion.

In reply to a shareholder, who complained of the small amount of extra net profit in comparison with the large increase in the gross profit during the past two years, the **Chairman** said he was convinced that the policy the directors were pursuing was the right one.

The report having been unanimously adopted, the retiring directors, Mr. Walter Leaf and Mr. Bennett Fitch, were re-elected.

An extraordinary meeting was then held to alter the articles of association, in accordance with the requirements of the new Companies' Act.

The proceedings then closed.

CENTRAL LONDON RAILWAY.

The ordinary general meeting of the Company was held at the Holborn Restaurant on Wednesday, Sir Henry Oakley (chairman) presiding.

The **Chairman**, in moving the adoption of the report, said they would see by the accounts that their expenditure during the half-year had been £158,000. Considerable payment was made to the contractors towards the finishing of their work—£127,000—and the balance had been paid for sundry additions that they had had to make, and which they should have to continue to make in order to enable them adequately to conduct the service. There was only one point in the capital account to which he would call attention, and that was the issue of debenture stock. A portion of that stock was reserved for the contractors, subject to the condition that it was not to be liable to interest until the line was opened for public use. That being accomplished they were bound to issue the debenture stock to them, and the Board proposed shortly to raise the money, and with a view to affording all the proprietors any advantage there might be in it, they should send a circular to every proprietor at the time of issue stating the position of the bonds and the price at which they would be issued. They would bear 4 per cent. interest, and as the security was undoubted, those who had money to invest would do well to add to their holdings. During the five months that they had been in actual work the number of passengers daily carried had progressed regularly and satisfactorily. They began with 80,000; they carried up to the end of December 101,000 per day, including Sundays, and for the month of January the number reached 108,000 per day. He was glad to say that nearly all their passengers were satisfied; he had heard of no complaint that had indicated any want of management of the line. They had very little doubt, therefore, that they should make their undertaking a model for all future underground railways. Their aim was to make the road through the tunnel as bright, as clean, and as comfortable as possible, to interpose as few restrictions on the ingress and egress of their passengers as possible, and to give them as little trouble and anxiety in dealing with their tickets as they could. The simple system they had adopted appeared to have met with general approval. On the question of numbers, they carried, roughly, 15 000,000 passengers in the five months. Of those, rather less than 1½ millions were workmen who booked before half-past seven in the morning, and were carried at the reduced fare of 2d. for the return journey. Their daily experience was that the public willingly paid their 2d. for a short distance when they could travel overhead for 1d. The *inter se* traffic between stations and for comparatively short distances was steadily augmenting. In the early morning and in the evening they had more than they could do, and many of the trains were crowded far beyond what was comfortable and what they desired to see. The Board had been turning their attention to that subject for some time, and their manager had exercised his ingenuity to run an exceptional number of trains during the crowded hours. The best they could do was to change engines and get the trains round to the other line in about 2 minutes 50 seconds. They had called the engineers into consultation and also the manager, and the latter went to Paris, as did several members of the Board, to see the working of the Paris underground railway, because it was said that on that line they had no such difficulties; nor had they, because at each end of their line there was a loop to enable the trains to run continuously round. Of course, at Shepherd's Bush the cost of such a loop would be comparatively light—it was estimated at about between £50,000 and £60,000—but the cost of a loop in the City was far more serious, for it would cost £400,000. They were satisfied, however, that if they constructed such a loop in the City and provided an additional station at Liverpool-street, they would, by the augmentation of the traffic owing to the centre they would create in Liverpool-street, and by the general increase of traffic owing to the additional facility of the line, be repaid even that large outlay. Therefore, the Board, advised by their engineers, had deposited a Bill in Parliament this session asking for power to make the loop. Their earnings per train mile for every mile they ran was 4s. 10½d. Comparing that with the average earnings of other railways, they found themselves in a very satisfactory condition indeed. Referring to the question of expenditure, the chairman explained that they spent at least £200 per week more in coal than they should spend under normal conditions. Notwithstanding this drawback they had achieved what was really a dividend of 3 per cent. for the five months in which it was earned. They would be obliged to declare it at 2½ per cent., because they had no power to pay this half year any further interest out of capital. I should mention that they had not put aside any sum this half year for depreciation. They would probably recommend the proprietors at some future time to assent to a fund being formed for depreciation, instead of charging each half-year with the amount expended in renewals.

Mr. Henry Tennant seconded the motion.

Several shareholders pointed out that they carried passengers over six miles for 2d., and questioned whether this was in their interest to do so.

The **Chairman**, in reply, said the directors were, of course, above prejudice in the matter of the fares; all they wanted to do was to ascertain what was the right thing. If the directors found that the fares they were charging were not remunerative, they would have no hesitation in making an alteration with a view to an improvement. It was rather remarkable that the fares suggested by a shareholder of 1d., 2d., and 3d. were the identical fares originally contemplated by the Board. On working the matter out, however, having regard to the experience which had been gained in America and Paris, and having also ascertained as nearly as they could before the line was opened what proportion of passengers they would be likely to carry, the directors came to the conclusion that it would be more advisable to charge a uniform fare. They carefully watched, not only their own working, but the working of the Paris railway and of the London electric railways. The City and South London earned, in round figures, 2s. 4d. per train mile, and their average fare was 2 06d.; the Liverpool Overhead Company earned 1s. 8d. per train mile, and their average fare was 1 82d.; and the North London Company—which they included because it had a very large traffic, and was an old-established and well-managed line—earned 3s. 1d. per train mile, while their average fare was 1 61d. Their own experience, so far, was that they earned 4s. 10½d. per train mile, and that their average fare was 1 90d. This result was better than on any of the other lines he had quoted, all of which, except the Paris railway—and they were doing so in a modified degree—charged sectional fares. As to the question of damage to other property, alleged to have been caused during construction, any payment to be made in respect of that would fall on the contractors, and not on the Company. Regarding vibration, they were advised that, having parliamentary rights, there was no question of liability as far as the Company was concerned, but the Company would of course, do all they possibly could to relieve adjoining owners from any

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inconvenience or annoyance, and they were rendering the Board of Trade all possible assistance in investigating the matter.

The resolution was carried unanimously, the dividends recommended were declared, and the retiring directors and auditor were re-elected.

At a special meeting the Bill referred to by the chairman was approved, and at a further meeting it was resolved: "That, pursuant to the powers conferred upon the Company by the Companies Clauses Consolidation Act, 1845, Sections 61 and 64, 196 980 ordinary shares of £10 each, 88,020 preferred half shares of £5 each, and 88,020 deferred half-shares of £5 each, all fully paid up in the capital of the Company, be converted or consolidated into capital stock to be divided amongst the shareholders according to the respective interest therein."

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The fourteenth ordinary general meeting of this Company was held on Wednesday at the offices, Great George street, Westminster, Mr. Granville R Ryder presiding.

The **Chairman**, in moving the adoption of the report, stated that the directors were able to propose a dividend making 12 per cent. for the year, and to carry forward £4,700. Coal had cost the Company about £2 000 more than in the previous year, and in the last three months of 1900 the weather in London was unusually light and free from fogs, to which circumstance he attributed the fact that they sold electricity to the amount of £2,000 less than in the corresponding period of the previous year. During the year the number of houses and shops lighted by the Company had increased by 214, and in the number of lamps there had been an advance of 15,636. They sold in the year 2 630 482 units, or an increase over the quantity sold in 1899 of about 166,000 units; but there was a disproportionate increase in the cost of production—namely, £37,326—as against £33,823 in the previous year, but this difference was shown at once in the higher price of coal. The new generating station which had been constructed in conjunction with the Notting Hill Electric Lighting Company, Limited, was approaching completion. A certain amount of electricity had been received from it, and it was expected to be in full working order in two months. Great results were anticipated from the new generating station when it was in full working order. During the year they had created a new transformer station, situate at the back of the Albert Hall, and it was in every respect convenient and well equipped. This would render unnecessary the accumulator station in Queen's-terrace-mews, which it was intended to discontinue.

Sir. F. J. Bramwell seconded the motion, which was carried unanimously.

APPOINTMENTS VACANT.

Electrical Engineers, Isle of Thanet Electric Tramways and Lighting Company, Limited, to take charge of power station, Feb. 22. Full particulars in our advertisement columns.

Electrician, to work up installation contracting business, also wiring, etc. Details in our advertisement columns.

Draughtsman and Assistant Engineer, with considerable experience in drawing office, experience in German and French advantageous. Details in our advertisement columns.

Fitters, several experienced in building and fitting up of commutators. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Sheffield.—Tenders are to be obtained for 25 extra double deck cars, trucks, and equipments.

Bournemouth.—The Town Council invite tenders for 42 electric cars. Tenders by March 2. Details in our advertisement columns.

Brighton.—The Council invite tenders for continuous current arc lamps and accessories for street lighting. Tenders by Feb. 25. Details in our advertisement columns.

Clyde Navigation.—The Trustees invite tenders for a three-ton electric wharf crane for Prince's Dock. Tenders by March 11. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for supplying and fixing trolley wires and attachments. Tenders by March 8. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for the supply, delivery, and erection of a traction switchboard. Tenders by Feb. 28. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for fuel economiser and additional Babcock and Wilcox boilers. Tenders by March 15. Details in our advertisement columns.

Darwen—The Corporation invite tenders for the supply and delivery of steel rails, fish and sole plates, tierods, bolts, etc., and copper bonds. Tenders by Feb. 25. Details in our advertisement columns.

Taunton.—The Corporation invite tenders for two 100-kw. tramway generators, one engine, and tramway switchboard and connections. Tenders by Feb. 25. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for the supply of underground electrical conduits, together with the necessary jointing apparatus. Tenders by Feb. 20. Details in our advertisement columns.

Beckenham.—The Council invite tenders for boilers, steam alternator and combined engine dynamo and motor, pipework, batteries, and switchboard. Tenders by Feb. 25. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for supplying and fixing trolley wires and attachments. Specifications etc., may be obtained at the City Engineer's Office, Municipal Buildings, Leeds. Tenders by March 8.

Long Eaton.—The Urban District Council invite tenders for producers, gas-engines, dynamos, switchboard, feeder and distribution cables, and conversion of street lamps. Tenders by Feb. 18. Details in our advertisement columns.

Canterbury.—The Lighting Committee invite tenders for the extension of the electricity works. Specification, etc., may be obtained at the City Surveyor's Office, Tudor-chambers, High-street, Canterbury. Tenders by Feb. 18.

Bormondsey.—The Council invite tenders for the construction, supply, and erection of (Section A) main switchboard and instruments; (Section B) battery of accumulators and accessories. Tenders by Feb. 25. Details in our advertisement columns.

Wallasey.—The Urban District Council invite tenders for the overhead equipment of about 10 miles of tramways and for the supply and erection of section boxes and the bonding of rails. Tenders by March 4. Details in our advertisement columns.

Bristol—The Electrical Committee invite tenders for coal conveyor and elevators and coal-discharging plant, including hoist, automatic weighing machine, tower, and bridge over roadway. Tenders by Feb. 21. Details in our advertisement columns.

Wallasey.—The Urban District Council invite tenders for the erection and completion of car sheds, stores, workshops, and dwellings at their tramway depôt, Seaview-road, Liscard, Wallasey. Tenders by March 4. Details in our advertisement columns.

Cardiff—The Corporation invite tenders for steam-pipes, exhaust pipes, injection and overflow pipes, feed pipes, drain pipes, engine-house flooring, and switchboard gallery and central service gangway. Tenders by March 18. Details in our advertisement columns.

Stockport.—The Gas and Electricity Committee invite tenders for supply and erection at their electricity works, Millgate Stockport, of a condensing plant capable of dealing with 20,000lb. of steam per hour. Specifications can be obtained from Mr. S. Meunier, engineer. Tenders by March 6.

Wallasey.—The Urban District Council invite tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. Tenders by March 4. Details in our advertisement columns.

Bournemouth—The Corporation invite tenders for the supply of three steam dynamos and two steam-driven surface condensers, and other works in connection therewith. Specifications, etc., may be obtained of Mr. F. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by March 2.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the supply of 1,600 tons of steel rails, 70 tons of fishplates, 50 tons of tiebars, and 45 tons of soleplates. Specifications, etc., can be obtained from the engineer, Mr. W. H. Travers, Church-street, Egremont. Tenders by Feb. 19.

Luton.—The Town Council invite tenders for wiring for electric lighting purposes the Council-chamber, town hall, free library, corn exchange, and baths. Sketches of designs and full details of the proposed works to be given. Further information can be obtained of the Borough Engineer. Tenders by March 4.

Grantown-on-Spey.—The Town Council invite tenders from electric light companies to supply electric light for public and private consumption within the burgh, stating highest price charged consumer, and terms for future purchase by the burgh. Tenders by March 6. Details in our advertisement columns.

Wimbledon.—The Urban District Council invite tenders for the supply and erection of steam and exhaust pipes, etc., and the moving of two boilers, feed pumps, feed-water heater, and storage tank, an independent surface-condensing plant, and two water-tube boilers. Tenders by Feb. 18. Details in our advertisement columns.

London, S.W.—The London County Council invite tenders for the supply of two blocks of water-tube boilers required for the electrical power generating station to be erected at the Camberwell depôt of their tramways. Full particulars may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by Feb. 19

Bristol.—The Electrical Committee invite tenders for the erection of the superstructure of the Avonbank electricity works, Feeder-road, Bristol. The work comprises a large amount of steelwork, as well as brickwork and concrete work. Specification, etc., can be obtained at the office of Henry Williams, Esq., architect, 24, Clare-street, Bristol. Tenders by March 12.

Southwark.—The Electric Light Committee invite tenders for the supply and erection of the following plant for their electric light station at Penrose-street, Walworth-road, S.E.: (Section A) One 400 kw. high-speed engine and dynamo and accessories;

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(B) two water-tube boilers, fitted with mechanical stokers, and extension to the steam and water mains. Tenders by Feb. 18. Details in our advertisement columns.

Huelva (Spain).—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's ambassador at Madrid, stating that tenders are invited by the Spanish Government not later than Feb. 21 for the establishment of a telephone system in the city of Huelva. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Glasgow.—The Corporation invite tenders for the supply of the following material: (1) 1,000, 2,000, or 3,000 tons steel straight track rails, 100, 200, or 300 tons steel curved rails, 50, 100, or 150 tons steel fishplates; (2) 50 tons steel tiebars. The rails and fishplates will be a separate contract from the tiebars. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield street, Glasgow. Tenders by Feb. 22.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, Newhampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston-street, Cleveland-road, and Bilston-road, to the borough boundary, amounting to a route length of about 4½ miles, mainly double track. Specification, etc., may be obtained on application at the Borough Engineer's Office, Town Hall, Wolverhampton. Tenders by Feb. 26.

RESULTS OF TENDERS.

Partick.—Messrs. D. Bruce Peebles and Co. have secured the contract for steam dynamos, balancers, and boosters.

Brighton.—Messrs. D. Bruce Peebles and Co. have secured the contract for the supply of one 330-kw. and two 200 kw. tramway sets.

Plymouth.—The Electricity Committee have accepted the tender of Mr. W. F. Blake, at £8,384, for the extension of the electricity works.

Eccles.—The Corporation have accepted the tender of Browett, Lindley, and Co., Limited, Sandon Works, Patricroft, at £732, for a 40 kw. steam alternator.

Ballinasloe.—The tender of the Ampère Electrical Company, of Dublin, has been accepted for the electric lighting of the new hospital block at the Ballinasloe District Asylum. The amount was £1 205.

Croydon.—The following tenders have been accepted: British Thomson-Houston Company, Limited, transformers, £68; Carrick and Ritchie, overhead travelling crane for the electric light station, £470.

Morecambe.—The tender of F. Moore, Morecambe, at £2 040, has been accepted for the extension of the present generating station, providing the Council agree to supply the necessary shingle free of cost; but if the Council cannot see their way to supply the shingle, the total amount of tender will be £2,110.

Bristol.—The Electrical Committee have entered into the following contracts: Low-tension power board, S. Z. de Ferranti, Limited, £193; storage battery, Electrical Power Storage Company, Limited, £766; electric crane, Higginbottom and Mannock, £772; steam circulating pump, Bumsted and Chandler, £460.

Sheffield.—The following tenders have been accepted: British Thomson-Houston Company, Limited, 1,000-kw. generator for the new Cole, Marchent, and Morley engine at the Kelham power station, £3,812. 12s.; J. G. Brill Company, six motor trucks required for the cars now being built at the Nether Edge Depôt, £58. 16s. for each complete truck.

Colchester.—The Council have accepted the tender of Messrs. Davey, Paxman, and Co., Limited, at £295, to supply, deliver, and fix the piping, valves, etc., required in connection with the surface condensing plant; also the tender (being the lowest) of the Electric Power Storage Company, at £822. 15s., to supply an additional storage battery, subject to the Local Government Board's sanction being obtained for the further loan.

Keighley.—The following tenders are recommended for acceptance: T. E. Sugden, Keighley, tiling the floor of the engine-house at the electricity works, £63. 15s.; Gabriel and Augenault, London, 500 230-volt incandescent electric lamps, £21. 17s. 6d.; Brush Electrical Engineering Company, Limited, London, 500 230-volt incandescent electric lamps, £21. 17s. 6d.; J. H. Heathman and Co., London, telescopic ladder for trimming arc lamps, £20. 6s. 9d.

Worthing.—The Corporation have received the following tenders for the supply and erection of a main switchboard:

W. J. Fryer and Co.	£806
John Fowler and Co. (Leeds) Limited (accepted)	1 015
Blackwell and Co., Limited	1,032
Lea and Warren	1,035
Spagnoletti and Crookes	1,030
Williamson and Joseph, Limited	1,040
Cowans, Limited	1 050
Brush Electric Company	1,075
Mechan and Sons	1 200
Cox-Walkers	1 205
General Electric Company	1,285
Siemens Bros.	1,293
Heaton and Smith, Limited	1,434
Nalder Bros. and Thompson, Limited	1,450
Crompton and Co., Limited	1,730

Swindon.—The Town Council have accepted the tender of Messrs. Siemens Bros. and Co., of Woolwich, for the supply of three dynamos, at £7,355, under Contract No. 1 of the scheme for the provision of a system of electric lighting and traction for the borough. There were in all 53 tenders, the highest being £9,400 and the lowest £6,046. The contract price includes, in addition to the three dynamos, the provision of three of Messrs. Browett and Lindley's (Manchester) triple-expansion engines of 350 h.p. each.

Colne.—The following tenders have been received by the Town Council:

Section No. 1.—Switchboard.

Mechan and Sons	£580 0 0
Electric Construction Company	1,030 0 0
Brush Electrical Engineering Company	920 0 0
Greenwood and Batley	1,188 0 0
Heaton and Smith	1 052 0 0
Verity's, Limited	930 0 0
Siemens Bros. and Co.	1,050 0 0
J. Fowler and Co.	762 0 0
Warren, Beattie, and Co.	800 0 0
Cowans, Limited (accepted)	630 0 0
Crompton and Co.	720 0 0
General Electric Company	1,015 0 0
S. H. Heywood	800 0 0
British Schuckert Company	800 0 0
Brook, Hirst, and Co.	760 0 0
Fryer and Co.	840 0 0
B. Thomas	953 0 0

Section No. 2.—Balancer booster.

Electric Construction Company	585 0 0
Brush Electrical Engineering Company	680 0 0
Greenwood and Batley	598 0 0
Bergtheil and Young	597 0 0
Lister Electric Power Company	550 0 0
Siemens Bros. and Co. (accepted)	515 0 0
J. Fowler and Co.	551 0 0
Warren, Beattie, and Co.	300 0 0
Crompton and Co.	640 0 0
General Electric Company	560 0 0
Salmony and Co.	545 0 0
D. B. Peebles and Co.	576 0 0
British Schuckert Company	689 0 0
Lancashire Dynamo Company	495 0 0
J. P. Hall and Co.	4 6 0 0
Newton Electrical Works	359 0 0
Mather and Platt	649 0 0
B. Thomas	523 0 0

Section No. 3.—Cables.

Henley's Telegraph Works Company	4 809 9 0
G. A. Nussbaum	6 562 10 0
Siemens Bros. and Co.	4 587 15 0
Johnson and Phillips	4 391 0 0
W. T. Glover and Co.	4 444 10 0
British Insulated Wire Company (accepted)	4 432 12 11
Callender's Cable and Construction Company	4 600 11 2
St. Helen's Cable Company	4 424 3 2
Western Electric Company	4,482 7 6

Section No. 4.—Earthenware conduits.

Albion Clay Company (accepted)	1,193 6 8
Maguire and Baucus	1 186 4 2
Johnson and Phillips	1,151 17 6
Doulton and Co.	1,135 16 8
H. Tugby and Co.	1,301 16 8

Section No. 5.—Superheater.

Babcock and Wilcox (accepted)	140 0 0
Lindsay, Burnet, and Co.	115 0 0

Section No. 6.—Accumulators.

		A.
Electric Power Storage Company	£1,278	£160
Chloride Electrical Storage Syndicate	1 961	*118
Ashmore, Benson, Pease, and Co.	1 345	134
Hart Accumulator Company	1,669	167
Tudor Accumulator Company	1,465	89
British Power and Traction Company (accepted)	1 293	75

A. Annual maintenance for 10 years. * For first five years; £138, for second five years.

Section No. 7.—Ejector condenser.

Korting Bros. (accepted)	69 10 0
T. Ledward and Co.	77 0 0

Section No. 8.—Motor centrifugal pump.

Electric Construction Company	200 0 0
W. H. Allen, Son, and Co.	170 0 0
Greenwood and Batley (accepted)	103 0 0
Korting Bros.	170 0 0
Lister Electric Power Company	140 0 0
Warren, Beattie, and Co.	123 0 0
Gwynnes, Limited	151 0 0
Lancashire Dynamo Company	130 0 0
Morley Electric Engineering Company	120 0 0
Dyslale and Co.	205 0 0
Newton Electrical Company	112 0 0
Mather and Platt	180 0 0
British Schuckert Company	150 0 0

Wolverhampton.—The Tramway Committee have recommended the Council to purchase nine new tramcars in accordance with the following tenders: (1) British Thomson-Houston Com-

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pany, Limited, for the supply of two single-deck tramcars (design B), at a cost of £544. 10s. each, and one single-deck tramcar (design C), at a cost of £539. 5s. (2) British Westinghouse Company, Limited, for the supply of two single-deck tramcars (design B), at a cost of £537. 8s. 6d. each, and one single deck tramcar (design C), at a cost of £536. (3) Messrs. Dick, Kerr, and Co., Limited, for the supply of two single-deck tramcars (design B), at a cost of £560 each, and one single-deck tramcar (design C), at a cost of £595. The total amount proposed to be expended on the nine cars is £4 954. 2s.

BUSINESS NOTES.

TRACTION.

Colchester.—The Town Council have agreed upon the site for the proposed tramways shed for £2,250.

Finchley.—The Urban District Council have decided to oppose the Finchley and Hendon Tramways Bill.

Middleton.—The Town Council intend to apply for a loan of £37,500 for the construction of electric tramways.

Yarmouth.—The construction of the proposed tramways, it is thought, will be commenced in three months' time.

Blackpool.—The tramways, the estimated cost of which is put at £94,060, are expected to be completed by Whitsuntide.

Stalybridge.—The tramways to be constructed in the district are estimated to cost £226 884 independent of rolling-stock.

Southport.—Sanction has been obtained to the borrowing of £75 000 for electrical equipment and reconstruction of tramways.

East Molesey.—The District Council have confirmed their resolution to oppose the London United Tramways Company's Bill.

Salford.—In consequence of his appointment as tramways manager, the tramways engineer's salary has been increased by £160.

Brighton.—The Town Council have decided to purchase two pieces of land on the Lewes-road for tramway sheds, etc., for £3,850.

Camberwell.—The Borough Council have approved the London County Council's scheme for constructing electric tramways in the district.

North Shields.—The new electric tramways to Whitley are now completed. The Board of Trade inspection took place on Wednesday.

Cardiff.—The borough engineer's salary has been increased by £100 per annum, rising to £250, on account of his additional tramway duties.

Broughty Ferry.—Negotiations are still proceeding with regard to the establishment of a tramway between Dundee and Broughty Ferry.

Dublin.—Messrs. Arthur Guinness, Son, and Co. are about to promote a parliamentary Bill to construct electric tramways at their premises in Dublin.

Whitehaven.—The Harbour Commissioners regard the West Cumberland electric tramway scheme as beneficial to the harbour, and have agreed to support it.

Battersea.—The Parliamentary Committee recommend the Borough Council to give their formal consent to the London County Council (Tramway) Bill.

Hampton Wick.—The District Council have refused to agree to the County Council becoming the purchasing authority in the matter of the tramways in their district.

Alvaston.—The Urban District Council have intimated their approval of the Derby Corporation Bill so far as it relates to the construction of tramways in the Alvaston district.

Scarborough.—The Corporation have granted a license for the running of electrical omnibuses in the borough. It is expected that the vehicles will be inaugurated at an early date.

Leamington.—The Town Council have sealed the amended agreement between the Corporation and the tramway company, and sanctioned the Tramway Committee's provisional order.

Brentford.—Mr. W. G. Cooke has been appointed by the Guardians as valuer to assess the property belonging to the London United Tramways Company in the several parishes within the union.

Rochdale.—As the result of a conference between representatives of the Rochdale, Heywood, and Bury Corporations, terms have now been provisionally arranged for the working of the Rochdale trams.

Sunderland.—A new electric car was run over the three unopened routes of the Sunderland tramways last week with most satisfactory results. The Board of Trade have been invited to inspect the new sections.

Tunbridge Wells.—A meeting of ratepayers will be held on the 27th inst. to consider the advisability of establishing a municipal tramway service in the borough, communicating, if possible, with the destructor on either side.

Darlington.—Negotiations are proceeding for the purchase by the Corporation of the horse tramways, with the object of establishing electric traction. The total cost is estimated at about £60,000. The opinion is expressed that electric tramways ought to be left alone by the municipality.

Brighouse.—The work of fixing guard boards over the electric cables belonging to the Corporation at various points in the centre of the borough where these overhead cables are crossed by telegraph and telephone wires was carried out this week.

Bradford.—The City Council have instructed the city surveyor and tramways manager to prepare specifications for the overhead equipment and all other work required for converting to electric traction the tramways at present leased to companies in the city.

Wolverhampton.—A long discussion took place at the Town Council meeting on Monday upon the merits of single and double decked tramcars, and as to the safety of the last named on a narrow gauge. It was eventually decided to purchase six single-decked cars and three double decked cars.

Stirling.—The Board of Trade have given powers to the Town Council to purchase that part of the tramway line within the burgh. It is expected, however, that an arrangement will be made whereby the British Electric Traction Company will acquire the whole line, and work the traffic by electricity.

Birkenhead.—The Town Council have resolved to issue workmen's tickets to any persons before 8 a.m. on weekdays, enabling the holder to travel the whole journey for a penny. A return twopenny ticket will also be issued. The resolution fixing certain fares for the New Ferry route has been confirmed.

Waterloo and City Railway.—In accordance with a new arrangement as to the working of this line, trains now run at intervals of five minutes, and directly the coaches have left the platform at Waterloo another train comes alongside so that passengers have an opportunity of selecting their seats for the short and fast journey.

Oldham.—At the monthly meeting of the Town Council last week it was stated that the total cost of the tramways scheme had been reduced from £27,102 to £26,091. That part of the Tramways Committee's report recommending that the laying of the Lee-street tramway should be commenced forthwith was rejected.

Tramway Receipts.—The receipts of the Brisbane Electric Tramways Company to Dec. 26 last show an increase of £300, and of the Buenos Ayres and Belgrano Electric Tramways Company to Jan. 13 an increase of £427. The receipts for January of the Cape Electric Tramways amount to £15,106, and of the Mexico Electric Tramways £16,800.

Dundee.—The Convener of the Tramways Committee stated at last week's meeting of the Town Council that the telephone wires in the extreme west of the city which crossed the tramway wires had been insulated. It was resolved to insist on the insulation of all telephone wires, or that they should be put underground. It has been decided not to grant free tramway passes to councillors.

The "Underground."—The District and Metropolitan Railways Joint Committee having considered the tenders which have been submitted for the conversion of the Underground Railway from steam to electric traction, the decision as to the letting of the contract will rest with the boards of directors of the respective companies, who will probably make a definite selection in the course of the next week.

Leeds.—The Town Council, on the recommendation of the Parliamentary Committee, have decided to oppose the Bill promoted by the Yorkshire Electric Power Syndicate, Limited, with a view to the exclusion of the city from the area of the syndicate's operations, and if found desirable, to act in conjunction with the other county boroughs affected. The salary of Mr. Harold G. Jekin, assistant tramway electrical engineer, has been increased by £50 per annum.

Protection of Hampstead Heath.—At the monthly meeting of the Metropolitan Public Gardens Association a favourable communication was read from the London County Council with regard to certain amendments it is proposed to secure in the Charing Cross, Euston, and Hampstead Railway Bill for the preservation of the Heath. The president and 21 members of the Royal Academy have petitioned the London County Council to oppose the proposed extension of the railway to the Heath.

East Middlesex Electricity Bill.—The ratepayers and owners of Edmonton and Enfield have declared against their District Councils joining in the promotion of this Bill. A poll was taken last Tuesday, when the figures were—Enfield; for the Bill, 1,691; against, 2,734—majority against, 1,043. Edmonton: for the Bill, 1,027; against, 1,597—majority against, 570. On Thursday night last week a meeting of ratepayers in the district of Southgate passed a resolution in favour of the Councils' joint action.

Private Bills.—The examiners have reported that the Paisley district tramways order has not complied with the Standing Orders of Parliament, as the promoters had failed to obtain the consent of the Paisley Corporation. The consent of the Johnstone Town Council, however, has been obtained, and the promoters are negotiating, with every hope of success, to obtain the consent of the Renfrew Town Council and the Renfrewshire County Council. The promoters have been allowed till the 21st inst. to see whether they can obtain the consent of these two bodies.

London County Council.—Next week the Council will be asked to pass estimates for £623,500 for the reconstruction for electric traction of the Council's tramways between (*a*) Westminster Bridge road and Upper Tooting road; (*b*) Kennington Park-road (at its junction with Kennington-road) and the terminus at Blackfriars road; and (*c*) St. George's-circus and the terminus in Waterloo-road, of sums not exceeding these amounts respectively in respect of (1) buildings and railway sidings, and (2) lines, machinery, generating plant, rolling stock, and electrical equipment.

Halifax.—The Town Council have approved the decision of the Tramways Electricity Committee to apply for sanction to borrow

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£130,000 in connection with the electricity department. At a cost of £12 000 the Corporation have resolved to construct a lift at Salterhebble, by means of which tramcars and other vehicles will be transferred from the hill on which the town is perched to the bed of the Calder Valley, 300ft., from which point tramway and other traffic to the towns of Sowerby Bridge and Elland will avoid encountering gradients. This will be the first lift of the kind in Great Britain.

Ayr.—The work of laying the first section of the electric tramways from Burns's Monument to Ayr, authorised in 1899, was commenced about a fortnight ago, and good progress has already been made. The Lighting Committee have arranged to supply electrical energy for the working of the tramways at the rate of 1½d. per unit up to 200,000 units, and 1d. per unit above that quantity. To meet the demand the committee are placing two additional generators and boilers at the works, and making extensions of the buildings. The cost of the entire scheme is £50,000. It is hoped that a considerable portion of the system will be ready for operations in the beginning of June next.

Sheffield.—The chairman of the Tramways Committee has prepared a statement with reference to the possible danger in connection with the electric tramway system. From this it appears that on the centre poles three guard wires are erected, and also on the side poles. In either of these cases, if telephone or other bare wires drop they are caught on the guard wires, which are connected to the rails, and there is no danger from the loose ends hanging down in the street. A memorial has been presented to the Tramways Committee urging the construction at the earliest possible moment of the extension of the Heeley tramway to Norton Woodseats. The through service of cars commenced yesterday.

The Proposed Electric Railway under the Solent.—Estimates have now been deposited by the promoters of this scheme, showing in detail the cost of the undertaking. The proposed railway, from its junction with the Lymington branch of the London and South-Western Railway at Sway to its junction with the Freshwater, Yarmouth and Newport Railway will be nearly eight miles in length, of which about 2 miles and 500 yards will be in tunnel under the Solent. The total cost of this scheme is estimated at £535 250, of which the tunnel section will cost £343 000. Throughout its whole length the railway will be constructed as a single line. The scheme is proposed to be carried out by an independent company with a capital of £600,000, of which £50 000 may be expended as interest out of capital during the construction of the railway. It is hoped that one-half of this capital will be subscribed for by the London and South-Western Railway Company.

Central London Railway.—As required by Parliament, the engineers have prepared estimates showing the capital which will have to be expended on new works in the event of the Bill promoted by the company receiving the sanction of both Houses. The total estimated expenditure is put down at £465 227, of which the proposed loop line extension from the Bank to Liverpool-street is estimated to cost £398,671. Of this sum £41 000 will be expended on the actual station accommodation, and £248 330 is the estimated cost of clearing an area of 20 poles for the Liverpool-street station. The balance of the total estimated expenditure will be spent on the construction of a loop line at the Shepherd's Bush terminus, which is estimated to require £59 922, and on a siding under Throgmorton street, which will cost £6,634. To meet this expenditure Parliament will be asked to sanction the creation of £600 000 additional ordinary capital, which includes a sum of £50,000, which may be expended as interest out of capital during the construction of the above works.

Manchester.—The tramways become the property of the Corporation on April 1 next. Prof. Kennedy in his last report says that the Bloom-street station ought not to be depended upon for a supply of electrical energy next winter on any tramway route other than the three already determined upon—namely, Bury New-road, Cheetham-hill, and Rochdale-road. This means that no electric tramcars can be run on any other route for about 18 months, and probably not until the Stuart-street station is completed. The cable laying has commenced, but none of the overhead equipment has been started, and the buildings are in such a backward state that the plant, which is partly ready for delivery, is being stored in various places in England and America. It will probably be three years before the system will be entirely converted to electric traction. It is roughly calculated that the increase in the wages bill over that paid by the carriage company will be about £16 000 per annum. The Corporation have promised to entertain the proposal to institute halfpenny fares on the Cheetham-hill route.

Barrow.—At last week's meeting of the Town Council the General Purposes Committee recommended that the date at which the Corporation reserve the right of purchasing the tramway undertaking be extended from 1919 to 1926. If, however, the British Electric Traction Company cared to submit fresh proposals, the committee would consider them. The license granted by the Board of Trade expired last Monday, but it is expected that a temporary license will be granted for three months. The committee's suggestion was adopted. The County Council have agreed upon the following prices to be charged the tramways company by the Corporation for the supply of current in place of those previously stated—viz, for the first 200,000 units per annum 2d. per unit; for the next 200,000 units per annum 1¾d. per unit; for the next 100,000 units per annum 1½d. per unit; for all above 500,000 units per annum 1¼d. per unit. On the recommendation of the Highways and Lighting Committee, the County Council have passed a resolution not to accept the terms offered by the company for the purchase of the tramways.

Unfounded Tramway Opposition.—In a circular letter to the Press, the Earl of Kinnoull, the chairman of the West-end Tramways Opposition Association, states that "the majority of these schemes are entirely uncalled for and unnecessary," and that "the introduction of tramways into well-inhabited districts almost inevitably brings about great depreciation in the value of residential and other property." With these statements, of course, it is impossible to agree, and if proof to the contrary were necessary, plenty of evidence is forthcoming from different parts of the country. In reply to enquiries from the London United Tramways Company, the town clerks of Sheffield, Dublin, Dover, Blackpool, Liverpool, Leeds, Cork, Kingstown, Coventry, Hull, Douglas, Hartlepool, Wednesbury, Walsall, Middlesbrough, and many other cities and towns have all sent messages to the same effect—viz that the tendency is for property to increase in value with the introduction of tramways. The reply from the town clerk of Dover is, perhaps, the best. He says: "No justification from our experience for impression named. Send critics here; all local opponents converted."

LIGHTING AND GENERAL.

Wallasey.—The time for receiving tenders has been prolonged to March 4.

Burnley.—Extensions of mains are to be carried out at a cost of about £2,350.

Sudbury.—It is proposed to borrow £20,000 for an electric supply scheme.

Halifax.—Application has been made to borrow £130,000 for electric supply extensions.

Darwen.—Application is to be made for a further loan of £2,000 for electric supply extensions.

York.—The City Council have decided to charge 5d. per unit up to 600, and above 600 and up to 2 000 4½d.

Exeter.—A scheme is under consideration for placing the local wires of the National Telephone Company underground.

Sleaford.—The Urban District Council have sealed tenders amounting to £5,000 in connection with the installation of electric light.

Penistone.—The Rural District Council are not taking any action with regard to the South Yorkshire Electric Power Company's Bill.

Hucknall Torkard.—The Urban District Council have decided to oppose the proposed Electrical Power Bill for the district so far as Hucknall parish is concerned.

Gillingham.—The District Council are instituting enquiries prior to taking decisive steps for the purchase of the New Brompton electricity supply works.

Lanchester.—The consideration of the Cleveland and Durham County Electrical Power Bill has been referred to a special committee of the Rural District Council.

Keswick.—The electric lighting company's charges for public lighting by electricity are being considered by the Lighting Committee of the Urban District Council.

Heanor, Codnor, and Loscoe.—The Urban District Council intends to join the Alfreton District Council in opposing the Derbyshire and Notts Electric Power Bill.

Accrington.—The proposed electrical extensions are to provide for next winter, and the Town Council expect to have full employment for the power proposed to be provided.

Salford.—On the recommendation of the Electric Light Committee, Mr. C. D. Taite, of Southport, has been appointed borough electrical engineer at a salary of £700 a year.

Warrington.—The Electric Lighting Committee are about to visit the works of Messrs. Willans and Robinson, of Rugby, to inspect and see tested the set of new engines.

Bristol.—The salary of Messrs. Phillips and Bird have been increased by £25 per annum, as from Jan. 1. 1901, with a further increase of £25 per annum as from Jan. 1, 1902.

Trowbridge.—The Urban District Council's agents have attended before the Board of Trade, and proved compliance with the Electric Lighting Acts and the Board of Trade rules.

Spalding.—At the last meeting of the Urban District Council the question of telephonic communication with Spalding was mentioned, and a committee was appointed to secure 10 annual subscribers.

Darlington.—The promoters of the Cleveland and Durham County Electric Power Bill have asked the Rural District Council to petition in its favour. The clerk has been requested to report on the subject.

New Works.—With regard to the note in our last issue *re* Messrs. Congdon and Powell's new works, we are informed that they have removed to Bravington Works, Bravington-road, Harrow-road, W.

Hampton Wick.—The District Council have decided to consult Mr. Lacey (Lacey, Clirehugh, and Sillar, Westminster) before approving the draft agreement with the Richmond Electricity and Power Supply Company.

Telephone Wires Underground.—It is reported that the National Telephone Company have decided, in order to allay the alarm already existing in Liverpool, to commence at once laying their wires underground.

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Alnwick.—Letters from Messrs. Leadbitter and Harvey and from the Board of Trade with reference to the proposal to provide Alnwick with electricity, are before the Lighting Committee.

Glasgow Telephones.—The Telephone Committee hope to be able to supply a few of their subscribers in March, and the completion of the work will be proceeded with as speedily as possible

Stafford.—The Town Council have decided to extend the electric cable from North-street along Rowley-street and George street at a cost of £190, applications having been received for a supply of current for motive power.

Fulham.—It is proposed to purchase two additional transformers at a cost of £265. Mr. Alexander Murdoch has been appointed assistant engineer at the electric light station in place of Mr. E. Garside, resigned.

Manchester.—At a meeting of the Electricity Committee of the Corporation on the 13th it was decided to recommend the appointment of Mr. Metzger, of Bath, as electrical engineer for the city. The salary is £800 a year.

Batley.—Sanction has been obtained to the borrowing of £25,402 by the Corporation for works of electrical energy. Tenders for the engines and dynamos required for the proposed electrical works are to be advertised for.

Aylesbury.—The Urban District Council have asked for an estimate for construction and maintenance of a Post Office telephone wire from the Council offices to the post office, and also to the sewage works and isolation hospital.

Blackburn.—The engineer is preparing, in conjunction with the consulting engineers, detail specifications for new buildings, new chimney, and engine and boiler plant at the generating station which will be required for the winter of 1902.

German East Africa.—The Budget Committee of the German Reichstag on Wednesday sanctioned the expenditure of 200 000 marks for the construction of a telegraph line between Dar-es-Salaam and Mpwapwa, in German East Africa.

Nantwich.—The draft of the agreement between the Rural District Council and Messrs. W. H. Trentham and Geo. R. Peers, the engineers on the proposed electric light works and refuse destructor, has been approved by the Council.

Bootle.—The electrical engineer's report will be issued at the end of March. It is stated that the cost of producing the electric light is decreasing. The lighting of Akenside and Gray streets is in hand, and the Derby-road lighting will be completed shortly.

Stroud.—The Stroud Traders' Association have passed a resolution with regard to the proposed scheme of electric light for Stroud, supporting the Urban District Council, who are about to oppose the Bill now being promoted in Parliament by the gas company.

Dublin.—The Local Government Board have given their absolute sanction to the £254.000 which has been applied for electric lighting, and with a view of facilitating the Corporation, they will grant that amount in sums of £50,000 as required during the contracts.

St. Annes.—The seven street lamps on South Promenade (between Eastbanke-road and Fairhaven-road) and the jubilee lamp at the parish church, are to be fitted with 50-c.p. lamps instead of 32. Accounts for machinery amounting to £1,108 have been passed for payment.

Hammersmith.—Provision was made in the last loan for electricity purposes obtained by the late Vestry for the expenditure of £1,000 in the purchase of several instruments required for testing purposes. Some of the instruments referred to are now to be obtained at a cost of £272. 8s. 8d.

Indiarubber.—The indiarubber production of the world for 1900 is estimated at 50,000 tons, 30,000 tons of which came from Brazil. Amongst the consumers, Great Britain heads the list with 20,000 tons, and nearly the same amount went to the United States. France and Belgium took about 3,000 tons each.

Dundee.—Notice of motion has been given that the Town Council consider the municipalisation of the telephone system, and appoint a small committee to make full enquiry into the matter, and in the meantime communicate with Glasgow regarding the steps taken in this direction by that Corporation.

Unfenced Machinery.—The Blackheath and District Electric Light Company was summoned last week by the inspector of factories for failing to fence dangerous machinery—a switchboard—whereby Arthur Robinson, a young man, was killed. Fines to the amount, with costs, of £41. 14s. were inflicted.

Cannock.—The Cannock Gas Company have filed notice of objection to the Council's application to the Board of Trade for a provisional order to supply electricity, chiefly on the ground that it would adversely affect their interests. On behalf of the Council an answer has been filed rebutting the gas company's arguments.

Nelson.—The Town Council have appointed Messrs. Gibbings and Baker consulting engineers for the proposed new scheme of electricity supply, with instructions to forthwith prepare plans of new electricity station near the refuse destructor, with a view to utilising the chimney thereat and the waste heat from the refuse destructor.

Malton.—The directors of the gas light company say in their report: "We purpose, having regard to the threatened competition of the electric light and the temporary depression which may possibly arise therefrom in the company's business, to take £250 from the divisible profits of the year and add it to the reserve fund."

Ashbourne.—The Finance Committee have recommended the Urban District Council with regard to the Derby and Nottingham Electric Supply Bill that the following clause be inserted: "Provided that the company should not exercise any of the powers in the district of this Council other than the laying of mains to another district."

London Gazette.—An adjudication order has been made out re T. A. Flather, 496, Meanwood-road, Leeds. The last day for receiving proofs in the estate of E. J. Paterson and C. F. Cooper, carrying on business as Paterson and Cooper, at European Works, Pownall-road, Dalston, London, is Feb. 2. Mr. E. C. Moore, 3, Crosby square, London, E.C., is trustee.

Salford.—At the recent conference of local authorities for the purpose of considering the municipalisation of telephones, three boroughs and 18 district councils were represented. A resolution in favour of municipalisation in the Manchester area was passed, and as at that time Manchester had not been consulted, a committee of five was appointed to formulate a scheme.

West Bromwich.—The Estates Committee of the Corporation have resolved to light the town hall and offices by electricity. The wiring and fittings will be put in at once, so as to be ready by the time the works are ready to generate and supply the current. It has also been decided to put in an electric motor for blowing the organ in place of the present gas-engine.

Crompton and Co.—With regard to the resolution mentioned in our last issue to the effect that the capital of the Company be increased to £300 000 by the issue of 46 000 new shares of £3 each, we learn that the directors have taken this step in order to provide for the growth of the electrical engineering industry by further working capital and by enlarging the works at Chelmsford.

Church Stretton.—On Monday a letter was read from the Church Stretton Land Company asking for the co-operation of the Urban District Council in an application they proposed to make for a provisional order to lay down electric cables for the lighting of Church Stretton. The Council decided not to consider the application until they had been supplied with a draft of the order.

Middlesbrough.—Mr. Hammond has submitted his estimates for an extension of the electric light works. These include the following items: boiler-house plant, £1 000; engine-house plant, £5 250; building work, £350; railway siding coal conveyor, etc., £1 665; mains, £3,937; meters, £900; arc lighting, £1,350; and general charges, contingencies, etc., £1,493—making a total of £21,000.

Croydon.—The Local Government Board have decided that they cannot entertain any future applications for borrowing capital for free wiring, consequently the Electricity Committee are unable to give effect to the free wiring scheme recommended in their report of Nov. 19 last, and adopted by the Council on Nov. 26. The committee have authorised an alteration in the method of supply of light to certain arc lamps at a cost of £84.

Dudley.—The Local Government Board have informed the Town Council, in reference to the refusal to grant the application of the Town Council for sanction to borrow £10 000 to wire the premises of consumers of electrical energy, that the Board did not see any advantage of the attendance of a deputation to discuss the matter, as having regard to the views expressed by the Board of Trade, they were debarred from reconsidering their decision.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Poplar Borough Council £27,360 for electric light installation, and the Fulham Borough Council £24,145 for dust destructor and street-lighting purposes. Mr. John Hall Rider, chief consulting and resident engineer for electric tramways and electric lighting under the Plymouth Corporation, was appointed as electrical engineer at a salary of £1,000 a year.

Thornhill.—The District Council have decided to lodge objections with the Board of Trade and parliamentary agents for the order to the application of the Northern Counties Electricity Supply Company for authority to produce and supply electricity for motive power and all other purposes in the Council's district. With regard to the South Yorkshire electric power scheme no action has been taken, the Council not desiring to oppose the Bill at present.

Morley.—The following report has been adopted by the Town Council: "Resolved that the Electric Lighting Committee undertake to supply the Edison and Swan lamps; that the cables be extended from the sub-station, near the Fountain Inn, for the purpose of lighting the Ebenezer Chapel; that the committee adopt the easy wiring system, and approve the terms of the agreement to be entered into by consumers who adopt the hire-purchase wiring system."

Share Market.—Electric shares were fairly active, but no changes of importance were recorded. Smithfields were good on the report, and Kensington and Notting Hill remained in demand. Westminsters were steady at 12½. British Electric Tractions were harder at 14-14½, a rise of ¼. All tractions are being bought by insiders, and higher prices are anticipated. Charing Cross Electric shares were unaltered on the dividend. There was also some demand for electric debentures.

Sheffield.—The Board of Trade have consented to the accounts of the electric lighting undertaking being made up to March 25 in each year, instead of Dec. 31, as at present. The town clerk has been instructed to defend any action which the Brush Electrical Engineering Company may commence against the Corporation for the payment of the balance of the contract price for the 600 kw. inductor plant at the electric light station, and to take all such proceedings as may be necessary.

Sunderland.—Great improvements are being made by the National Telephone Company at Sunderland, according to the *Northern Echo*. The whole of the wires have recently been placed

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underground, and return wires have also been added. Within a few months subscribers in the Wearside town will have no need to "ring up." A new device is about to be installed which will so act that the lifting of the receiver by the caller will automatically inform the exchange that a connection is required.

Maidstone.—The Electric Light Committee last week submitted the following report, which, however, was ultimately withdrawn: "That, in reply to their advertisement, they have received several tenders offering to negotiate the loan for £38,000. The lowest tender received is that of Mr. Horace G. Rayner, who states that he is prepared to introduce the same at 3½ per cent., his commission being 10s. per cent., inclusive of law charges, stamp duty, and all expenses. Your committee recommend the acceptance of this offer."

Charing Cross and Strand Co.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have decided to recommend a dividend for the half-year ended Dec. 31, 1900, at the rate of 9½ per cent. per annum, making (with the interim dividend distributed for the half-year ended June 30, 1900, at the rate of 8½ per cent. per annum) a dividend payable for the year 1900 of 9 per cent. on the ordinary share capital. The lamps connected during the past year have amounted to the equivalent of 39 431 8 c.p. lamps.

Sell's Telegraphic Addresses.—The usefulness of the sixteenth issue of "Sell's Directory of Registered Telegraphic Addresses," just published, has been considerably increased by a number (50 000 it is stated) of alterations made to bring the work up to date Telephone numbers of subscribers on the trunk lines and the addresses of consuls in foreign countries are added. A map of Africa south of the Zambesi, which is full of useful mercantile statistical information, is appended. This will be found of great value by all connected with African trade.

Evesham.—At a quarterly meeting of the Town Council on Wednesday the Chairman of the Gas Committee reported the results of the enquiries as to the installation of electric lighting in various towns, and explained the reasons which induced the committee not to recommend electric lighting at present. It would require an expenditure of at least £10,000 and it would be necessary to make an income of not less than £1,000 a year before they saw any chance of profit. The subject was referred to the General Purposes Committee for further consideration.

Worcester.—The Council have appointed Mr. E. E. Hoadley, who for the past year has acted as electrical engineer to the committee's satisfaction, to be chief assistant in the electricity department, and to devote his attention especially to the work connected with the proposed generating station, at the salary of £250 per annum, subject to the appointment being terminable by one month's notice on either side. Mr. Hoadley is to be permitted to receive in addition 3 per cent. on the Council's outlay for supervising the wiring of houses, etc., under the Council's scheme.

Grimsby.—A portion of the town was for the first time lighted with the Corporation's electric light on Monday. There are now 20 arc lamps ready for street illumination, and the current was switched on to these experimentally with satisfactory results. The whole of the installation is now nearly completed, and it was stated on Tuesday that the current will be available for private consumers at once. The total sum authorised to be spent for the Grimsby light works is £55,000 Five arc lamps are to be erected in George street. Osborne-street, and Bethlehem-street at an estimated cost of £120.

Worksop.—The Derbyshire and Notts Electric Power Company's Bill is considered detrimental to the interests of the Urban District Council, who have an electric power and lighting scheme in hand, inasmuch as they would have power to go through the Council's district and in some cases to supply electric power. The Council's suggested price is 5d. to 6d. per unit, whereas that of the company is stated at 2d. The Council last week decided to approach the promoters with the object of inducing them to expunge Worksop urban district from their proposals; if not, the Council would consider as to opposing the Bill.

Pongo.—At Monday's meeting of the District Council a letter was received from the Lewisham and District Electric Supply Company, Limited, stating that in pursuance of an agreement made with the late Lewisham Board of Works they were applying for an electric light provisional order for the whole of the district of that Board, which included the present area of the District Council. They had already obtained the assent of Lewisham to the provisional order, a copy of which was enclosed, and they now required to have the consent of the District Council. It was eventually decided to discuss the matter in committee.

Shannon Water and Electric Power Co.—This Company propose to generate and supply electricity and "to acquire and work any patents relating to the supply of water for motive power, and to the generation and distribution of electrical energy." The area within which the Company propose to carry on business is to be so much of the counties of Clare and Limerick as are within a radius of 30 miles of the townland of Springfield. The capital of the Company is to be £365,000. The first directors are to be Mr. William Brownlow, Mr. John Chambré, Mr. Alfred Lane Joynt, Mr. Henry Herbert Montague Smith, and Baron Lurgan Brown.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Edmundsons' Electricity Corporation, Limited, 13,363 6 per cent. cumulative preference shares of £5 each; and to allow the following securities to be quoted in the official list: British Columbia Electric Railway Company, Limited. 20.000 ordinary shares of £10 each, fully paid, Nos. 1 to 20,000, and £250,000 4½ per cent. first mortgage debentures of £40 each, Nos. 1 to 6,250 (renewed application); Edmundsons' Electricity Corporation, Limited, further issue of £45,000 4 per cent. first mortgage debenture stock.

Dewsbury.—At the last meeting of the Council, the services of Mr. Jonas were very highly spoken of. It was said that he came at a time when, owing to the action of the Board of Trade, the committee were faced with the expense of doubling the capacity of their mains, as the mains were not suitable to the current they were called on to carry. On the advice of Mr. Jonas it was decided not to double the mains, but to double the voltage, which would allow them to send the amount they required through the same copper—a result of a saving of from £4,000 to £5,000. When Mr. Jonas came there was a loss on the plant of about £479; last year they had cleared a profit of £201.

Ramsgate.—The engineer of the gas and water undertakings has been instructed to prepare plans and specifications and invite tenders for laying cables to supply electricity along the front of the borough between the east end of the Victoria-parade and the west end of the West Cliff Promenade, and through the following streets: High-street to Chatham-street, Harbour-street to the Sands, King street to Boundary-road, Queen street to Addington-street. He has also been instructed to communicate with the Isle of Thanet Electric Tramways and Lighting Company, Limited, and ascertain the terms upon which they would be willing to supply the Corporation with electric current.

Cape-to-Cairo Telegraph.—Mr. Robert Williams, who returned a few days ago from a trip up the Nile, visited Aberdeen on Saturday last. On Saturday next he sails for the Cape to meet Mr. Rhodes with regard to important matters relating to the Cape to Cairo telegraph scheme, in which Mr. Williams is largely concerned, and in connection with which he is getting a barge constructed by Messrs. Hall, Russell, and Co. This vessel is to be used on the great African lakes in conveying telegraph poles and other material for the construction of the line. Mr. Williams spent a good deal of time in Messrs. Hall, Russell, and Co.'s shipbuilding yard on Saturday inspecting the progress of the work on the barge.—*Aberdeen Journal.*

Greenwich.—Consent has been given by the Lewisham Borough Council to the application by the Lewisham and District Electric Supply Company, Limited, for a provisional order to supply electricity in the parish of Lewisham. It was stated at the meeting of the Council on Wednesday, as an argument against suggested installation of municipal plant, that in the borough Sydenham, Blackheath, and Lee were already covered by private companies, and that the rates which had been agreed upon by the late Lewisham District Board of Works and the Electric Extension Company. Limited (of which company the Lewisham and District Electric Supply Company were the nominees) approved by the late District Board, were very low, and compared very favourably with the rates of municipal undertakings generally.

Bradford.—On Friday evening last the employés at the Corporation electricity works, Bolton-road, met at the works to show their appreciation of Mr. R. C. Hickling, one of their colleagues who has volunteered for active service in South Africa with the Electrical Engineers Corps, by presenting him with a pair of field glasses and pipe. Mr. Eastwood presided. Mr. Saunders, in making the presentation, regretted the unavoidable absence of Mr. Chattock, the chief engineer, and spoke of the esteem and good feeling that existed between Mr. Hickling and his colleagues. He added that should Mr. Hickling desire to return back to Bradford at the end of his active service, his present post would be at his disposal. Several other members of the staff endorsed Mr. Saunders's remarks, to which Mr. Hickling suitably responded.

Birkenhead.—The Council have considerably reduced the price of electrical energy. During the winter quarters (October to March) for the first hour and a half of maximum demand 6d. per unit will be charged to ordinary consumers; for the second hour and a half of maximum demand, 3d. per unit; afterwards, 1½d. per unit. Summer quarters (April to September): first half hour of maximum demand, 6d. per unit; second half hour maximum demand, 3d. per unit; afterwards, 1½d. per unit. For power purposes during the winter quarter the charges will be: for the first hour and a half of maximum demand, 4d. per unit; second hour and a half of maximum demand, 3d. per unit; afterwards, 1½d. per unit. Summer quarters: first half hour of maximum demand 4d. per unit; second half hour of maximum demand, 3d. per unit; afterwards, 1½d. per unit.

Boilers.—The boiler-house of the Pan-American Exhibition, which is to be held at Buffalo, N.Y., U.S.A., from May 1 to Nov. 1 this year, will contain four Climax boilers, built by the Clonbrock Steam Boiler Company, Brooklyn, N.Y. These boilers will be about 13ft. external diameter, will stand over 31ft. high to the base of a 48in. chimney stack, and will have a minimum evaporative capacity of 15,000lb. of water per hour each. They will be fired with natural gases, but will have the regular coal grates covered with firebrick, so that in case of failure of the gas supply the covering can be removed, and the boiler run with coal without serious interruption of the service. These Climax boilers are now being built in this country by Messrs. B. R. Rowland and Co., Limited, Climax Works, Reddish, near Manchester, who are the sole manufacturers outside the United States.

Tunbridge Wells.—A sub-committee of the Lighting Committee are about to inspect and report upon the lighting of Benhall Mill-road from Forest-road to the sanatorium. The electrical engineer has been instructed to purchase one enclosed arc lamp and seven other arc lamps in order to complete the lighting of Church-road, Crescent-road, London-road, and St. John's-road. The town clerk is to report as to the power of the committee to

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undertake the work of wiring houses for electric light installations. The National Electric Wiring Company having asked whether the Corporation were prepared to purchase the free-wired installations belonging to the company in Tunbridge Wells, they have been informed that the Corporation have no power to purchase the installations. Mr. Blackburn, of the firm of Blackburn, Starling, and Co., Limited, is now preparing a report upon the suggested heightening of the chimney shaft at the central station.

Festival.—The annual festival of the employés of the National Telephone Company was held last week in the National Halls at Glasgow. Mr. W. A Valentine, district manager, occupied the chair. After tea the Chairman delivered a brief address, in course of which of which he referred to the wonderful developments in electrical science during the last 60 years. He also said that last year the National Telephone Company had 121,000 subscribers, and at the present time 180 000 people were connected with telephone exchanges throughout the country. The number of messages passing between different subscribers last year was 617,000 000. In Glasgow they were at the present time engaged in substituting metallic circuits for the single wires, and only those engaged in the business could realise the magnitude of such an undertaking. Their business in Glasgow was now going up by leaps and bounds, last year having been by far the most successful in the company's history.

Christchurch.—The Guardians have received a letter from the Local Government Board with reference to the proposed provision of a system of electric lighting at the workhouse and cottage homes, asking that the matter be deferred for the present. The Board are of opinion that the scheme was too costly, and they would like to know whether the Guardians could not obtain a supply of electricity from Bournemouth, which they considered would be better than generating their own. It appears that Mr. Peers, consulting electrical engineer, had pointed out to the Local Government Board that Bournemouth was five or six miles from the workhouse, and that the electric supply could not be very well obtained from there, but the Board wished to be informed upon what terms the electric supply company would supply the house and for how many years. The matter is now in the hands of the Buildings Committee, who will enquire on what terms the supply would be made.

Maidenhead.—The Electric Lighting Committee have decided not to make any amendment in the number of lamps for private lighting, which is placed at 3 000, nor to reduce the number of units per lamp; they have also decided that the figures with regard to sewage pumping and launch charging shall remain unaltered, but they have reduced the estimated amount to be derived from meter rents to £100, in view of the fact that there is now a cheaper meter on the market. This recommendation has been approved by the Town Council. It is stated that the number of 8-c.p. lamps which could safely be connected without increase in the plant provided for in the estimate will be 5 000. Notice has been given to move the following resolution: "If it be the intention of this Council to carry out the lighting of the town by electricity, notice should be given of the same by advertisement offering a premium for the best and second best plans, specification, and estimates for carrying out the necessary work."

Dalkeith.—At Monday's meeting of the Town Council the chief business on the agenda was the question of the electric lighting of the burgh in connection with Messrs. Crompton and Co., who had intimated that the price of 3d. was for the supply of electric current only, and did not include the erection of the lamps. The Town Clerk said he had had no reply from Messrs. Crompton and Co., but Bailie Chisholm stated that while in London a week ago he had had a meeting with the general manager of Messrs. Crompton and Co. The agreement forwarded lately to Dalkeith was made out in similar terms to those of other towns, and Messrs. Crompton and Co. were themselves unaware that the lamps were to be provided. Having, however, been shown the proposals made to Dalkeith Council by their (Messrs. Crompton's) Edinburgh agent, they said they must carry out that agreement, although at a loss. The Bailie, in reply, said that the company seemed to be quite willing to give way on the point as to the upkeep of the lamps.

Skipton.—The Urban District Council, who are seeking a provisional order of the Board of Trade authorising them to supply electricity in their district, last week had before them a letter from Messrs. Baker, Lees, and Co., parliamentary agents, who stated that they had been informed by the Board of Trade that, having regard to the advance made in electrical science, and to the development of methods of distribution since 1899, when the maximum price of 8d. per unit was adopted, and as they understand that the price actually charged is as a rule much less than 8d., the Board are of opinion that the time has come when the maximum of 8d. should no longer be allowed. They propose, therefore, in the provisional orders now before them and in all orders applied for in the future, to fix a maximum of 6d. per unit. The Council directed the clerk to appeal to the Board of Trade to allow the price to remain at 8d. in the Skipton order on the ground that the Council had applied for the order on the faith of the price inserted in the Board's model orders.

Manchester Telephones.—The proceedings of the special committee *re* telephones, which were adopted at the last meeting of the Council, stated that the city surveyor submitted plans and gave explanations with reference to applications which were before the Council in 1899 as to underground wires. The first line in question was 1,186 yards long—in Ashton Old-road. There was also in the same road a short length of 27 yards across the road to the company's offices, also a line in Oldham-road, Collyhurst, 1 mile 1,624 yards in length. The committee resolved that permission be granted to the National Telephone Company to lay the short length of underground wires (27 yards or thereabouts) in Ashton Old-road, and that the necessary agreements be prepared. It was also resolved that the committee were not prepared to consent to the placing of any telephone wires underground, except the short length referred to, but that they offered no objection to overhead wires being provided, in order that the telephonic communication desired might be obtained.

Otley.—The report of the engineer (Mr. George Wilkinson, M I M E., Harrogate) appointed by the District Council to report upon the question of the establishment of a public electricity supply for the town has just been presented to the Council, and has been submitted to the Electric Lighting Committee of the Council. Mr. Wilkinson's proposals include the establishment of a steam driven generating plant in a field near the river capable of providing 6,750 8 c.p. lamps. He estimates the capital outlay at £18,000, and the annual expenditure at £1 122. 15s. The revenue is to be derived from the sale of current to 6,750 lamps at 6d. per unit, averaging 7s. per lamp per annum—a total of £2,362. 10s. Thus the annual gross profit is £1 239 15s., and the net profit is estimated at £231. 15s. In comparing this scheme with that for obtaining a supply in bulk from the Yorkshire Electric Supply Syndicate, he estimates the total annual expenditure for the latter at £2,110. 10s., and the receipts at £2,250, thus giving a net annual profit in favour of local works of £92. 5s.

Sales of Plant.—The Postmaster-General is selling about 30 tons of guttapercha 70 tons of old copper wire, plates, etc., and a quantity of other metals (brass, zinc, and iron), indiarubber-covered copper wire, tools, raw and limed side pieces, electric incandescent lamp tops, accumulators, etc. Particulars of the sale appear in another column. We also refer readers to our last week's issue for details of the following: The Blackburn Corporation invite offers for two Willans-Siemens 45 kw. continuous current direct coupled steam dynamos. Voltage, 110 to 150; steam pressure, 180lb.—The Electric Lighting Committee of Aberdeen have for disposal two direct-coupled continuous-current Willans Elwell Parker sets. Engines 38 h.p; dynamos, 23 kw. (170 amperes at 135 volts), together with a spare armature to fit either machine, and some engine spare parts.—The Great Eastern Railway Company invite tenders for the purchase of the whole or any part of the existing steam and hand power cranes, etc, and also for the present electric light installation at Parkeston Quay.

Private Bills.—The report by the Chairman of Committees of the House of Lords and the Chairman of Ways and Means in the House of Commons under Section 2 of the Private Legislation Procedure (Scotland) Act, 1899, issued this week by the Scottish Office in the following terms, states that the committee are of opinion (1) that the provisions of the Caledonian Electric Power Order, the Clyde Valley Electrical Power Order, the Glasgow and Renfrew District Railway Transfer Order, are of such a character that they ought to be dealt with by private Bills and not by provisional orders; (2) that the Paisley Police Public Health and Tramways Order may proceed so far as it relates to tramways. Mr. Campion, one of the examiners appointed under Standing Orders, has reported to the Secretary for Scotland that in the case of the following draft provisional orders the general orders have been complied with: Clydebank Tramways, Dundee Corporation, Falkirk and District Tramways, Kilmarnock Corporation, Stirling Corporation. A Bill has been deposited at the Scottish Office in substitution for the draft provisional order in each case in which the chairmen of the two Houses of Parliament previously decided that the order could only proceed as a Bill. In the case of the Charing Cross, Hammersmith, and District Electric Railway Bill the necessary proofs have been given, but the examiner will report a non compliance in the Tyneside Tramways and Tramroads Bill. The examiners have decided to sit again at Westminster on the 18th, 21st, and 28th inst. to receive proofs of compliance with Standing Orders.

Telephone Arbitration.—An arbitration case was heard at Pontypridd Police Court on Tuesday morning between the Postmaster General and the Glamorgan County Council, the arbitrator being Mr. J. Ignatius William, stipendiary magistrate. The subject at issue related to the proposal to establish a telephone call office at the Llantrisant post office, and the laying of wires between Pontypridd and that place on the road leading through Pencoedcae and over the hill overlooking Pontypridd. The County Council objected to the erection of poles on the ground that the road is too narrow. Sir Robert Hunter (London) solicitor to the Postmaster General, appeared on behalf of the Post Office, and Mr. B. F. Williams, K C, and Mr. Rhys Williams (instructed by Mr. W. E. R. Allen, solicitor) for the County Council. Mr. Blandy Jenkins, J.P. (chairman of the Council) was present. The following terms, to be embodied in the stipendiary's award, were agreed to—viz: that consent be given to the Postmaster-General to place telegraph poles over roads from Pontypridd to Llantrisant maintained by the Glamorgan County Council, the line entering the road at the stone depôt near the Penrhiw Colliery upon the following terms: (1) no pole to be placed on metalled roads; (2) subject as aforesaid, the position of the poles to be settled between the engineer to the Post Office and the county surveyor, with reference to magistrates, necessary; (3) the Postmaster-General to make good any damage done in the execution or maintenance of work; (4) the County Council to be at liberty to withdraw consent at three months' notice. The Postmaster-General, if he objects to remove the poles from the highway, to take immediate steps to bring the difficulty for decision to arbitrator's tribunal,

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Battersea.—At the meeting of the Borough Council on Wednesday the Works Committee reported that on Jan. 9 the Council, on the recommendation of the committee, decided to accept the tender of the Edison and Swan United Electric Light Company Limited, for the supply of electrical fittings for wiring the new baths, subject to their entering into the usual contract. The company have raised objections to signing the contract, and, as a matter of urgency, the committee have instructed the surveyor to obtain the fittings from the General Electric Company The Lighting Committee reported that for the appointment of electrical engineer to the Council at a salary of £350 with residence at the works, 50 applications had been received, three of the applicants being selected for interview that night. They are: Mr. Hugh Rose Forbes Mackay, chief assistant to the Edinburgh Corporation; Mr. Albert Frederick Nixon, engineer on the staff of Messrs. Kennedy and Jenkin; and Mr. Leonard Leslie Robinson, chief engineer and representative of Mr. Robert Hammond.

Bolton.—The growing demand for current for both tramway traction and lighting will render requisite some important extensions in connection with the Bolton Corporation electricity department at its generating station in Spa-road. In the tramway service it is expected that a dozen additional heavy bogie cars will shortly be running, whilst electricity as an illuminant is an ever-increasing quantity in the town. Over a score of places of worship and schools have had the light installed, and others have it in contemplation, whilst by reason of its purity and convenience it is recommending itself to private consumers in increasing number. With the view to providing for future developments, the electrical engineer (Mr. A. A. Day) has been formulating a plan as to the capacity of the existing buildings and site for additional power, which it is proposed to lay down by instalments as the need may arise. The existing plant is of 4 500 h.p., supplied with steam by nine boilers, and it is now proposed to add two 1,500-h.p. engines, with equivalent boiler power. The latter will entail a considerable extension of the boiler-house.

Telegraphs and Telephones.—The Cables Communication Commission recently appointed by the Government will receive strong support from the Associated Chambers of Commerce at their annual meeting. The Newcastle and Gateshead and the South of Scotland Chambers urge that all our Colonies and dependencies should have telegraphic communication apart from the jurisdiction of foreign nations and entirely under the control of the Imperial Government, and the Liverpool Chamber advocates an enquiry into telegraphic communication between the different parts of the Empire and the charges for the same with a view to increased efficiency and economy in the telegraph service for commercial purposes. The Liverpool Chamber wants additional and improved cables between the United Kingdom and the Continent; and Edinburgh desires the Post Office to continue northward the main underground cables now open between London and Birmingham "in order to prevent the breakdowns which happen every season." As to the telephonic communication Liverpool and Southampton urge that, owing to the uncertainty attending the use of the trunk-line telephones, the service should be expedited.

Burry Port.—The trial of the electric light installation at Burry Port took place on Thursday last week with great success, when the docks and property about them were lighted up for the first time. The Burry Port and Gwendraeth Valley Railway Company have recently erected a commodious engine and boiler house, under whose roof has just been placed electric light machinery by Messrs. Crompton, of Chelmsford, to be followed later by hydraulic machinery for use on the docks and sidings Powerful lamps, each of 3 600 c.p., have been placed at frequent intervals about the docks and adjoining railways, which will much facilitate the loading and discharging of vessels at night as well as dealing with railway traffic in the sidings The locomotive shed has been lighted by incandescent lights, and arrangements made for hand electric lamps on flexible cables for the use of cleaners when working under and about the engines. The whole of the workshops, offices, and company's houses have also been lighted by numerous incandescent lights. The installation has been entirely carried out by the Burry Port and Gwendraeth Valley Railway Company, under the superintendence of their engineer, Mr. Robert A. Carr, A.M.I.C.E.

Barrow.—The County Council have adopted a report of their Electricity Committee on the supply of electricity to Vickerstown, including a letter from the Isle of Walney Estates Company, Limited, making the following offer with regard to the electric lighting of Vickerstown for the consideration of this committee—that is to say: (*a*) streets and houses to be lighted by the Corporation with electricity; (*b*) the price to be paid by the company for electric current in the houses, etc., shall not exceed the rate prevailing for the time being in the borough generally; (*c*) the company shall guarantee that the total aggregate consumption of electricity in Vickerstown, irrespective of the streets, shall not be less than £1,000 per annum for five years, and that should the actual consumption amount to less, at current rates, than an average of £1 000 per annum, then the company shall pay to the Corporation the difference between that sum and the value of current actually supplied, less the sum saved through not having to generate the deficiency. The committee recommended that the offer of the estates company, so far as it relates to the electric lighting of the houses, be accepted, and that the necessary mains be laid at an estimated cost of about £6 207, subject to the company executing an agreement in terms to be approved by this committee.

Yorkshire Electric Power Syndicate.—A meeting of the council of the Bradford Chamber of Commerce was held last week, at which a deputation was received from the Yorkshire Electric Power Syndicate, Limited. It was stated that the company did not interfere with any existing provisional orders granting powers of supply, and to meet any possible objection it had been agreed to insert a clause in the Bill as follows: "Nothing in this Act shall prejudice any application by any local authority for a provisional order under the principal Acts for power to supply energy within their district." It was thought that that would safeguard everybody. The Chairman said that the Leeds Chamber of Commerce had passed a resolution in favour of the principle of the Bill, and the Darfield local authority had decided to support the Bill. Several of the directors of the Yorkshire Electric Power Syndicate Limited, had an interview with the Mayor of Bradford (Mr. William C. Lupton) and the town clerk (Mr. F. Stevens) with a view to securing the support of the Corporation to their parliamentary Bill. After the scheme had been fully explained, it was intimated to the deputation that the matter would be reported to the Parliamentary Committee of the Corporation, but that it would probably be deemed necessary in any case to lodge a formal petition against the Bill, in order that certain clauses for the protection of the interests of the Corporation may be inserted.

Cooling Towers.—The Electric Light Committee of Edinburgh Town Council recently visited a number of towns in connection with the proposal to fit up M'Donald-road station with cooling tower and condensing plant. From a report of these visits we gather that when the deputation arrived at Bolton the cooling-tower and condensing arrangements were in operation. There were large clouds of watery vapour hanging about the neighbourhood of the station and as the horse-power production was only 2 500, while at M'Donald-road this would be multiplied 12 times, the deputation decided that such a system would not suit Edinburgh. At Oldham, where 1 300 h.p. was at work, they saw another cooling tower where there were no fans at work, natural ventilation alone being depended upon. Here also there were large clouds of steam hanging about the neighbourhood. In London, where they saw the station of the Central London Railway at Shepherd's Bush, there was 5,000 h.p. in operation, and the cooling tower was vomiting forth such immense clouds of steam and watery vapour that the members of the deputation had to put up their umbrellas. Next the works on the South London Railway at Stockwell, on the Surrey side, were visited with similar results. At Brighton the station is in the middle of the town, among low class houses and factories, and the cooling tower is erected on the top of the station roof, as would have to be done at M'Donald-road. Here also the deputation were conclusively of opinion that such an arrangement would not do for Edinburgh, and, consequently, there will be at M'Donald-road neither cooling towers nor condensing plant, and the waste steam will be sent up an iron pipe to the top of the chimney.

Hereford.—The Town Council have adopted a report of the Electric Lighting Committee recording the sanction of the Local Government Board to a loan of £5 000 and that the 250 kw. triple-expansion engine and dynamo (the tender of the Silvertown Company for which they had provisionally accepted) was in course of construction. The committee reported that the existing machinery continued to give every satisfaction. The financial results for the year ended Dec. 31 last were as follows: total units sold 66,031; producing (including meter rents), £1,608. 7s. 9d.; working expenses (including salaries, wages, oil, coal, waste, and sundries), £695. 15s. 3d.; interest, £577. 10s. 11d.—total, £1,273. 6s. 2d.; leaving a profit of repayment of capital of £335. 1s. 7d. The committee stated that almost the only complaints that had reached them from consumers had had reference to the cost of the current, and they advised the Council to reduce as from the end of that quarter the period of the maximum demand from two hours to one hour per day to such customers only as paid their accounts within one month after delivery. This would make the cost of the current 6d. for the first hour and 4d. for every subsequent hour, and would be recognised as a very material concession. As a consumer might on some particular day use an abnormal quantity of electricity, and if the demand was not of frequent occurrence, it was doubtless a hardship that the maximum demand for the whole half-year should be increased owing to such an occasional consumption, the committee recommended that consumers be permitted to have their maximum demand indicators reset on six separate days in each half-year on giving notice to the engineer that they anticipated an abnormal consumption on the day in question.

Ayr.—A report by the burgh electrical engineer, Mr. A. J. Fuller, has been submitted to the Council, in which he states that during the last month the whole of the works have been maintained and run in perfect order. The output during the month was 2,000 units in excess of the quantity generated during the same period last year. The engineer says he had experienced some difficulty during the month in getting the arc lamps to burn through the regulation period, owing to the bad quality of the carbons delivered in the last batch, and pending further steps he has arranged for the lamps to be trimmed double in order to avoid their going out in the early hours of the morning. He made a number of suggestions, and in consequence it was resolved at Tuesday's meeting that the rate of interest to be paid by tenants on the cost of installations provided by the Corporation under the municipal wiring system be reduced from 7½ to 5 per cent. It was also agreed to extend the cable to supply the hospital, and to charge the local authority with interest at 5 per cent. on the cost of the extension from the junction of Heathfield-road with Prestwick-road, such charge to cease as soon as the general infectious diseases hospital takes a supply. The engineer's plan showing the

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proposed extensions on the ground adjoining the works was approved of, and it was agreed to instruct Mr. John Eaglesham to carry out the work, provided he was able to take it in hand at once. Mr. Fuller was instructed to prepare a specification and ask for tenders from six of the best makers of switchboards, without advertising, and submit them to a future meeting. He was also authorised, in view of the fact that Messrs. Callender had the contract for laying the cables for the tramways, and will shortly be laying the cable in the streets, to procure from them a tender for the alterations required in connection with the change of system in the central area, and report to next meeting.

Keighley.—The Electricity Committee have prepared a report recommending that the charges for electricity consumed by meter be as follows: "For lighting purposes: (1) for any quantity up to 500 units consumed in any half-year ending June 30 or Dec. 31, at the rate of 5d. per unit; (2) for all units consumed above 500 in any half-year ending June 30 or Dec. 31, at the rate of 4½d. per unit. A rental of 10s. per annum, payable half-yearly, will be charged for every meter installed. That, as an alternative, consumers be charged on the 'maximum demand' or 'Brighton' system, on the following basis: the charge for electricity consumed by meter in the half-years ending June 30 or Dec. 31 respectively will be at the rate of 7d. per unit until the amount equals that required by the consumer's maximum demand for 182½ hours, or for one hour per day during the half-year. All electricity consumed in excess of this quantity in the respective half-years will be charged at the rate of 3d. per unit. The consumer's demand will be taken to be the maximum rate at which electricity has been consumed in the respective half-years, and will be determined by the consumer's demand indicator. A rental of 5s. per annum, payable half-yearly, in addition to the ordinary meter rent of 10s., will be charged for each demand indicator installed. Consumers may, with the consent of the committee, adopt which method of payment they choose. For motive power and heating purposes: (1) for the first 10,000 units consumed in any half-year ending June 30 or Dec. 31, at the rate of 3d. per unit; (2) for all units consumed between 10,000 and 25,000 in any half-year as above, at the rate of 2½d. per unit; (3) for all units consumed between 25,000 and 50,000 in any half-year as above, at a rate of 2¼d. per unit; (4) for all units consumed above 50,000, at a rate to be agreed upon between the Corporation and the consumer." Mr. W. Mackintosh, from the Southport Corporation electricity works, is to be appointed to the post of assistant electrical engineer.

Colchester.—The Town Council have sealed mortgages of the general district rate to the amount of £6,000 for electric lighting. The report of the borough electrical engineer, adopted at the last meeting, gives the following figures: Output of electricity in units during December, 1900, 19,443; 1899, 9,935. Maximum Christmas load in kilowatts during December, 1900, 162; 1899, 78. Number of equivalent 8-c.p. lamps connected during month of December, 1900, 450; 1899, 99. Total number of lamps now connected during 1900 9 793; 1899, 4 503. Number of consumers during December, 1900, 160; 1899, 88. Mr. Siller also states: "Although we have not yet connected a single public light, we hold the position of being the second station in the United Kingdom for progress during the last 12 months. The only town showing a better average than Colchester is Wimbledon, and it must be taken into consideration that Wimbledon has almost entirely lighted the streets during the last year." The engineer mentioned that several consumers had complained to him of the amount of the charge for lighting purposes, and suggested the advisability of the Electric Light Committee considering the question of reducing the price. Subsequently the committee resolved that the borough accountant prepare a financial statement for the purpose of enabling them to take into consideration the question of reducing the price, if practicable, as from April 1. The borough surveyor's plans and detailed estimates for the addition to the battery-house (estimated cost £250) and proposed underground storage tank (estimated cost £160) respectively have been forwarded to the Local Government Board. A plan is to be prepared showing the manner in which it is proposed to erect the cooler over the roadway between the works and the bakery to the east thereof. Mr. W. H. Massey has reported, stating that the whole of the machinery and plant appeared to be in good condition on the occasion of his inspection on Dec. 14, and adding that the "committee may therefore rest assured that they were fully justified in taking over the works at the end of the period for which Messrs. Siemens contracted to run them; and as soon as the cooling arrangements which I advised you to go in for about a year and a half ago are completed, you ought to have no further trouble with the condensing plant."

Underground Telegraphs.—At a meeting of the directors of the Glasgow Chamber of Commerce on Tuesday a copy was submitted of the memorial by the Chamber to the Postmaster-General urging the adoption of an underground system of telegraphs. It was pointed out that the memorialists, representing the commercial and manufacturing interests of Glasgow and the West of Scotland, had in recent years much reason to complain of frequent interruptions, and, in some cases, of the total collapse of the telegraphic service occasioned by storms. These interruptions and disturbances had caused loss, and put the merchants, manufacturers, and traders of this country at material disadvantage to their rivals in trade and commerce on the Continent, and especially in Germany, where such interruptions are now, through the adoption of the underground system of telegraphy, unknown. The memorialists were satisfied that the only means whereby such derangements of the telegraph service could be avoided, and the service placed on a footing creditable to the department and satisfactory to the nation, was by the establishment and maintenance of underground wires between the principal cities and towns of the United Kingdom. The memorialists were aware that the initial cost of such an undertaking was great, and that an underground telegraph system could not be worked with the same rapidity as the aerial system, but, on the other hand, they believed it could not be disputed that the upkeep and maintenance of overhead wires were much greater than the underground system, and that by the improvements in the science of telegraphy in recent years the difficulties which caused retardation with underground wires had been largely removed, the cost of working diminished, and the expeditious transmission of messages by this system greatly accelerated. To ensure at all times a trustworthy means of communication the main telegraphic service of this country should not be aerial, but, if not entirely certainly principally an underground system, supplemented where necessary by overhead wires. The President (Mr. G. Handasyde Dick) stated that copies of the memorial had been sent to other chambers. Replies had been received from Kirkcaldy, Dunfermline, Sunderland, Birmingham, and Aberdeen, all expressing sympathy with the action of the Glasgow Chamber. There was every indication that the matter was going to be taken up by the chambers of commerce throughout the country.

Taunton.—At Tuesday's meeting of the Town Council a report of the Electric Lighting Committee was discussed, stating that arrangements are being made for the work of laying of the trams to be commenced on an early date, and the committee have advertised for tenders for the electrical plant. The company hope to start running the trams by the middle of May. The statement of accounts of the electricity department for the year ending Dec. 31, 1900, showed a net profit of £706. 5s. 11d., which, with a balance of £94. 0s. 5d. brought forward from last year, leaves a balance of £800. 6s. 4d. to be disposed of. The committee have carried £750 of the balance to a reserve fund to meet renewals and other contingencies, and the balance of £50. 6s. 4d. will be carried forward to the next account. In anticipation of the continued prosperity of the electricity department the committee have resolved to reduce the charge for each public arc lamp by £1. 10s. per annum, to charge all places of worship owning their own installation 5d. (instead of 6d.) per unit, and to charge consumers under the demand system 3d. per unit (instead of 4d.) after the first hour, the foregoing alterations to take effect as from Jan. 1, 1901. With regard to the accounts, it was stated that the working expenses amounted to £3,678 and receipts to £6,603, leaving a profit of £2,965, which was more than sufficient to pay 6½ per cent. on the £45,000 capital sanctioned. Of that £2,965, £1,349 has been paid for interest on mortgage debt due to date, and also of interest on overdraft on temporary loan; and £955 was transferred to the stock redemption fund. The loan (£4,408) has been paid off. Thus after having paid every penny they had to up to Dec. 31, 1900, the committee show a net profit of £706, to which they added £94 carried forward from the previous year's account, which gave them a balance in hand of £800. Their working expenses increased to the extent of £834, and their receipts as much as £1,629, or nearly double that amount. The condensing plant had been a great benefit. In 1897 one ton of coal produced 162 units; last year a like quantity of coal produced 311 units. He thought that proved the wisdom of the Council in having acted upon the advice of their consulting engineer to lay down the plant. Of the increased receipts, £737 was due to the increased use of private lighting, and £334 public lighting. The report was adopted as far as given above, and the salary of Mr. E. B. Thornhill, the electrical engineer, was increased by £100 per annum, and the rest, which deals with a special report by Messrs. Kincaid, Waller, and Manville, and an application by the Council to borrow a further £17,780, was adjourned to Feb. 19.

Bury St. Edmund's.—The Electric Lighting Committee reported on Tuesday that they had considered a report by the electrical engineer on public street-lighting and expenditure on capital account. The report dealt with the three following schemes: (1) A system of mains and cables distinct from those laid down for private lighting, the capital cost of which is estimated at £8,050. The cost for lighting and maintenance is £988 per year, and estimated revenue £879. (2) The portion of the mains called the feeders to be dispensed with, the present mains for private lighting taking their places; the estimated capital expenditure being £6 299, the annual cost £820, and the annual income £879. No. 3 scheme provided for the lighting of only that portion of the town in which mains were at present laid—about 100 lamps—no special mains being required, except for the Brown Estate. The capital cost was estimated at £1,040, the annual cost at £309, and the annual income £274. The report also referred to probable expenditure in the near future. The present plant being only just capable of supplying the public and private lighting during the next winter, it was thought that it would be quite unable to cope with the winter of 1902-3. Some extensions to the private lighting mains, it was suggested, should also be undertaken. It was, therefore, urged that provision ought to be made for extensions at the works and to the mains, the additional cost of which was estimated at £4,890, making a total capital, if the No. 2 scheme was adopted, of £11,189. It was also stated that money should be borrowed for the cottages built on the site. The committee unanimously recommended the adoption of No. 2 scheme, and that provision be also made for the extension of the works referred to. The committee also recommended that a capital sum of £12,000 be raised and application is to be made

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to the Local Government Board for their sanction to the raising by the Council of the sum of £12,000 for the purpose of laying cables and other work for public lighting by electricity, including the cost of the two new cottages, and also for the purpose of extending the present works and mains to meet future requirements, the sum to be repaid in 25 years by means of a sinking fund in the usual way. The £820 referred to as annual cost for public lighting do not include the eight arc lights about to be erected in some of the principal streets of the borough, the estimated cost of each of which is £13 per annum, or a total of £104 for the eight arc lights. Since the last monthly meeting applications have been received from seven persons for 201 8-c.p. lamps. During the five weeks of the new year 4,750 units were sold, representing a gross revenue of £112. 10s., the expenses of working, including management, wages, etc., for the same time amounting to £72. 8s. Instruments for testing the amount of energy given out by the batteries are to be obtained at the cost of £25, and the engineer's suggestion as to the new cottages is to be carried out. A charge of 4d. per unit will be made for special street lamps. The Electric Lighting Committee have appointed the Mayor, Alderman Lake, and Councillor Jaggard as a sub-committee to meet a similar committee from Bury St. Edmund's Gas Company to discuss the question as to the purchase of street lamps and lamp-posts by the Town Council.

PROVISIONAL PATENTS, 1901

FEBRUARY 4.

2317. An improvement in electric stop motions for warping machines. Thomas Holt, Limited, and Frank Ashworth Holt, 17, St. Ann's square, Manchester.

2320. Improvements in the method of covering cables, wires, and conductors for electrical purposes with india rubber or other insulating material and in machinery therefor. William Hanchett, 4, St. Ann's-square, Manchester.

2322. A double-wheel contact on a rocker for overhead electric tram contact. Harry Garstang, 69, Darwen-street, Blackburn.

2330. Improvements in and connected with controlling arrangement in telephone exchanges for branch or trunk lines. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien Gesellschaft Mix und Genest, Germany.)

2345. Electric meters. Edward S. Halsey, 601, Omaha building, Chicago, U.S.A. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 5, 1900, being date of application in United States.) (Complete specification.)

2353. Improvements in gear for collecting the current on electric locomotives, electric trams, electric cranes, and such like machines. Edward Colin Wilson, 66, Victoria Park-road, South Hackney, London.

2363. Electrode for galvanic cells. Frederic Landolt, 52, Chancery-lane, London.

2394. Improvements in distributing electricity and in apparatus for use therein. Robert Bolton Ransford, 24, Southampton-buildings, Chancery-lane, London. (La Société Anonyme des Brevets Dolter, France.) (Complete specification.)

2411. Improvements in and relating to electric motors. Martin Kallmann, 18, Southampton-buildings, Chancery-lane, London.

FEBRUARY 5.

2420. Silent automatic switch arrangement for electric motors for church organs. Harry Garstang, 69, Darwen-street, Blackburn.

2421. Improvements in electric incandescent lamps. John Johnston Green and Edward Obley Green, Commercial-street, Halifax.

2438. Improvements in electric motor-starting switches. Edward Woodrowe Cowan and Alfred Still, Springfield-lane, Salford, Manchester.

2461. Improvements in conduits for electric wires. Emmett D. Page, 52, Chancery-lane, London.

2471. Improvements relating to electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Maxwell Scott, United States.)

2474. Improvements relating to transmitters for telephones. Lemuel Mellett and Albert Franklyn Henderson, 45, Southampton-buildings, Chancery lane, London. (Complete specification.)

2488. Apparatus for disinfecting the transmitters and receivers of telephones. Cyrus Fletcher Axtell, 53, Chancery-lane, London. (Complete specification.)

2490. Improvements in storage batteries. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2497. Improvements relating to electric igniters. Jean Marie Ricard and François Clement Cory, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2505. Improvements in and in apparatus for obtaining metals by electrolysis. Arthur Percy Strohmenger and Antoine Bonaventure Pescatore, 322, High Holborn, London.

2523. Improvements in means for the distribution of electricity on the three-wire system for electric traction on rails. Alexander Bewicke Blackburn and Ernest Sherwood Woollard Moore, 47, Lincoln's-inn-fields, London.

FEBRUARY 6.

2536. Improvements relating to the commutators of dynamo-electric machines. Walter Langdon-Davies, 101, Southwark-street, London.

2553. Improvements in electric arc lamps. August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

2570 Improvements in or connected with electrical signalling apparatus. William John Mildon, 22, Glasshouse-street, Regent-street, London. (Complete specification.)

2579. Fabrics for electric heating purposes. Joseph Michel Camille Herrgott, 23, Southampton-buildings, Chancery-lane, London.

2587. Improvements in electric batteries. George Rosset, 55 Chancery-lane, London.

2607. Improvements in electrical transformers. Arthur Francis Berry and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

FEBRUARY 7.

2618. Improvements in electrical heating apparatus. Albert Loacker and Franz Riedl, 4, Corporation-street, Manchester.

2619. Improvements in electrically-heated smoothing irons. Albert Loacker and Franz Riedl, 4, Corporation-street, Manchester.

2636 Improvements relating to overhead electrical conductors, such as trolley wires, for electric trams and the like. Arthur Pass, 34, Castle-street, Liverpool.

2643. Improvements in and connected with the diaphragms of phonographs and such like instruments. Ernest George Craven, 33, Chancery-lane, London.

2659 Improvements in electric arc lamps. Helios Upton Company and Thomas Spencer, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2689 Improvements in or relating to electrolytic electricity meters. Francis Malger Staunton, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

2692. Improvements in incandescent electric lamps. Levi Lobenthal, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2696 Improvements in means for protecting electrical conductors. Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

FEBRUARY 8.

2729. Improvements in apparatus for regulating electric generators. Count Albert de Dion and Georges Bouton, 47, Lincoln's-inn fields, London.

2741. Electrode plate for forming Plante cells. Rudolf Hager, 321, High Holborn, London.

2776. Improvements in electric fuses. Callender's Cable and Construction Company, Limited, and James Ormiston Callender, 24, Southampton-buildings, Chancery-lane, London.

2779. Improvements relating to electric conductors. William Gordon Potter, 27, Chancery-lane, London.

FEBRUARY 9.

2793. Improvements in and in connection with the storage of electricity. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

2806. Improvements relating to electric light fittings, such as electroliers, brackets, or the like. Richard Bertram Leach, 64 Barton-arcade, Manchester.

2830. Improvements in means for electrically igniting miners' safety lamps. Robert Octavius Best and Ackroyd and Best, Limited, 33, Chancery-lane, London.

2834. Improvements in or relating to telegraph apparatus. Frederick George Creed and William Arthur Coulson, 46, Lincoln's-inn-fields, London.

2835 Improvements in the manufacture of thermo-electric couples. Eugène Hermite and Charles Friend Cooper, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 1, 1900, being date of application in France.) (Complete specification.)

2836. Improvements in the manufacture of thermo-electric couples. Eugène Hermite and Charles Friend Cooper, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

2838. Apparatus for governing the output of dynamos when driven at different speeds. Horace James Jordan Hummel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

2853. Improvements in electric batteries. George William Johnson, 47, Lincoln's-inn-fields, London. (Société Paul Chapuy et Cie., France.)

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2645. Improvements relating to apparatus for starting and regulating or controlling electromotors. Jasper Wetter, 37, Essex-street, Strand, London. (The Elektricitäts Aktien-Gesellschaft, vormals Schuckert und Co., Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on March 8.

1900.

2176. Regulating mechanism for arc lamps. Eckstein and Angold.

2212. Electric arc lamps. Peritz.

2260. Electric arc lamps. Bremer.

2513. Apparatus for recording, without friction, the indications of electrical and other measuring and indicating devices. Eckstein and Coates.

2783. Electrical arc furnaces. Johnson. (Deutsche Gold und Silber-Scheide Anstalt vorm. Roessler und Birger Carlson.)

3683. Electricity meters. Marion Emily Reason, William Paddison, and Herbert Charles Hughes (executors of the late Henry Reason), and Reason Manufacturing Company, Limited.

4387. Systems of alternating-current electrical distribution. Young. (Date applied for under International Convention, Aug. 8, 1899.)

4709. Electric cable joint-boxes. Nisbett.

5016. Porous diaphragms for electrolytic apparatus. Holland and Laurie.

5767. Construction of carrier for globes or glasses of electric, gas, or oil lamps. Stanley.

6496. Means for dropping, or cutting out broken overhead conductors on electric railways. Skopec and Orel.

6615. Terminals and binding screws for electric batteries and connections. Edwards.

8208. High-potential electric switches or circuit breakers. British Thomson-Houston Company, Limited. (Hewlett.)

10612. Arc lamps. Martin, Stewart, Brown, and Boggs.

13616. Apparatus for indicating phase and frequency relations in electric alternating-current systems. Clarke.

18921. Electric furnaces. Benedicks.

19138. Electric arc lamps. Schuster.

19512. Electric circuit breakers or switches. Lake. (McElroy-Grunow Electric Railway System.)

19554. Combined telephone and sound telegraph apparatus. Ljungman.

21149. Electrolytic process for the precipitation of metals and alloys from their solutions, as also for the deposition of metals or alloys on other metals or alloys or on other substances. Meurant.

22142. Telephone relay. Hagemann and Poulsen.

1901.

434. Secondary electric batteries. Lake. (Globe Electric Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Feb. 9	525	466	+ 59	24,782	21,469
Birmingham Trams.	,, 9	4 030	3 682	+ 348	22,912	—
Blackburn Corp'rat'n	Jan. 13	1 191	—	—	2 724	— *b*
Blackpool Corporatn.	Feb. 7	143	133	+ 10	29 190	21,494
Blackpool-Fleetwood	, 9	139	128	+ 11	814	869
Bolton Corporation..	,, 10	1,302	—	—	7 957	-
Bradford City Trams	,, 10	761	295	+ 466	4,351	2,015
Bristol Tramways Co.	,, 8	3,320	2 362	+ 958	—	—
Carlisle Tr'mw'ys Co	,, 2	106	—	—	558	—
Central London Ry.	,, 9	6,129	—	—	36 707	*a* —
City & South London	,, 10	2 020	1,149	+ 871	11 999	6 739
Cork E. T. and L. Co.	, 7	334	278	+ 56	1,843	17 32
Dover Tramways ...	,, 2	139	149	- 9	775	756
Dublin & Lucan E.R.	,, 9	86	49	+ 37	419	310
Dublin U.T., elec. cars	,, 8	2 964	2,644	+ 320	—	—
Dublin S.D. Electric	,, 8	631	545	+ 86	—	—
Dundee Tram Co. ...	,, 6	452	343	+ 109	17,527	2,379
Glasgow Corporation	,, 9	8,188	7,432	+ 736	—	—
Halifax Corporation	,, 11	695	446	+ 249	34 360	27,079
Huddersfield Corp'n.	—	609	494	+ 115	30,918*b*	28 479
Hull Corporat'n E.S.	,, 9	1 509	—	—	61 318*b*	—
Liverpool Corporat'n	,, 2	7,348	6,471	+ 877	39 499	33 097
Liverpool Overhead	,, 10	1,515	1,344	+ 171	8,913	8,817
Portsmouth Corpn...	,, 9	600	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 10	2,852	—	—	—	—
Southampton Trams	,, 7	563	327	+ 236	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	,, 8	325	213	+ 112	2,023	1,316

a From July 30, 1900. *b* Since April 1 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. shares, 1-125,000	1	–	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	–	10½-11½
—— 40,001-70,000	5	–	11 9/16-11 11/16
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅝-6⅛
—— 5 per cent. Mortgage Debentures	100	–	100-105
British Electric Works, Ordinary, 50,001-95,000	1	–	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	–	⅛-¼
—— 4½ per cent. First Mortgage Debentures	108	–	95-97
British Westinghouse Elec. and Manuf. 6 per cent. Pref.	5	–	4½-4¾
Brush Electrical Engineering, Ordinary	2	–	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	–	2-2⅛
—— 4½ per cent. Debenture Stock	100	..	105-110
—— 4½ per cent. 2nd Debenture Stock	100	–	101-103
Callender's Cable, Debentures	100	–	109-113
—— Ordinary	5	–	13-14
—— 5 per cent. Pref.	5	–	5½-5⅝
Crompton and Co.	2	–	2⅛-2⅜
—— 5 per cent. Debentures	—	–	100-103
Edison and Swan United, Ordinary	2	–	1⅝-2⅛
—— 5 per cent. Debentures	5	–	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	–	93-95
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	–	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1⅝-2⅛
—— 7 per cent. Cumulative Pref.	2	–	2⅜-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
W. T. Henley's Telegraph Works, Ordinary	5	–	14-15
—— 4½ per cent. Preference	5	–	5½-6
—— 4½ per cent. Debentures	100	–	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	20½-21½
—— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	12	–	41-45
—— 5 per cent. Bonds	100	–	101-104
Telegraph Manufacturing, Ordinary	5	–	10-11
—— 5 per cent. Cum. Pref.	5	–	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	–	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	–	6⅞-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,501-101,200	1	..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	..	70-75
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	–	10-11
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	–	7⅛-8⅛
—— 7 per cent. Preference	5	–	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5	–	6½-7
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	–	5⅞-6⅛
Chelsea Electricity Supply	5	–	6½-7
—— 4½ per cent. Debentures	100	–	109-113
City of London, Ordinary	10	..	7-8
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (60 p.c. pd.) Red.	—	..	61-63
County of London and Brush Provincial, Ordinary	10	–	8¾-9¼
—— 6 per cent. Cum. Pref.	10	–	11¾-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4¾-5⅛
—— 4½ per cent. First Mort. Deb.	100	–	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	–	7¼-7¾
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10½
London Electric, Ordinary	2	–	1½-2
—— 6 per cent. Pref.	5	–	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
—— 3¾ per cent. Mortgage Debenture, Red	100	–	96-99
Notting Hill Electric Lighting	10	–	15½-16½
Oriental, 1879	1	–	1⅛-1⅜
—— 45 Shares	5	–	7-7½
—— 44½ Shares, New	4½	–	5⅞-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	–	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	–	65-75
Royal Electrical Company of Montreal	$100	–	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	–	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 4 per cent. Debenture Stock	100	..	89-90
South London, Ordinary	5	–	2¼-2½
St. James's and Pall Mall, Ordinary, 101-30,080	5	–	14½-15½
—— 7 per cent. Pref.	5	–	8¼-9½
—— 3¾ per cent. Deb.	100	–	98-101
Westminster, Ordinary	5	–	12-13
—— 30,001-100,437	5	–	11½-12½
Electric Railways.—			
Central London, Ordinary	10	–	8¼-9
—— Pref. Half-Shares	5	–	4½-5⅛
—— " " deferred	5	–	2¾-4
City and South London, Consolidated Ordinary	100	–	47-51
—— Ordinary	10	–	4-5
—— 4 per cent. Debenture Stock	100	–	115-120
—— 5 per cent. Pref. Stock '91	100	–	135-140
—— " " " '96	100	–	130-135
Liverpool Overhead, 5 per cent. Pref.	—	–	12½-13½
Waterloo and City, Ordinary	100	–	94-97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-16
Brisbane Tramway	100	–	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	–	9⅜-10⅛
British Electric Traction, Ordinary	10	–	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10	–	12-13
—— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4⅛-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅛-5
—— 5 per cent. Deb. Stock, Red.	100	–	104-107
—— Prov. Cert., all paid	—	–	95-98
Kidderminster and District Lighting and Traction, Pref.	10	–	9¾-10½
New General Traction, Ordinary	5	–	3¾-4
—— 6 per cent. Cum. Pref.	5	–	4⅛-5⅛
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	16-17
—— 5 per cent. Cum. Pref.	10	..	10½-10⅞
Potteries Electric Traction, Ordinary, 26,667-40,000	10	–	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
—— 4½ per cent. Debenture Stock	100	–	102-105
Telephones.—			
National Telephone, Ordinary	5	–	4⅛-4⅜
—— 6 per cent. Cum. First Pref.	10	–	13-14
—— 6 per cent. Cum. Second Pref.	10	–	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	–	4⅛-5⅛
—— 4 per cent. Deb. Stock, Red.	100	–	98-101
—— 3½ per cent. Deb. Stock, Red.	100	–	94-97
Oriental Telephone and Electric Company	1	–	¾-1⅛

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NOTES.

New Form of Magazine.—The proprietors of *Cassier's Magazine* inform us that they are now issuing a library edition, bound in cloth with gilt lettering, in place of the old paper cover. In this form, it is conceived, the magazine will be better kept in a good state of preservation.

Personal.—We are pleased to hear that Mr. George W. Smith, who for 30 years has been the manager in France of the Persan works of the India Rubber, Gutta Percha, and Telegraph Works Company, has received from the French Government the Cross of the Legion of Honour. On the 9th inst. about 700 of the firm's workpeople, as a demonstration of their esteem and affection for their chief, presented him with a cross of that order in brilliants.

Telegraph and Telephone Charges on the Congo.—It is interesting to note the tariff fixed for the telegraph and telephone on the Congo. For instance, a telegram of 15 words from Boma to Matadi costs 1s. 8d., to Tumba 2s., to Leopoldville 2s. 6d., and to Lukolela 4s. The charge for every additional five words is 5d. For the use of the telephone on the various sections for every five minutes the price is exactly the same as that for a telegram of 15 words, an additional 10d. being charged if the conversation lasts for 10 minutes.

Birmingham Local Section.—The inaugural meeting of the Birmingham Local Section of the Institution of Electrical Engineers, which was to have been held on Jan. 23, has now been fixed for Wednesday, Feb. 27, in the university buildings, Edmund-street, at 8 p.m., when, as already announced, Dr. Oliver Lodge, chairman of the section, will deliver an inaugural address, and the President of the Institution, Prof. John Perry, will be present. The hon. secretary of the section is Mr. D. K. Morris, to whom all letters should be addressed at the University, Birmingham.

Committee Proceedings.—The members of the Metropolitan Borough Council of Fulham on Wednesday last were assembled in special meeting to consider the question as to the privacy of committee meetings. An attempt to exclude the Press from certain committees was frustrated recently, and it is now proposed that each committee shall decide the matter separately. Personally we believe that all committees should meet in private, as much trouble and often scandal would be prevented were the details discussed in committee kept absolutely secret. Another advantage is that the long-winded speaker is apt to lose his main incentive when reporters are banished.

Glasgow Electrical Congress.—The Institution of Electrical Engineers, it was announced at the last meeting, have been asked to take charge of the organisation of the electrical section of the engineering congress to be held in Glasgow this year in connection with the Glasgow Exhibition. The days named for the congress are Sept. 4, 5, and 6, and the secretary will be pleased to receive the names of any members who wish to read papers at the same. We understand that a number of visits to interesting works in the neighbourhood of Glasgow are to be arranged for the afternoons, and that the electrical section of the congress will meet on each morning of the three days in question.

Electro-Harmonic Society.—We would remind our readers of the concert (ladies' night) which the above society are holding to-night (Friday) at the St. James's Hall Restaurant (Banqueting Hall), Regent-street, W. It will commence at 8 o'clock precisely, and Mr. Henry Edmunds will be in the chair. The vocal music will be provided by Miss Gertrude Maxted, Miss Mary Hay, and Mr. Braxton Smith, while Miss Trixie Defries will give three violin solos. Humorous sketches and recitations are to be contributed by Mr. James G. Dunn, Mr. Herbert Harvey, and Mr. Edward Minshall. Messrs. T. E. Gatehouse and A. E Izard, Prof.R.A.M., are the musical directors, and the last-named will officiate at the piano.

The Southport Tramways.—At a recent meeting of the Town Council it was mentioned that the Tramways Committee had, on the advice of their engineer, already placed a number of Post Office wires underground at points at which they crossed the track. We gather from the report that in such instances the work of laying the underground wires is done by the Post Office at the expense of the Corporation tramways. Again, the telegraph wires of the Lancashire and Yorkshire Railway Company had also been placed underneath a bridge where the line was crossed by the tramways instead of over the road. These pre cautions show that the engineer responsible for the work at Southport has been energetic in his endeavours to avoid all chance of accident.

Electric Waves.—Last week Dr. Molloy, the rector of the Catholic University of Ireland, delivered the Friday evening discourse at the Royal Institution. The lecture was a most interesting *résumé* of the whole subject of electric waves, commencing with the work of Henry, Kelvin, and Clerk Maxwell before dealing with the more recent work done by Hertz, Röntgen, and others. As is usual in these lectures, a number of experiments were given. Dr. Molloy showed the refraction, reflection, and polarisation of electric waves. He explained that the electric waves used by him were from 6in. to 7in. in length, and their place in the spectrum was below the infra-red rays. The X-rays were above the ultra-violet rays. As to the future, Dr. Molloy said that much work remained to be done, and that the scientific men of the twentieth century must endeavour to reveal the nature of that mysterious substance pervading all space which transmitted heat, light, and electricity from point to point without loss, and which was termed the ether.

The Manchester Section.—A meeting of this section of the Institution of Electrical Engineers was held at the Owen's College, Manchester, on the 12th inst., Dr. E. Hopkinson in the chair. The Chairman announced that in consequence of an application on the part of the Manchester Society of Junior Electrical Engineers, a students' section for the Manchester disrrict was in course of formation, and there was a promise of a large number of applications for membership from the Junior Society and from students outside the society. The students would have a right to attend the meetings and to enjoy the other privileges of the Manchester Section. The chairman then introduced Dr. John T. Nicolson, M.I.C.E., who read a paper "On the Training of Electrical Engineers." This paper we referred to in our notes last week. In the discussion which followed, Prof. C. Wilson, Dr. Lees, Dr. Hopkinson, Messrs. W. G. Rhodes, C. H. Wordingham, A. F. Guy, and W. H. Gee took part. A vote of thanks to Dr. Nicolson concluded the proceedings.

Insulated Overhead Conductors.—In confined situations round ironworks and blast furnaces where a great quantity of metal is employed trolley wires often become short-circuited to earth. Mr. E. B. Cheatham, in the *American Electrician*, describes an insulated trolley conductor which is in use round the Boston and Montana Copper Smelting Works at Great Falls. The locomotives used in this instance are of the small type, requiring low overhead conductors, and it was found necessary to so insulate these conductors that the men would not hit them with their iron rods which they have to use round the furnaces. After a number of trials, the present method of

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using a trolley conductor in an inverted wooden trough has been adopted with great success. The conductor consists of a flat copper strip secured to the bottom of the inverted trough. The collector is simply a flat copper end on the trolley pole. The author states that the wooden sides of the trough keep the collector always in place, in spite of sharp curves.

The Liberty and Property Defence League.—This league has just issued its eighteenth annual report, in which lists of the parliamentary Bills opposed by the league during the chief session of 1900 are grouped, with short summaries of the proposals and effects involved, according as they affected land and houses, commerce, trade and industry. The report of the Select Committee enquiring into boiler registration is quoted with satisfaction. The committee, it will be remembered, reported strongly against the advisability of legislation, holding it of the greatest importance to maintain the responsibility of the boiler user for the condition and safety of the boiler which he works, and believing that legislation giving any Government department control over the inspection of boilers would be a grave mistake, and that State certification of registration, unless accompanied by State control, would not be of any practical value. The report also refers to the success of the various Electricity Supply Bills, the passage of which the league claims to have materially assisted.

Tramway Congress.—The Tramways and Light Railways Association are looking well ahead in their endeavours to promote the welfare of their members. Thus the association has approached the Union Internationale Permanente de Tramways with an invitation to hold their 1902 congress in London. This invitation has been accepted, and the dates chosen for the congress are July 1, 2, 3, and 4 of next year. The secretary of the Tramways and Light Railways Association, Mr. Norman A. Thompson, now invites members of the association to enrol themselves as members of the Union Internationale. The subscription is £2 per annum for tramway companies, and 10s. for private members. The union is doing good work on the Continent, and we hope that the meeting in London will enable our tramway and light railway engineers to extend their interests. The publications of the society alone are well worth the annual subscription. We also learn that a light railway exhibition is being organised by the *Tramway World*, to be held during the week the congress meets in London.

Submarine Aqueducts.—An interesting experiment in submarine aqueduct building is just now being carried out by the New York Gas and Electric Light, Heat, and Power Company at their power plant in that city. Here it is proposed, according to the *Railway and Engineering Review*, to build a duct under the East River, through which all the water required for condensing purposes at the plant will be obtained. This duct will be a steel pipe 12½ft. in diameter and 225ft. long, and is now being built at the yard of Lewis Nixon, the shipbuilding firm, 38 miles away from the power plant. When the length is completed, the whole structure will be towed up the bay and sunk in the place required. The final details will consist merely of riveting the tunnel with the shore approaches. The Manhattan Elevated Railway Company has also given contracts for a similar structure. The gas company's tunnel, however, will be considerably longer than that of the Manhattan Company. The latter is to be 40ft. in length, and square, with walls 17ft. by 19ft. Both tunnels will be under 23ft. of water, so that they will not interfere with the shipping in any way.

Sleet on Trolley Wires.—We notice in the *American Electrician* for this month a short article by Mr. A. B. Weeks on the use of sleet-cutters for removing ice and sleet from trolley wires. It seems that the experience in the States has shown that when half-melted snow is lodging on the trolley wire and freezing, the ordinary wheel is quite incapable of removing the same without causing serious interruption to the supply of current to the car. In such conditions the author advocates the use of a scraper, which can be easily fixed on the end of the trolley pole after the trolley wheel has been removed. This scraper, which is made to embrace the wire, is constructed in the form of a rounded V. The scraper is made of steel, the cutting edge being drawn to a dark blue. It would be thought that the steel edge would cut the trolley wire, but careful tests and close observation prove that it does not harm the wire in the least. The frozen sleet which has to be removed seems to afford the pretection required. The author adds that as the pressure on the wire is only from 15lb. to 40lb., the scraper would not do much damage even if it were run on the wire after the ice had been taken off. It is usual, however, to remove the scraper and revert to the trolley wheel after the one run along the line, which is quite sufficient to clear away the ice.

Projected American Automobile Service.—Chicago is to have a new service of electrically-propelled vehicles, including a cab service running in conjunction with the electric 'buses. In view of the failure of the London electric cab service, it will be most interesting to watch the result of the enterprise of our friends on the other side of the Atlantic. The *Western Electrician* gives an outline of the scheme, which is being promoted by a new corporation, to be known as the Chicago Automobile Transportation Company. It is proposed in the first instance to put as many as 348 'buses and 160 cabs on the various routes. Four stations will be provided. One is to be near the Union depôt, and another as near as possible to the terminus of each regular route. Besides being used as stables these stations will be utilised for charging purposes. Each 'bus will be equipped with a specially-designed 9-h.p. motor having an overload rating of 130 per cent. The battery will consist of 40 cells, with a 222 ampere-hour capacity, working on a five-hour discharge rate. With a maximum speed of 10 miles an hour it is proposed to use a controller with four speeds. One electrical brake and two of a mechanical nature will be provided. Together with the battery, which will have a weight of 1,800lb., the conveyance will weigh 5,400lb. If this proposed passenger service should prove a success, the company intend to take up the question of parcel delivery by automobiles, and to put on several hundred vehicles of this class to make delivery of merchandise, for carrying mails, distributing newspapers, and general express business.

Central London Railway Construction.—Further expert evidence was given before Mr. J. W. Penfold, architect, at the resumed hearing of the claim by Lord Herschell and Mr. Wm. Baillie, as the executors of the late Mrs. Mary Cunliffe, against the Central London Railway Company for damage to the house, 2, Lancaster-gate, due, as alleged, to the construction of the line. Mr. Arthur Manton, C.E., chief agent for the contractor who had charge of the construction of the section of the railway in question, attributed the damage solely to the bursting of the main of the East London Waterworks Company in 1897. Respecting the method of cutting through the clay by means of Greathead shields, the witness denied that the system could have had any effect whatever on the upper strata. During the cross-examination of Mr. Manton it was admitted that Mr. Price, the contractor referred to above, would be responsible to the railway company for any liability cast upon them on account of defects in workmanship. Sir

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Douglas Fox agreed that the damage complained of could not possibly have been caused by the construction of the railway. The primary reason why he thought the railway could not have caused the damage was that, if it had, he felt sure it would have been manifested some time in the autumn of 1897, before the tunnel reached the spot. His experience of the railway was that whenever there had been any movement it was always before the railway tunnel reached the place. The hearing now stands adjourned till the 1st of next month, but from the expert evidence already adduced it seems sufficiently clear that the construction of the tunnels by means of the Greathead shields is in no way responsible for the damage to house property situate in the vicinity of the railway.

Huddersfield Tramways.—We understand that there has been some slight delay over the inauguration of a complete service of electric cars over those sections of the Huddersfield tramways already equipped. This delay is due to the Board of Trade inspectors requiring certain small modifications to be made before issuing a certificate. While the delay is, of course, vexatious to those connected with the line, we are sure that in the long run it will be to the advantage of all concerned that the Board of Trade requirements should be promptly attended to. Respecting the guard wires, Mr. Trotter reports that only one or two additional ones were required, but he emphasises the fact that whereas in some streets rosettes are employed instead of poles to support some of the span wires, these rosettes are of no service as a means of earthing the guard wires. He also requires that the iron poles which are used for this purpose should be bonded to the tramway track. After a number of experimental runs last week, the regular service was commenced on Monday last on the Crosland Moor and Linthwaite routes, whereas the other section to Longwood will be opened next Monday. Up to the present a 20-minute service is proposed on each of the routes, which will, of course, give a much more frequent service where these routes coincide in the middle of the town. We believe that the Corporation would be well advised in the near future to run a more frequent service, even if they required smaller cars in order to keep down working expenses. Just as we are going to press we hear of an accident at Huddersfield, for which the driver seems to be solely to blame. At the top of a down grade the driver locked the wheels of the car with the hand-brakes, and then tried to get the electric brakes to check the car, which, of course, they could not do with the wheels locked. Luckily no serious damage was done.

Tesla Telegraphs.—The *Daily Chronicle* is the last medium to take up the exploitation of Mr. Tesla's invention in connection with wireless telegraphy, and the editor has tried to get additional light on the supposed inventions which Mr. Tesla states enables him to communicate between England and America, using the earth as a conductor. In consequence of these statements, the editor has interviewed Mr. Marconi and asked him to explain Tesla's inventions. The result is what one would expect—*i.e.*, that a good deal of information was given to the interviewer on the question of Mr. Marconi's own success in sending long-distance messages in England; to be more correct, we should say Mr. Marconi's success in sending messages over the sea from one point along the coast to another. For such work Mr. Marconi holds the record with a distance of 196 miles, as he succeeded in sending readable signals between St. Catherine's Point, in the Isle of Wight, and Mullion, at the Lizard. When, however, Mr. Marconi came to analyse Mr. Tesla's statements, we find a good deal we can object to. For instance, a statement by Mr. Marconi that the highest voltage at which any quantity of current has yet been obtained in practice is only 10,000 volts alternating, which is the working pressure at Niagara. The disparity between this voltage and the voltage employed in wireless telegraphy is, of course, enormous; but surely Mr. Marconi knows that voltages of three times this value are in regular work in certain transmission schemes in America—in fact, the whole interview throws no light on the supposed inventions, which we are inclined to regard as existing mostly in the mind of the original interviewer of Mr. Tesla. We cannot, however, hold that scientist free from blame in allowing his name to be associated with such schemes without giving practical experimental facts to support his conclusions.

Temperature Regulator.—We notice in the January number of the *Physical Review* a description of an automatic temperature regulator which was designed in the physical laboratory of the Cornell University by Mr. C. T. Knipp. It seems that in this laboratory they had need for absolutely uniform temperatures which could be varied up to 380deg. C., and which could be maintained constant for a day or more at a time. The heating was done by means of electricity, the source of which was a 110-volt Edison dynamo. It was found, however, that the fluctuation of the load on this dynamo was enough to upset the constancy of the temperature in the oven in which the experiments were carried out. To avoid this, an automatic regulator was devised which has certainly novel features. It consists of two copper-iron thermostats which are suspended in the oven. The ends of the thermostats are delicately pivoted. The free end is connected by linkwork to the relay contact which makes or breaks the heating circuit. The end of the relay lever contains a number of holes, and the connecting link between the levers driven by the thermostats and this relay lever can be moved so that the temperature at which the contact is made can be varied. The article in question illustrates the apparatus, and also gives curves of the results obtained. When working at 25deg. C., the variation in temperature after the apparatus had had a steady run was not more than half a degree between the extremes. When working at about 376deg. C., the variation between maximum and minimum was more like 1deg. The arrangements for heating the oven consisted of two coils, one of which provided the bulk of the heat lost in radiation, and tended to keep the oven at 5deg. or 6deg. below the temperature required. The smaller coil to add the remaining 5deg. or 6deg. was controlled by the thermostats by which the circuit was alternately made and broken.

A Cabling Record.—The last West Indian mail brings home particulars of an extraordinary record in the matter of submarine cabling, which has to be placed to the credit of the West India and Panama Company. When her Majesty the late Queen passed away at Osborne the Greenwich time was 6.45 p.m., which represents in Demerara the hour of 2.53 in the afternoon. The cable company's depôt was surrounded at that time by a crowd of her Majesty's subjects in British Guiana—Europeans, imported East Indian labourers, African blacks descended from the old slaves, and others—who were all alike watching with painful interest the bulletins about the Great White Queen. At 3.15 local time, or 7.7 Greenwich time, the notice was published that the Queen was dead, and the impulsive coloured people burst into tears. Mr. R. T. Brown, the West India Company's secretary in London, thus announced the news in our far-away colony, the other side of the world, long before the majority of Londoners knew that the Queen was dead. More than

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that, his record feat in 22 minutes outstripped the Government communication through the Secretary of State for the Colonies, and the local governor, whilst putting a flag at half-mast, had to await confirmation from the Government before adopting the procedure usual on the death of a sovereign. The more the feat is looked into, the more astonishing do the achievements of modern science appear. The news was conveyed from Osborne to the telegraph office, thence under sea to the mainland, thence to one of the Atlantic cable companies, and so across the ocean to America. On the other side it was sent southwards overland, and put once more on a submarine system, this time the West India Company's own cable. Their system alone is several thousand miles in length, and touches all the chief islands of the West Indies, the extreme end of the system being Demerara on the mainland. The company had never had such momentous news to transmit before in the 30 years of their existence, and they proved worthy of the occasion.

A Large Transformer Contract.—The Westinghouse Electric and Manufacturing Company, of America, have just received what is said to be the largest single order for transformers ever given. This order was received from the Chambly Manufacturing Company, and is for 20 transformers each of 2,750 kw. capacity. These transformers will be of the Westinghouse air-blast type, and will weigh approximately 11 tons and stand 9ft. high. Ten of the transformers are to be employed to raise from 2,200 up to 25,000 volts. The frequency is given as 8,000 alternations, which works out at 133 alternations per second. This seems to be very high. The input into the transformers is to be two-phase and the output three-phase currents. The remaining 10 transformers are for lowering the voltage, and will receive three-phase currents from the line at 22,000 volts and deliver two-phase currents of either 2,400 or 4,800 volts as required. The blowers for furnishing the air blast for cooling both the raising and lowering transformers are operated by Westinghouse type C induction motors. The well-known Westinghouse methods of construction are employed in these transformers, both primary and secondary being divided into several flat coils wound with many layers, and few turns per layer, each coil being insulated separately. The advantages of this construction are that it divides the total E.M.F. between the several coils, reducing proportionately the strain of each individual coil; also it divides the E.M.F. in a single coil between many layers, thus reducing the potential between the adjacent layers. The regulation of the transformers is also improved, and the windings may be connected easily in series or multiple, thus giving a wide range of E.M.F. Also in case of damage to a coil a substitute may be provided with but little trouble, and without sending the transformer to the works. The iron and copper used have been so carefully prepared that high efficiency, considerably over 98 per cent., is to be obtained. It is also claimed by the Westinghouse engineers that they have found an iron which will not change in hysteresis losses with time. The design of the windings of the transformers in order to change the current from two-phase to three-phase is that due to the inventive skill of Mr. C. F. Scott, of the Westinghouse Company.

Electrically-Driven Refrigerating Plant.—Before the Liverpool Engineering Society last week Mr. J. Wemyss Anderson read a valuable paper, the latter part of which refers to the use of electricity for refrigerating machinery. The author points out that large quantities of electrical power could be used with advantage for driving the whole of a refrigerating plant, particularly in small or moderately-sized districts, as a means of bringing up the day load in the electrical generating stations. The output from such stations is, of course, greatest during the winter months, and the hours of large demand extend over a fair portion of the day. It so happens that the requirements of refrigeration during the same period would be small, and consequently, if the plant were electrically driven, it could easily be arranged that it should be stopped during the period of maximum demand. On the other hand, the total electrical output for ordinary purposes is smallest during the summer months, but now we find that the refrigerating requirements are large, so that if a generating plant and a refrigerating store were running in conjunction, a more balanced arrangement it would be hard to imagine. Thus, it is not hard to imagine a combination of refuse destructor, electrical generating station, and refrigerating plant working in conjunction. The quantity of chilled and frozen goods coming into this country has been and is advancing by leaps and bounds, and the question of transport over the sea has been answered by fitting up complete refrigerating machines and cold chambers on shipboard—as complete in every feature and detail as the cold stores on land. With respect to transport on land the railway companies provide special refrigerator cars. The car is insulated by felt and air spaces, and is refrigerated by crushed ice being placed in special cans provided. In Liverpool, however, it cannot be said that ideal arrangements exist for either icing these cars or for loading same with refrigerated produce. However, it is not hard to imagine the railway companies and Dock Board arranging for the refrigerator cars to run either on the top of or in the quay sheds, where the once handling would place the goods on the railway—the cars, on the way to the dock, being iced in succession from a special depôt. The paper closed with a reference to the great value which might result from the utilisation of liquid air, which, in the author's opinion, is an ideal power.

Electric Train-Lighting.—We have several times referred to the advantages of using electricity as the illuminant on railway carriages. In a great number of instances the passenger merely remembers the advantages which the electric light gives him as an illuminant, but there is another point in connection with the use of electric light on trains which must not be neglected by railway engineers when designing new stock. We refer to the danger which arises from the use of other means of illuminant in the event of a railway accident. The experience of the United States in this respect is worthy of quoting. In the old days they used stoves for heating, with the result that a number of serious accidents were made much more costly as regards loss of life by the fact that these stoves immediately set light to the *débris* after an accident had occurred. The same result has been noticed with cars lighted by gas. When a train is smashed up, the gas cylinders, as a rule, burst, and in consequence an explosive mixture of gas and air surrounds the wreckage. Cases are on record where explosions have resulted, greatly increasing the damage and loss of life. With electric lighting, however, the dynamo being driven off the car axle, there is no possibility of a fire occurring in consequence of a breakdown. Another most valuable advantage derived from the use of this method of car-lighting is that there is no need to put the trains into sidings in order to recharge them with gas or to trim oil lamps, as the very fact of running the trains generates the electricity for lighting. This in times of heavy traffic is a most valuable advantage, as it renders a train always available night and day. Various new means of coupling these dynamos to the car axle have been brought forward of recent

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years, but we have yet to see a new system which is at once so effective and so simple as that adopted by the English company who specialise in this matter—Messrs. J. Stone and Co. It will be remembered that this firm so suspend their dynamo that its weight gives the necessary tension to the belt. The suspension is also arranged so that the belt will slip when the normal output from the machine is exceeded. In this way the dynamo give a constant voltage independent of speed, which is an essential feature in this work. The cost of upkeep must be reasonable in view of the large amount of new stock which is equipped by companies having experience with this system.

The Liverpool Accident.—The fatal accident at Liverpool caused by telephone wires falling on to the trolley wire of the electric tramways has stirred up a good deal of discussion amongst all the municipal authorities owning electric tramways in England. We gather from the reports of these discussions in the town councils that in a number of towns indiarubber gloves had before the accident been provided on every tramcar. These, of which two pairs are supplied, will enable the conductor and driver of the car to handle any fallen wires with impunity, even if the same are in direct connection with the trolley wire. As a precaution, therefore, the provision of these indiarubber gloves, and of pliers by which the fallen wires can be cut, is good. On the other hand, it is desirable that means should be taken to prevent any telegraph or telephone wires becoming connected to the 500-volt circuit even if they do fall. The best solution of this problem is the placing of the wires in question underground, so that there is no possibility of the Liverpool conditions being repeated. It will also be remembered that at Liverpool earthed guard wires were not provided. Instead of these, strips of wood were fixed over the trolley wire, in order to support and insulate from it any wires which might fall. Until the Board of Trade enquiry has been held we cannot say how far these strips of wood were defective, but a heavy fall of wet snow would do much to lower their insulating properties. The other alternative, that of using earthed guard wires over the trolley wires, is the one more generally adopted, and it should give much more protection against accidental contacts between a fallen wire and the trolley. In such a case, if the fallen wire becomes connected from the trolley wire, it is almost sure to be connected at the same time to the earthed wire, which will make the circuit breaker in the sectional pillar disconnect the half-mile of trolley wire affected. We notice that Mr. J. H. Rider, the electrical engineer to the London County Council, and late engineer to the Plymouth Corporation, has written to the chairman of the Tramways Committee of the latter town. In this letter he expresses his opinion that the proper thing for the Council to do is to prohibit the crossing of public streets by telephone wires unless (1) all wires crossing any street be made to do so at one place and at one place only; (2) the number of wires fastened to any one support (post or chimney) be limited; (3) a strong wire netting, or laced-wire support, be fixed immediately under the telephone wire crossing so as to catch any wire before it can come near the trolley wire, or the telephone wires be insulated and made up into the form of a cable, and carried by strong steel wire supports, also insulated. The guard wires over the trolley wires could then be taken down, and another source of danger removed. The Councils should insist on the Telephone Company putting their wires underground.

Insulated Returns.—At the meeting of the South Metropolitan Gas Company held last week, Mr. George Livesey referred to the damage which he considered was likely to be caused to gas and water mains by the multiplication of electric tramways and railways in the Metropolis. He said he had been shown a circular issued by the London Chamber of Commerce in reference to this question. In this circular attention was drawn to a clause which the Wrexham Water Company were trying to get inserted in the Wrexham Tramways Bill. This clause would read as follows: "Notwithstanding anything contained in the Wrexham District Tramways Act, 1873, or the Wrexham District Tramways Order, 1899, the promoters shall be liable for any loss or damage to the water mains or pipes of the Wrexham Waterworks Company resulting from fusion or electrolytic action caused by any currents generated or used for the purposes of electric traction on any of the tramways authorised by the said Act or order." In the circular it was stated that the prejudicial effect of this and its far-reaching consequences on the electric traction industry would be seen at once, and it went on to say that it was most desirable that no promoter should give way on the point, or agree to any modification of the Joint Committee clauses, and that arrangements were being made to fight a test case during the ensuing session in the general interests of the electric industry. Mr. Livesey objected to the Chamber of Commerce taking up the cudgels on behalf of one industry. That electric traction people should be at liberty to let their waste current escape, to the damage of other people's property and to the danger of the public, was a doctrine to which he could not subscribe. He added that the gas and water companies of London intended to oppose the Bills of all such electric undertakings until they got the only protection which was really worth having—namely, insulated return conductors. The secretary of the London Chamber of Commerce has sent us a copy of the circular complained of, which when read as a whole shows that Mr. Livesey's limited quotations are hardly fair to that body. The clauses which are usually inserted in Electric Tramway Bills to protect gas and water companies were settled in 1893 after a committee of both Houses of Parliament had heard evidence on the subject of electrolysis to underground pipes due to tramway currents. One section of these clauses reads thus: "The tramway company shall take all reasonable precautions in constructing, placing, and maintaining their electric lines and circuits and other works of all descriptions, and also in working the undertaking so as not injuriously to affect by fusion or electrolytic action any gas or water pipes or other metallic pipes, structures, or substances, or to interfere with the working of any wire, line, or apparatus used for the purpose of transmitting electric power, or of telegraphic, telephonic, or electric signalling communication, or the currents in such wire, line, or apparatus." Another clause makes the tramway company responsible for the due observance of regulations made by the Board of Trade. We think the Electrical Trades' Section of the Chamber of Commerce is quite right in trying to prevent individual promoters giving away the advantage of Board of Trade control and placing themselves in the hands of rivals. If the Wrexham clause were generally accepted, there is little doubt but that the tramway companies would be called upon to make good damage which they may not have been responsible for. The secretary of the Chamber of Commerce adds, in a letter to us, that so far from the chamber being only willing to "take up the cudgels on behalf of one particular industry," it may be pointed out that if the gas and water companies wished to utilise the machinery of the chamber in the same way as its electrical section has done similar facilities would be afforded to them, as the organisation of the chamber expressly provides for the furtherance of sectional interests when desired.

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FULHAM COMBINED ELECTRICITY AND REFUSE DESTRUCTOR WORKS.

Mr. Russell Forrester Ferguson, borough electrical engineer, was born in the city of Glasgow, and was educated at the academy there. He served his apprenticeship with Mr. William Young, of Ardrossan, Ayrshire, after which he sailed as an engineer, and was latterly a chief engineer of the River Steam Navigation Company, India. On returning home, Mr. Ferguson took up electrical work, and studied under Prof. Jamieson, of the West of Scotland Training College, Glasgow, holding at the same time the position of chief draughtsman to Messrs. Muir, Mavor, and Coulson, Glasgow.

In 1891 Mr. Ferguson was appointed first engineer to the Brighton Corporation electricity works; then in 1892 as construction engineer to the City of London Electric Lighting Company's large station at Bankside, which position he held till 1896, when he was appointed temporary resident engineer during the construction of the Shoreditch combined electricity and refuse destructor scheme, and was afterwards engaged as guarantee engineer for Messrs. Manlove, Alliott, and Co., Limited, Nottingham, who were contractors for the refuse destructor. In 1898 Mr. Ferguson was appointed clerk of works for the borough of Fulham combined electricity and refuse destructor works, and takes the position of chief engineer and manager when the works are handed over by the contractors.

The borough of Fulham has marked the dawn of the new century by the inauguration of a combined refuse destructor, electricity supply, and disinfector scheme, the whole presenting several novel and interesting features which will be more particularly described in the account which, through the courtesy of the consulting engineer and the contractors, we are privileged to give.

Considerable discussion has taken place from time to time at Fulham on electrical matters, but no very definite step was taken to provide an installation until May, 1895, when a committee was appointed on the motion of Mr. W. R. Sayer, a veteran member of the Vestry, to consider the desirability of obtaining electric lighting powers with the idea of erecting electricity works in conjunction with a refuse destructor. Mr. Tom Green, the leader of the Moderate party, was elected chairman of the committee, and devoted much time and attention to the duties of his position, which he held with conspicuous success till the vicissitudes of party warfare and the birth of the new Fulham Borough Council necessitated the appointment of a new chairman in the autumn of 1900. Mr. Timothy Davies was then elected to this important position, which he still holds.

In the autumn of 1895 the committee resolved to obtain expert advice on the whole subject, and Mr. F. H. Medhurst was appointed to report on the subject generally. The recommendations contained in his report were, briefly, that a combined scheme consisting of a refuse destructor, electric lighting works, and a disinfector would be a commercial success, and that an initial installation should be put down on the high-pressure alternating system to supply some 15,000 8-c.p. lamps. The Vestry therefore decided to apply for an electric lighting order, which was obtained in the summer of 1897, and soon afterwards a deputation visited various towns with the object of satisfying the Vestry as to the desirability of the proposed combined scheme. The result of these investigations was that in April, 1898, Mr. Medhurst was instructed to prepare the necessary plans and specifications for a combined scheme, to be erected on an excellent riverside site which the Vestry had with commendable foresight acquired a year or so previously.

In view of the growing demand throughout the country for electric light and power, it was considered desirable to increase the capacity of the station beyond that originally proposed, and a plant capable of supplying a total of 30,000 8-c.p. lamps connected to the mains, exclusive of spare plant, has therefore been installed. The capital outlay amounts to over £100,000, and the contracts entered into are as follows:

Buildings, comprising destructor-house, engine-room, offices, and transformer chamber; also a small building for public disinfecting purposes, F. G. Minter, Westminster	£22,970
Refuse destructor, steam-raising plant, inclined roadway, and chimney shaft, Horsfall Destructor Company	16,760
Generating plant, including steam-pipes, condensing plant, mains, etc., and apparatus for the above-mentioned disinfector building, General Electric Company, Limited, of London and Manchester	46,000

Additional contracts for the supply of coal-handling plant and meters, wellsinking, extra foundations, and engineering expenses increase the total to £108,000.

Site.

The generating station is situated on a well-adapted site in the Townmead-road, having an area of about four acres and a frontage to the Thames of 370ft., protected by a massive quay wall. The present works cover but a small portion of the site, and there is, therefore, ample space for the extensions which will no doubt be necessary at no distant date.

Buildings.

The general arrangement of the buildings will be seen in Fig. 1. Substantial construction and due provision for light and ventilation have been aimed at with considerable success. Externally they are of red brick with relieving bands of white Suffolk brick. The boiler and engine rooms stand parallel to each other and at right angles to the river, the offices standing between the end of the engine-room and the river-wall. The offices, therefore, face the river. They are of a particularly commodious nature, and comprise the following apartments on the first floor: resident engineer's office, assistant engineer's office, chief clerk's office, general office, attendants' room, a lavatory and bathroom. There is also a testing-room on the first floor of this block, and on the ground floor there are stores, a meter-testing room, workshops for light work and repairs, the water-softening and filtering room with the well-pump driving gear. Beneath this block of offices is also the pump-room; both these latter rooms being reached from the engine-room. Access may be had to the offices both from the general entrance outside and from the engine-room, destructor-house, etc. In addition, a corridor leads direct from the offices to the switchboard gallery, and a window in the assistant engineer's office affords a complete view of the engine-room. An exterior view of the main buildings taken from the office corner is shown in Fig. 2.

Destructor-House and Steam-Raising Plant.

The destructor and boiler house is a lofty building, 35ft. high to the springing of the roof, 137ft. in length, and 87ft. wide. It contains 12 destructor cells with room for an additional four cells. The present cells are arranged in two groups of six each on either side of six Babcock and Wilcox boilers, as shown in Fig. 1, and are capable of efficiently destroying 120 tons of refuse in 24 hours. Over the boiler firing floor, and extending from end to end of the building, is the tipping floor to which the carts are brought for the purpose of discharging their loads on to the tops of the groups of cells where the refuse is fed into the furnaces. The tipping floor is arranged to allow of the storage of a

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considerable quantity of refuse, so that the working of the plant may be continued without interruption. Access to the tipping floor is obtained by means of an inclined roadway having a gradient of about 1 in 14, at the foot of which there is a weighbridge and house where an account will be kept of the weight of refuse brought in.

mentioned above, the refuse itself closing the openings when the operation of charging is complete, and thus obviating the necessity for doors on the tops of the furnaces. Each furnace is provided with a sloping fire-brick hearth, on which the refuse rests before being drawn forward from below on to the grate bars. The grate bars

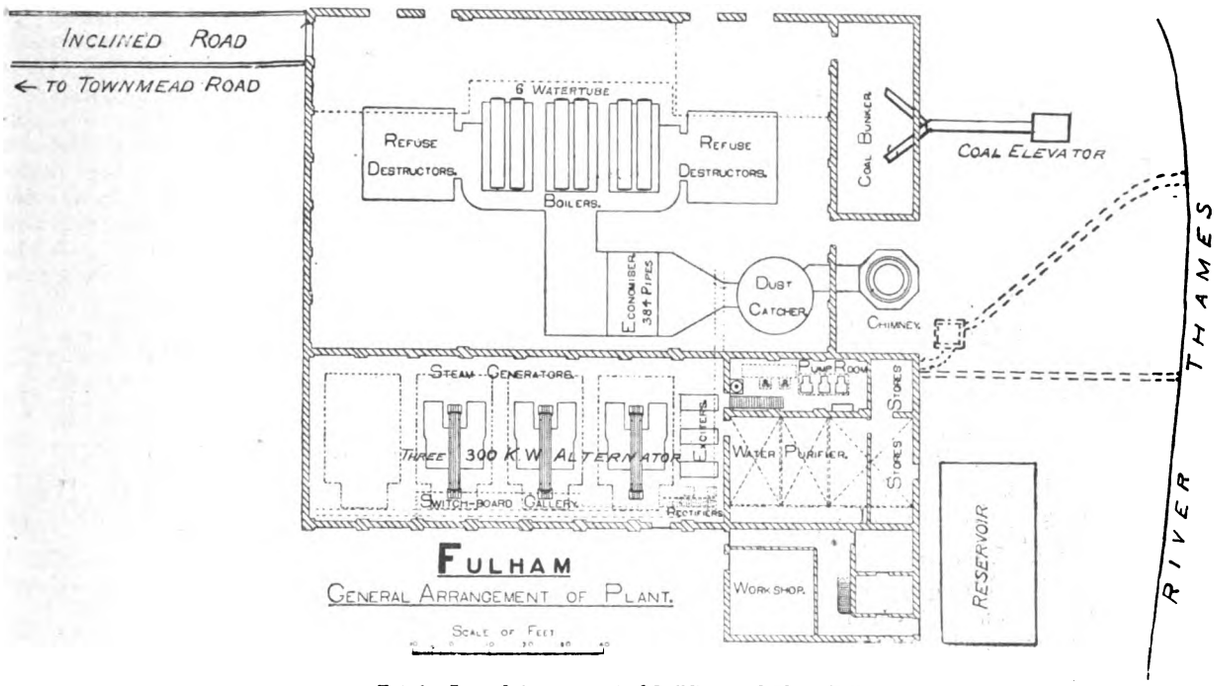

FIG. 1.—General Arrangement of Buildings and Plant, Fulham.

The destructor furnaces are of the standard Horsfall type, each having a grate area of 30 square feet. The boilers are of the Babcock and Wilcox water-tube pattern, each having a heating surface of 1,284 square feet, and each provided with Vicars mechanical stokers electrically driven by a motor, the destructor gases being led into each of the boilers by means of an opening behind the bridge, the flue to this opening being provided with a suitable damper so that the boiler may be heated at will from the destructor or be fed with coal. Provision has also been made for firing the boilers by hand in the event of interruption in the working of the mechanical stokers, and forced draught has been applied to each boiler. The refuse is fed into the destructor furnaces through charging openings on the tops of the blocks of the cells, as have fine spaces between them, and are made all in one length, so that there is no obstruction to the clinkering tools in traversing the length of the bars. The furnace crown is composed of special fire-resisting blocks, specially mixed and burned, capable of standing not only high temperatures, but rapid changes of temperature. At the sides of the furnaces, and extending about 8in. above

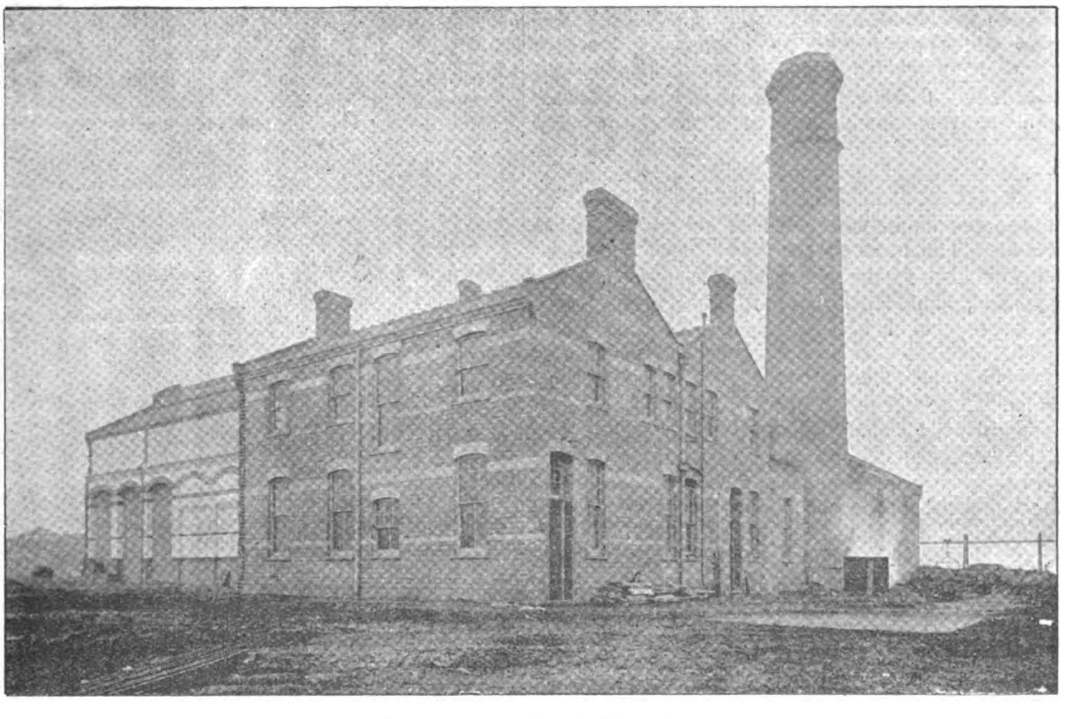

FIG. 2.—Exterior View of Main Buildings, Fulham.

the grate bars, are cast-iron side boxes, through which the whole of the air for combustion is passed. These boxes serve the double purpose of heating the air for combustion, and at the same time protecting the sides of the furnaces from the undermining action which takes place with brick sides owing to the clinker adhering thereto and causing rapid deterioration. Each of these side boxes is provided with a valve controlled from

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the front of the furnaces, and openings for the delivery of the mixed air and steam forming the blast into the ashpit underneath the grate bars. The air for the blast is drawn from above the charging decks of the furnaces, through large hoods, by means of powerful steam-blasts, and thus ventilation of the upper part of the destructor-house is assisted, and any smells arising from the refuse on the decks are partially drawn off and passed into the furnaces. The steam trumpets by which the blast is promoted are of special construction, the principal feature being the adoption of the Horsfall flat steam jet apparatus, which gives the maximum of blast with the minimum of steam used. The blasts force the air into longitudinal air passages (Fig. 3) extending under the furnaces, and communicating by means of the valves above described with the side air-boxes of the furnaces. There is a single outlet for the products of combustion from each furnace placed in the crown of the arch at the front of the furnaces in such a manner as to draw off the escaping gases over the hottest part of the fire, thus cremating them before they leave the furnaces. The unburnt gases which have been given off by the refuse drying at the back of the furnace are thus subjected to a temperature of from 1,800deg. to 2,000deg. F. before passing away to the flues. The exhaust openings from the furnaces lead into flues, which in turn open into a main flue which runs the whole length of both blocks of cells and the battery of boilers between them, the flue being on ground level under the blocks of cells, but below ground level under the boilers. The furnaces are provided with massive steel buckstays and tiebolts and with cast-iron cleaning and clinker doors, the latter being lined with firebrick. The clinker doors are of the balanced type, and are so arranged as to open the whole width of the furnaces at once. Branch flues with dampers are provided from the main flue to lead the gases into the furnaces of the boilers, and also by-pass flues, by means of which the hot gases can be led past the boilers to the chimney. The dampers in the hottest parts of these latter are swivel dampers of a special design, being kept cool by means of water circulation.

The boilers are constructed for a pressure of 160lb. per square inch, and no difficulty is found in maintaining this pressure by means of the hot gases brought from the furnaces until the demand for steam becomes too heavy. The clinker is drawn from the furnaces into iron skips carried on an overhead railway, by which it is conveyed to the wharf alongside the river. Two Green's economisers, each having a heating surface of 1,920 square feet, are erected between the boilers and a dust-catcher near the chimney, a by-pass being provided to carry the gases to the dust-catcher direct when desired.

The dust-catcher is a large circular brick chamber lined with firebrick, with a domed roof of the same materials. The structure is strengthened by massive iron rings and buckstays, and is so constructed as to cause the gases to swirl round rapidly within it in such a way as to throw off the dust, which they carry along with them by centrifugal force. Cleaning doors are provided for the removal of the dust at any time without stopping the furnaces.

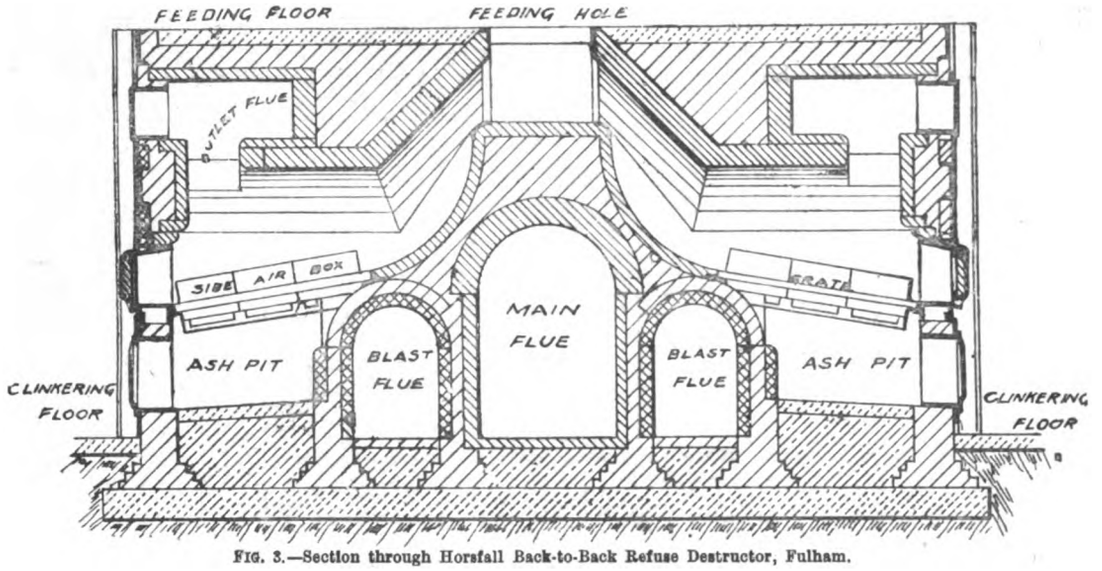

FIG. 3.—Section through Horsfall Back-to-Back Refuse Destructor, Fulham.

The chimney, which was also built by the Horsfall Destructor Company, Limited, has a height of 100ft. and an internal diameter of 8ft. It is octagonal in form, and is lined throughout with firebrick. The engineer estimates the amount of refuse that will be passed through the

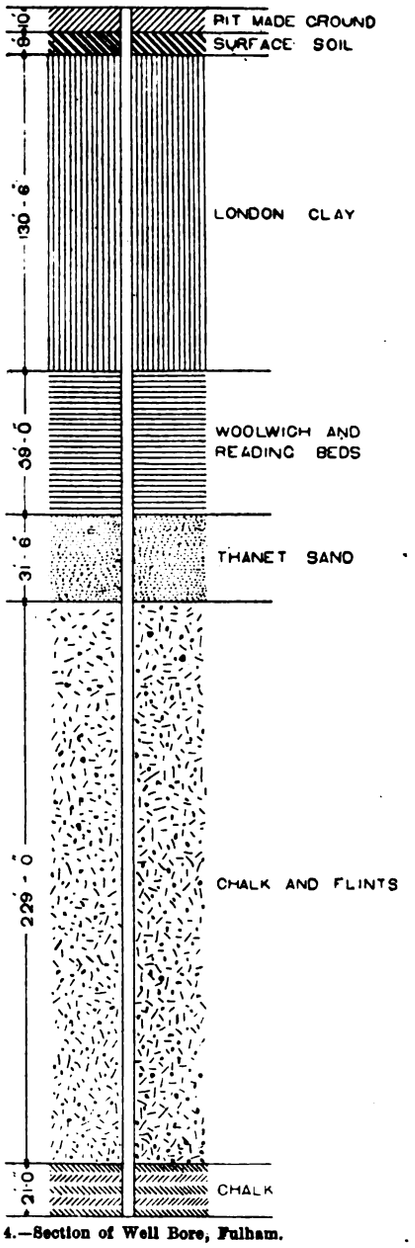

FIG. 4.—Section of Well Bore, Fulham.

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destructor per annum at 40,000 tons approximately, and places its calorific value at one-twentieth that of good steam coal. The Borough Council, therefore, expects to save the cost of 2,000 tons of coal per annum.

Pipework.

The system of steam-pipes consists of a 9in. diameter ring main, with a branch to each steam alternator, and an auxiliary ring main of 3½in. diameter, which supplies the three exciter engines and feed pumps. The steam-pipes are of lap-welded steel, with mild-steel flanges, and are supported on roller bearers. Ample provision has been made for expansion by the adoption of copper bends, and the range is drained by means of six separators of Holden and Brooke's manufacture, which are connected to steam-traps discharging to the feed-water tank, the traps being fitted with three-way cocks and by-passes to allow of inspection. The main exhaust pipe is of cast iron 24in. in diameter. The exhaust steam from the exciter engines is taken by cast-iron pipes, 6in. in diameter, to a Royle's feed-water heater situated in the pump-room, to which the exhaust from the feed pumps is also led, the heater being arranged with a by-pass to allow the engines to exhaust direct to the atmosphere when required.

Careful attention has been given to the supply of water for boiler feed and condensing purposes. River water is used for the latter, but it was not considered suitable for boiler feed purposes. An artesian well, sunk to a depth of 500ft. with successful results, will supply all water required for the boilers, there being a supply from the town mains in addition as a stand-by. The well bore (a section of which is shown in Fig. 4) is uniform throughout, with a diameter of 9½in., and is lined with steel tubes to a depth of some 300ft. It was sunk by Messrs. A. C. Potter and Co., of 1, Leadenhall-street, E.C., who carried out the work under a separate contract placed with them. The pump barrel is 7½in. diameter, and is placed at a depth of 165ft. from the surface with 30ft. of suction pipe, the still-water level being 104ft. from the surface.

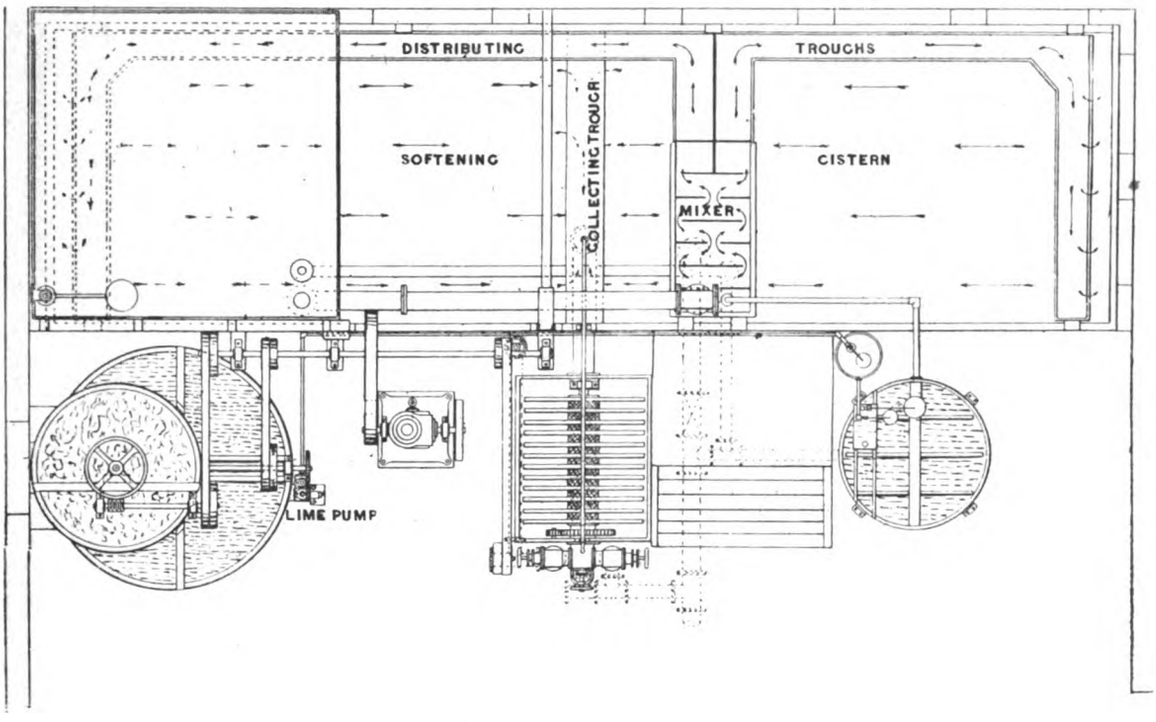

Fig. 5.—Plan of Water-Softening Plant, Fulham.

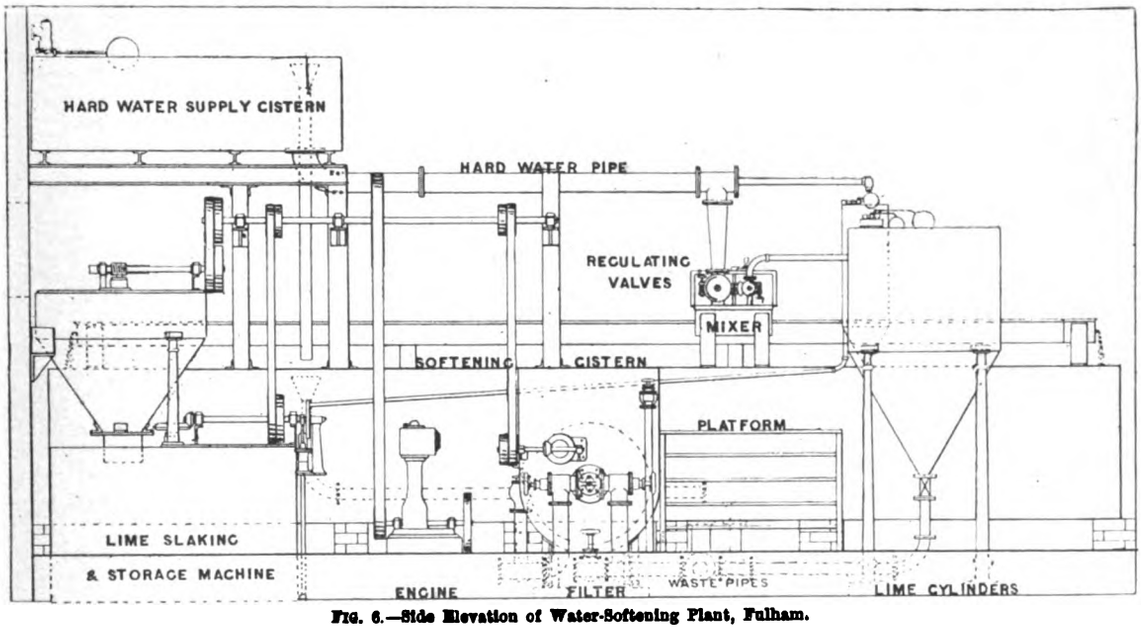

Fig. 6.—Side Elevation of Water-Softening Plant, Fulham.

The pump is driven through spur gearing by a 14-b.h.p. motor. The water, whether taken from the well or town mains, will be softened by apparatus described later, and led to an underground reservoir in connection therewith, having a capacity of 35,000 gallons, whence it flows by gravity to the feed tank in the pump-room. There is also a direct connection between the town mains and feed tank to meet emergencies. Two vertical Weir pumps are installed for boiler feed purposes, each pump being

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capable of delivering 4,000 gallons an hour. A duplicate system of feed pipes has been arranged, the water passing in one case through the feed-water heater mentioned above and the two economisers in parallel, or through the economisers alone, and in the other case direct to the boilers. The feed pipes are of wrought iron, 3½in. diameter, with heavy cast flanges and copper bends to the boilers. The drain-pipe system appears to have been well thought out, but calls for no special mention. Hopkinson's valves are used throughout the steam and feed pipe systems, and the pipes and flanges are lagged with coverings of sectional magnesia.

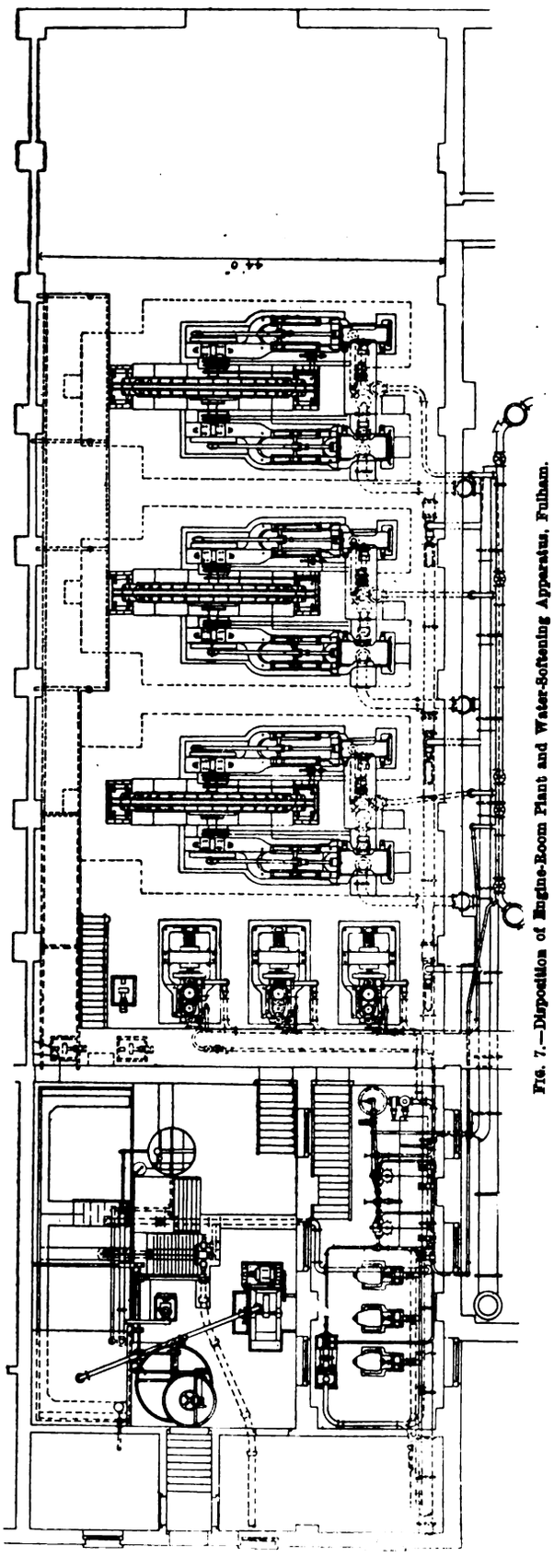

FIG. 7.—Disposition of Engine-Room Plant and Water-Softening Apparatus, Fulham.

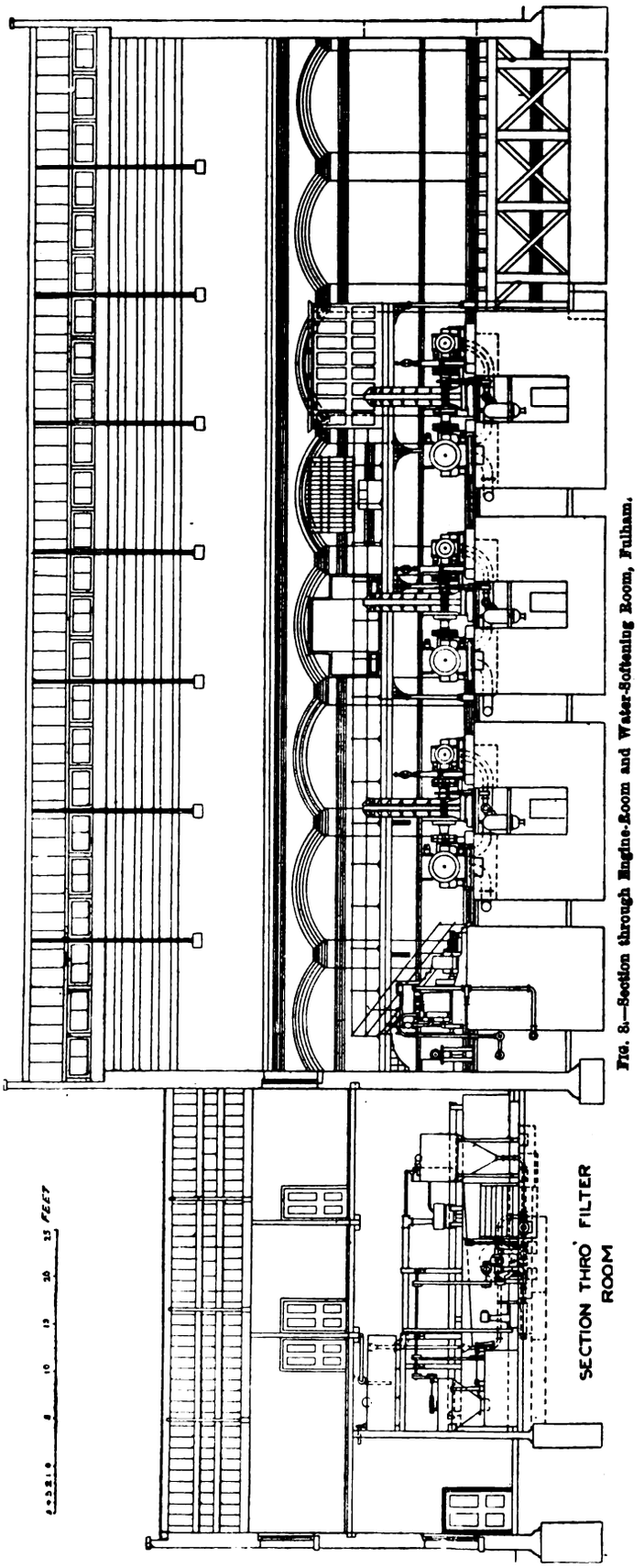

FIG. 8.—Section through Engine-Room and Water-Softening Room, Fulham.

WATER-SOFTENING PROCESS.

The water-softening plant above referred to treats the water by Clark's process carried out on the "Atkins" system, named after the inventor, Mr. W. G. Atkins, whereby a certain quantity of caustic lime is added to the water, mixed with it, run into large tanks, where the chalk is precipitated, and finally filtered. The plant is capable of dealing with 8,000 to 10,000 gallons of water per hour. A plan and elevation of its arrangement are shown respectively in Figs. 5 and 6. The guarantee requires that any intelligent workman can operate the plant, and that water with 15 or less degrees of hardness must be softened so

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that the hardness is reduced to less than one-half grain of carbonate of lime per gallon if required. The plant consists of the following parts: (1) a lime slaking, straining, and storing machine; (2) a cylinder in which lime-water is formed, and therefore termed the lime-water cylinder; (3) a "mixer," being a shallow trough fitted with baffle plates; (4) a cistern in which the actual softening takes place; (5) a filter. The method of working is as follows: The lime is delivered direct into a hopper, which forms part of the lime-slaking machine. The machine is set in motion, and in a few hours sufficient lime to last three weeks is automatically reduced to the form of "cream of lime," and stored in a mill under the hopper. This mill is fitted with stirring arms and a self-cleaning strainer. About once a day the "cream of lime" is stirred, and a certain quantity pumped into the lime-water cylinder. A jet of water is admitted at the bottom of this cylinder, and passes out at the top as a saturated solution of lime-water. It is then conducted to the "mixer," where it is joined by the hard water. There are two specially constructed regulating valves by which any desired quantity of hard water and the correct proportion of lime-water can be adjusted, and both supplies can be turned on or off without interfering with the other. Whilst flowing through the mixer, the lime-water and hard water mix automatically in a few seconds, and the water is delivered into the softening cistern, which is always full, and where water is always flowing through. It is during this period that the actual softening takes place, which may be described thus: Chalk is dissolved in water by carbonic acid gas; this is termed bicarbonate of lime. When caustic or quicklime is added to such water, the gas

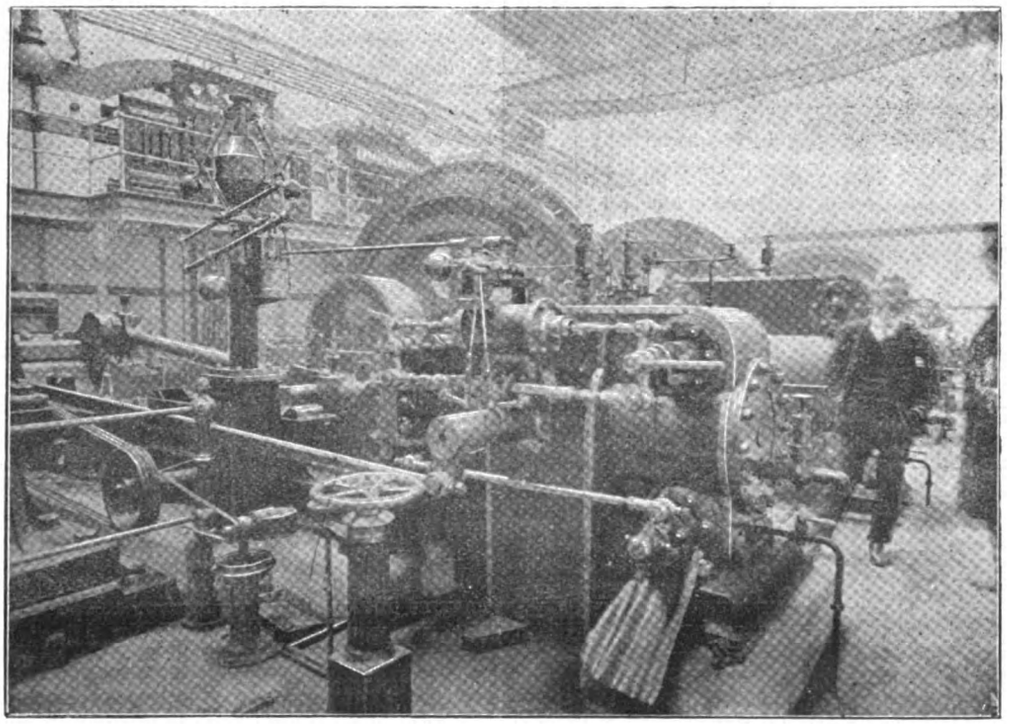

FIG. 9.—General View of Engine-Room, showing High-Pressure Cylinder and Valve Gear of Musgrave Engine in Foreground, Fulham.

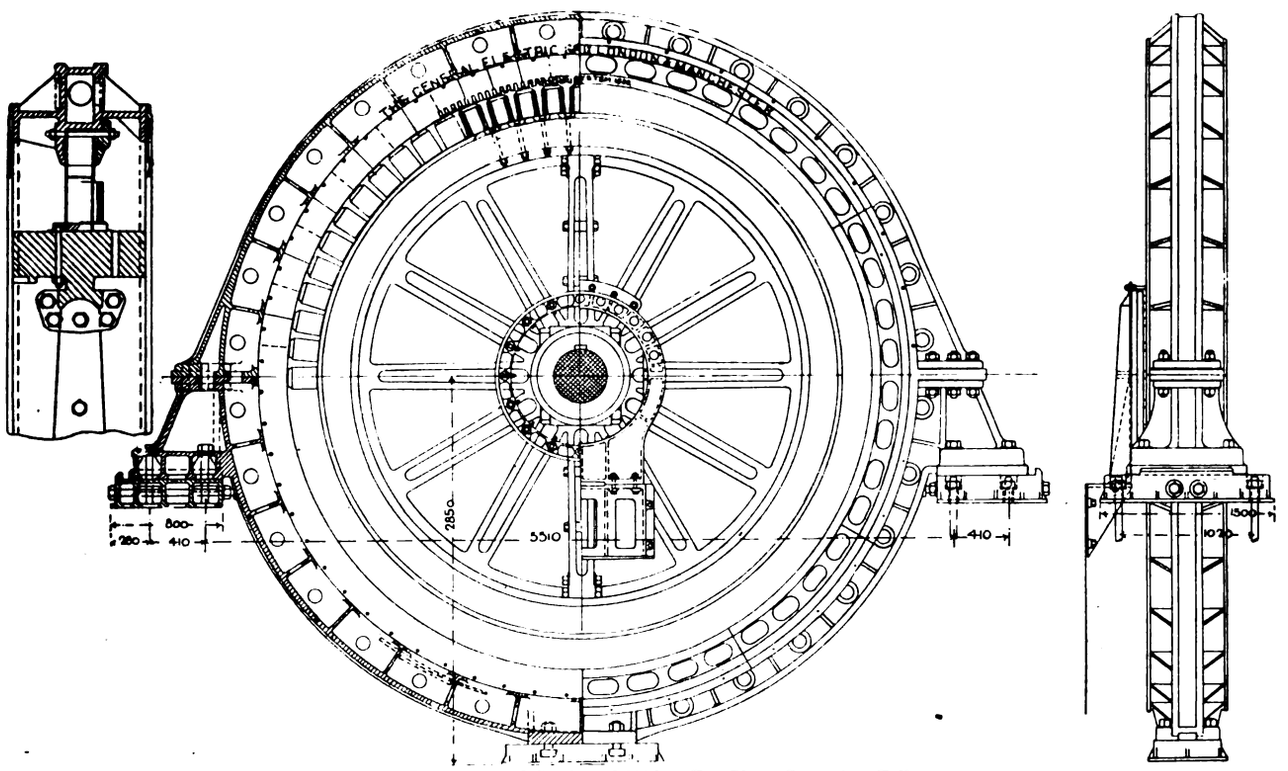

FIG. 10.—Elevations and Section of 800-kw. Two-Phase Generator, Fulham.

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releases the chalk, which, together with the lime, is precipitated. It should be carefully noted—for it is a point on which misapprehension exists—that so long as the chalk is in solution it hardens the water, but as soon as it is precipitated, or in suspension, it has no hardening effect. The water is now soft, but excessively turbid owing to the deposit. This may be allowed to subside, or be removed by filtration much more quickly. The important point is that the softening or precipitation of the chalk is a strictly chemical action, whereas the removal of the precipitate, whether by subsidence or filtration, is entirely mechanical, and has no power whatever to soften the water. The filter consists of a series of hollow discs covered with cotton filter cloth. The discs are secured to a hollow centre tube, and the tube and discs mounted in a cistern. The water is admitted to the cistern, filters through the cloth, leaving the deposit on the outside, passes inside the hollow discs to the centre tube, and is delivered outside the cistern. When cleaning is necessary—usually once a day—the discs and tube are revolved by means of gearing provided for this purpose, jets of water play on the discs, and the deposit which has been arrested is washed off in a few minutes, passes down a waste-pipe, and filtering can be resumed. The advantages claimed by this system of filtering are that the filtering medium is cheap, it is arranged vertically, and takes up little room, and is readily cleaned by mechanical means.

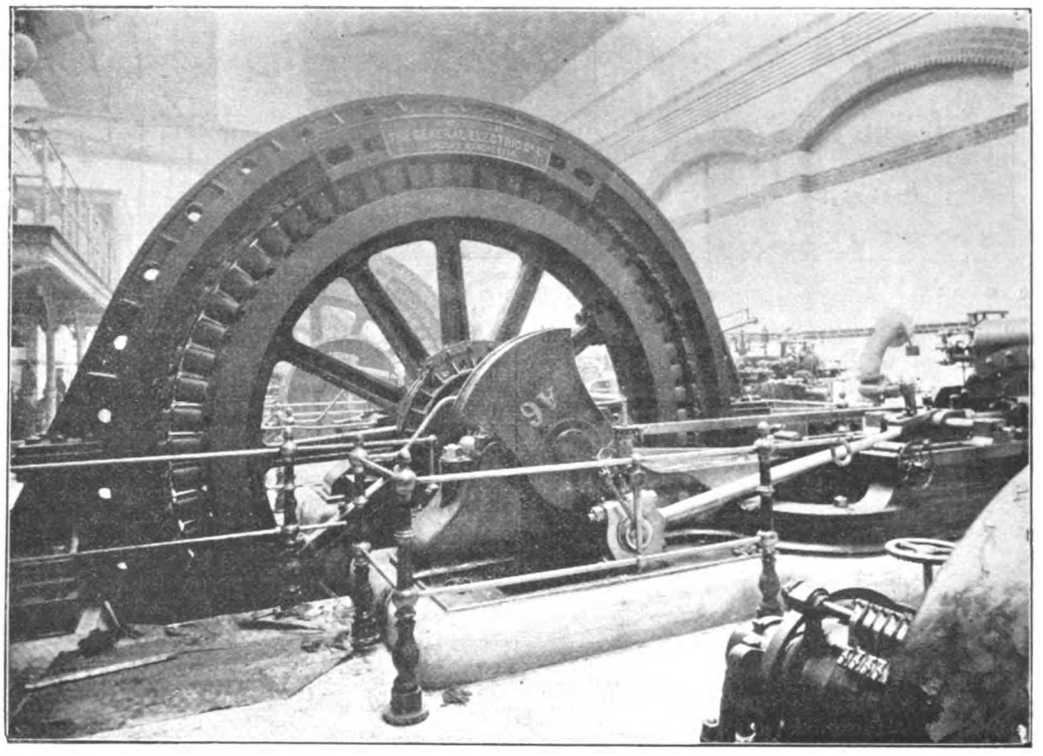

FIG. 11.—View of 300-kw. Two-Phase Generator, Fulham.

ENGINE-ROOM PLANT.

The engine-room, which is 110ft. long, 42ft. wide, and 30ft. in height to the springing of the roof, is well adapted for the machinery it contains. The walls are entirely faced with white glazed bricks, relieved by bands and string-courses of salt glazed bricks. The floor is paved with mosaic work, with hand-laid borders. A special feature of the room is the absence of all pipework, which is arranged under the floor level. The general arrangement of the engine-room plant is shown in Figs. 7 and 8. A gallery runs round two sides of the room, and carries the main switchboards and a switchboard attendant's office. Space is left at one end of the room for an extension engine and dynamo. Two entrances to the destructor-house are provided from the engine-room, one from the gallery and one from the floor, and these are carefully protected by double doors and glazed screens with the object of keeping out dust. The steam alternators are three in number, each set containing a two-phase generator of the flywheel type, coupled direct to a horizontal compound condensing engine. The engines are of the slow-speed Corliss type, made by Messrs. J. Musgrave and Sons, Limited, of Bolton, and each is capable of giving 450 b.h.p. when supplied with steam at a pressure of 130lb. per square inch at the engine stop valve and a vacuum of 24in. of mercury in the exhaust pipe. The governor is capable of controlling the speed of the engine within 3 per cent. from no load to full load, and is provided with means of adjustment to vary the speed 5 per cent. about the mean speed whilst running. There is a continuous and automatic system of lubrication, with the requisite draining arrangements for waste oil fitted to all working parts. The pistons are fitted with Buckley's patent packings. The cylinders are non-jacketed. The high-pressure cylinders are 17in. diameter and the low-pressure cylinders are 33in., and have a stroke of 3ft. 6in. The high-pressure cylinders are fitted with Corliss valves and Musgrave's patent automatic cut-off motion, connected direct to the governor (see Fig. 9), thereby dispensing with an equilibrium throttle valve, and giving greater regularity in the speed of the engine. The low-pressure cylinders also have Corliss valves. The cylinders are lagged with planished steel and fitted with Crompton's patent metallic packings.

The three two-phase generators were constructed by the General Electric Company, Limited, at their Manchester works. Each generator is capable of giving a normal output of 300 kw., each of the two sets of coils being capable of giving 150 kw. at all E.M.F.'s from 2,800 to 3,000 volts at the terminals of the machines. The machines will also give an overload of 330 kw. continuously for two hours. The speed is 93·7 revolutions per minute, and the frequency 50 cycles per second. Two elevations and a section of one of these 300-kw. generators are given in Fig. 10. The energy stored in the flywheel when running at its normal speed is 1,800,000 foot-pounds. The field-magnet poles with their windings are fixed on the periphery of the flywheel. The poles are laminated, riveted together, and fixed to the flywheel rim by means of steel wedges, the latter being securely fastened to the flywheel by strong bolts passing through its rim. There are 64 laminated poles on each flywheel, wound with round copper wire, the exciting current being brought to them through two slip rings. The diameter over the poles is about 14ft. The necessary current for exciting the field coils is obtained from the continuous-current dynamos driven by high-speed engines mentioned below. On the inner circumference of the stationary armature are spaced 256 slots which carry the copper windings. These

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windings are arranged to form two circuits, one for each phase. The windings of the one circuit have straight ends, whilst those for the other circuit have bent ends, as is the usual practice. The insulation between the coils and the iron frame is efficiently effected by mica tubes, the coils being fastened securely in the slots by means of strong fibre wedges. The general appearance of one of the 300-kw. generators is seen in Fig. 11. The four ends of the two series of windings are brought out to terminals, from which the current is carried to the switchboard for distribution to the various circuits.

There are three continuous-current dynamos (Fig. 12), which were also made by the General Electric Company, Limited, for exciting and other purposes. Each is capable of giving an output of 600 amperes at 100 to 110 volts at a speed of 460 revolutions per minute, and each is direct coupled on one bedplate to a high-speed enclosed type compound engine of Messrs. Musgrave's make. They supply not only the necessary current for exciting the field-magnet circuits of the three large generators, but also the various electric motors which are used for driving the condensing plant, economisers, and stokers. They also supply the necessary power for lighting the buildings

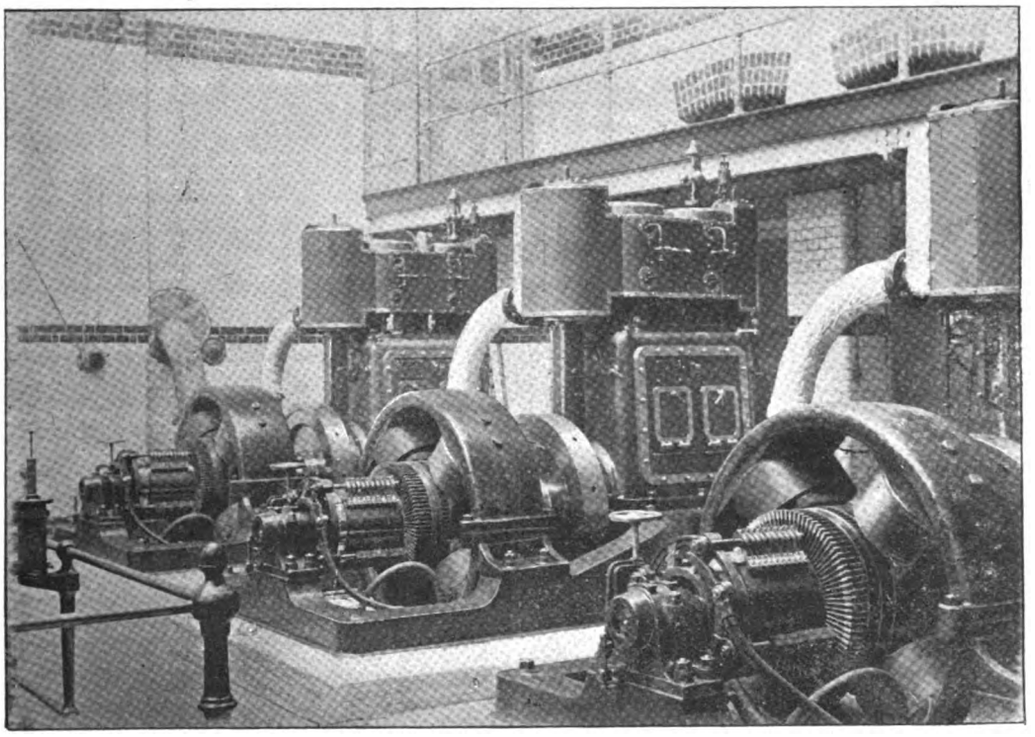

Fig. 12.—Continuous-Current Plant, Fulham.

and inclined roadway by arc and incandescent lamps. Either of the three dynamos are, of course, far more than capable of supplying the current required for the three generators. The dynamos are shunt-wound, having four poles with cast-steel yokes, whilst the armatures are of the slotted type with former-wound coils placed in the slots. The commutator is built up of hard-drawn copper, fitted with carbon brushes, and conforms to the usual specification as to temperature and fixed position of brushes. Three of Ferranti's latest-type rectifiers are placed in one corner of the room, with provision for a fourth, for supplying the public lighting circuits. The switchboard in connection with these is fixed on the wall beside the rectifiers; it is arranged for three circuits, any one of which can be fed from any one of the rectifiers. A 15-ton overhead crane traverses the room from end to end.

Condensing Plant.

The three steam alternators are fitted with Korting ejector condensers, placed partly above the engine-room floor-level and partly in the pipe trench. A branch is run from each condenser to the main exhaust pipe, in which is fixed a Blake and Knowles automatic exhaust valve to enable the steam to reach the atmosphere in case of any failure of the condensing plant. Each condenser is required to give a vacuum of 24in. of mercury when dealing with 10,000lb. of steam per hour. The condensers are supplied with water from a large tank placed on the roof of the pump-room, kept filled by three motor-driven centrifugal pumps of 18 b.h.p. each, running at 1,200 revolutions per minute, the motors being the General Electric Company, Limited, standard make. These pumps are placed in the pump-room, and are each capable of delivering 33,000 gallons of water per hour through a total lift of 48ft. at low tide. The supply pipe to the condensers is 14in. in diameter, and is carried on brackets fixed to the wall of the destructor house, with 9in. diameter branches to each condenser. The water returns to the river through cast-iron pipes discharging over a concrete apron on the foreshore. The condensing water is drawn from a closed sump made of piles on the foreshore, but as water could not be obtained from this sump at all states of the tide a line of 24in. cast-iron pipes was run out into the river for a distance of 170ft. These pipes have spherical joints to allow of some slight play, and terminate in a cast-iron sump, which is always submerged. In order to clean the second sump and line of pipes of the river mud which is expected to collect in it, arrangements have been made for discharging the contents of the overhead tank already referred to into the pipes when required. It is anticipated that the powerful flush that will thus be obtained will have the desired effect.

Main Switchboards.

The switchboard for controlling the distributing circuits and alternators is fixed on a gallery 10ft. above the floor level, so as to enable the engineer-in-charge to have a full view of the machinery in operation below. The board, which is of the Ferranti type, is divided into 15 panels, six of which are allotted to the generators, six to the feeders, two for the rectifiers, and one for a testing circuit. Each generator panel contains one ampere-meter, one main switch for connecting and disconnecting the machine to the 'bus bars and the necessary safety fuses. The circuit panels are fitted in a similar manner, and the whole are of enamelled slate. The usual synchronising voltmeters, transformer, etc., are provided, and also a plug board, so that any section of the 'bus bars and corresponding panel or cable connections can be connected up to a testing circuit leading to the testing-room. Plugs are used for isolating the various sections. In the office on the switchboard gallery are a recording voltmeter for continuously recording the pressure across the 'bus bars, and six recording wattmeters placed in the earthed connecting cables to the

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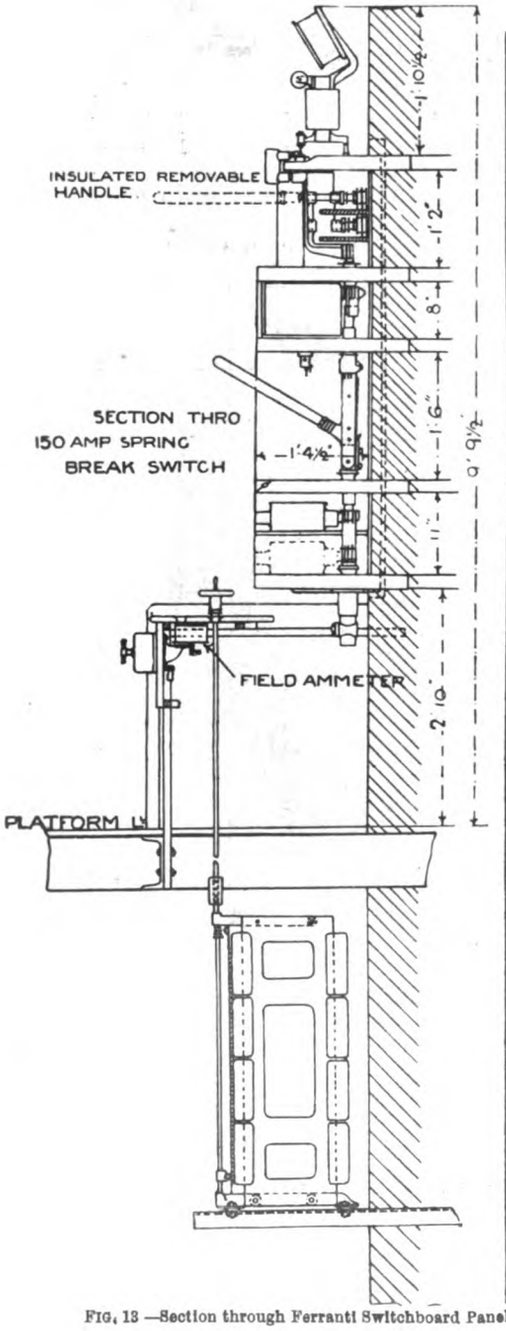
alternators, so that the outputs of both phases of the alternators may be continuously recorded. A pilot voltmeter on the main board also indicates the pressure on the network at all times. A section through one of the Ferranti switchboard panels is shown in Fig. 13. The low-pressure board, also on the gallery, is provided with the usual instruments, switches, and shunt regulators for the three 60-kw. dynamos above mentioned, and also switches and fuses for controlling the various motors in the building and the lighting of the station. All the principal connections between the switchboards and machines are run beneath the floor level and made with rubber-insulated pressure is reduced from 2,800 volts to 200 volts by static transformers, two-wire distributors radiating from the sub-stations, the two phases being run—the one down one side of the streets, the second down the other side. The two phases will, therefore, be available everywhere where energy is required for motors. In addition to the above, two circuits of single cable run through the principal streets for public arc lighting, which is described later on. Spare ducts have been provided liberally for future extensions. Fig. 14 will give a good idea of the extent of the distributing network of mains, besides showing the relative position of the generating station thereto.



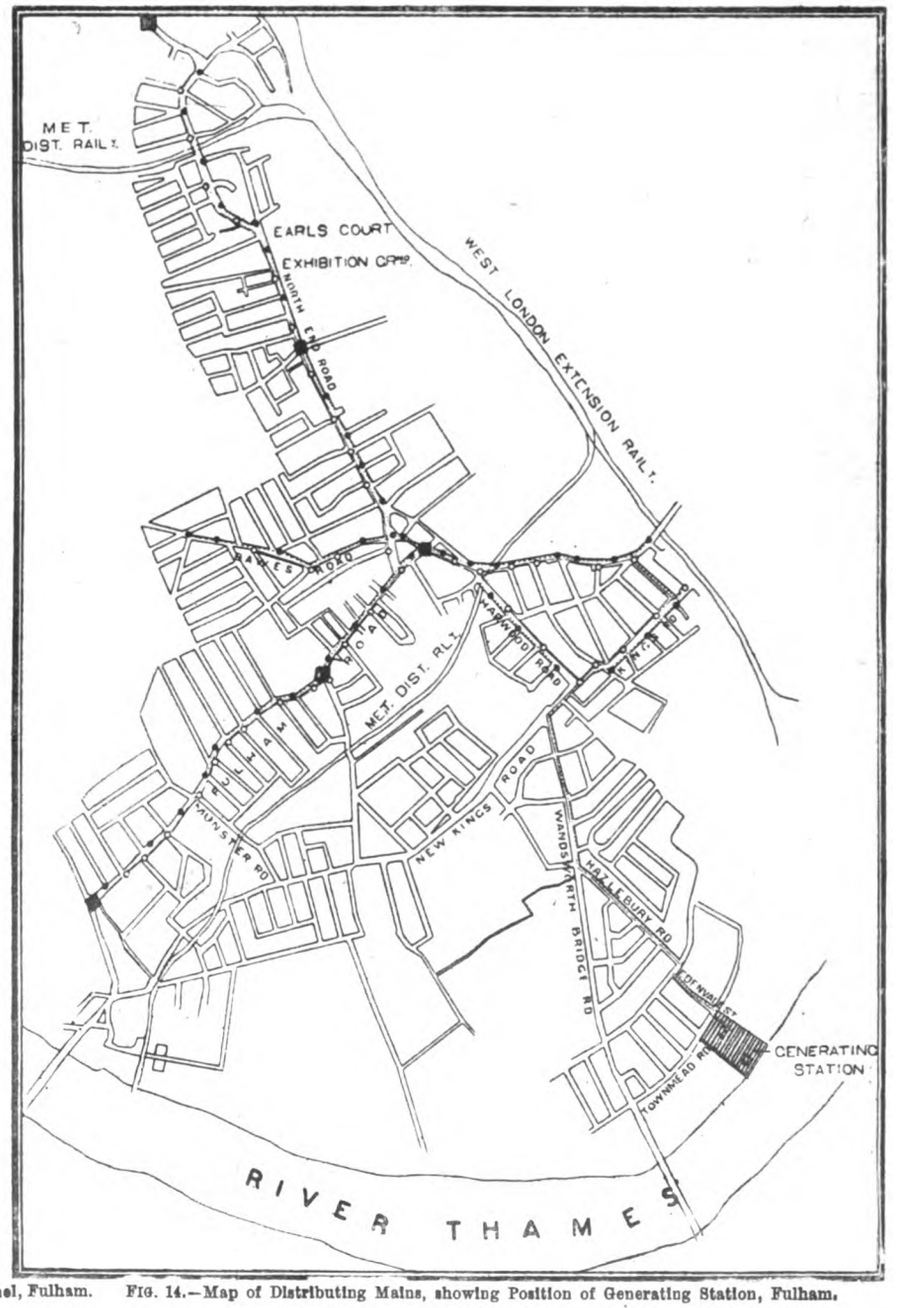


FIG. 13.—Section through Ferranti Switchboard Panel, Fulham. FIG. 14.—Map of Distributing Mains, showing Position of Generating Station, Fulham.

and, in the case of the high-pressure cables, lead-covered cables.

MAINS.

The cables for public and private lighting purposes were supplied by the British Insulated Wire Company, Limited, and are concentric, lead covered, yarned outside, and compounded. They are drawn into Doulton conduits under the footpaths, and into cast-iron pipes where under roadways. At road crossings, however, wrought-iron pipes embedded in concrete have been used, special reducing pieces of Doulton ware being employed for gradually changing the shape of the ducts from the square form of the Doulton conduit to the round form of the iron pipes. High-pressure feeders for both phases run from the generating station to the sub-stations where the

SUB-STATIONS.

There are at present five sub-stations, each of which contains two 50-kw. transformers, one for each phase. The high-pressure windings of these transformers are connected up to the feeders through quick-break fly-off switches and fuses, while the low-pressure sides are connected up to the distributors through removable spring contact fuses. The switching arrangements, as well as the transformers, are placed in watertight cases, all ironwork is earthed, and a Cardew earthing device fitted to each transformer. Due provision has been made for ventilating the sub-stations, which are lighted with incandescent lamps supplied off the low-pressure bars in the switchboxes. The chambers are all lined throughout with white glazed bricks. With the exception of the refuse destructors and Babcock-Wilcox

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boilers (which were supplied under the Horsfall Company's contract), the General Electric Company, Limited, as contractors, have been responsible for the whole of the machinery and plant so far described.

Public Lighting.

The public lighting consists of 86 arc lamps carried on posts of ornamental design, bearing the borough arms, and run in two circuits of about half the number on each. The lamps are 12-ampere, 32-hour, double-carbon lamps of the General Electric Company, Limited, standard type, fixed about 25ft. from the ground. Brackets are also provided on each post for two 32-c.p. incandescent lamps, which are automatically switched on when the arc lamps are switched off or fail. The well-known Edmunds's switch is employed for this purpose, and is fixed in the base of each lamp-post. This switch, it may be mentioned, has recently been redesigned and improved. The lamps are supplied with current through the rectifiers at the generating station, and the two circuits have been so arranged that in the event of one circuit failing the street-lighting would only be reduced by one-half, and no district would be placed in darkness. On the map of the distributing mains (Fig. 14) the positions of the arc lamps on the two circuits are distinguished by white and black circles, while black squares mark the positions of the sub-stations.

Private Lighting.

Private consumers will be supplied at a pressure of 200 volts, while for motors both a single-phase and a two-phase supply will be at hand. The charge for lighting purposes is 5d. a unit, and for motive power 2½d. a unit during the hours of daylight. No meter rent will be charged. No free-wiring contract has been entered into, but it is satisfactory to note that the number of applications for energy already amount to an equivalent of some 10,000 8-c.p. lamps.

Station Lighting.

With the exception of the offices, the cables are carried in watertight "Simplex" steel conduits. There are six distribution boards, to which the current is transmitted from the works' lighting board, which is placed under the switchboard gallery in the engine-room. The inclined roadway and destructor house are lighted by eight 12-ampere arc lamps, four similar lamps being suspended from swivelling brackets of handsome design, two on either side of the engine-room. There is also a large number of incandescent lamps, and wall plugs have been provided at all points where hand-lamps will be required for inspecting and cleaning purposes.

Coal-Handling Plant.

Coal will be brought to the station by water, and will be raised from the lighters alongside the quay by a steam crane fitted with a Hone's patent grab. It will then be dropped into an Ingrey weighing machine, which automatically weighs, records, and discharges the loads, and adds up the successive quantities passing through the machine. After being discharged from the shoot of the weighing machine, the coal is conveyed to the top of the bunker by an electrically-driven elevator (a section of which is shown in Fig. 15), whence it is deposited in different parts of the bunker through shoots.

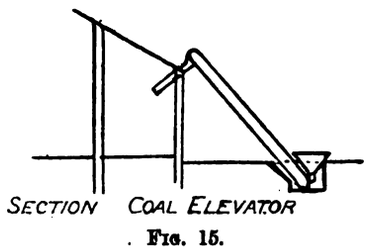


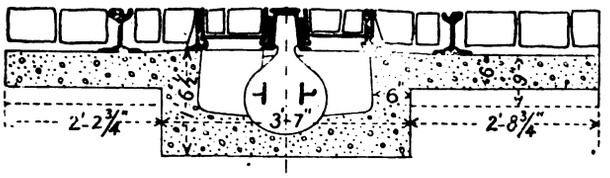
Fig. 15.

Opening Ceremony.

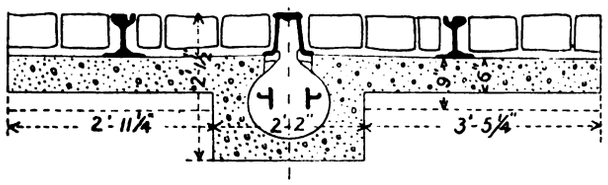
The formal ceremony of switching on the electric light in Fulham was performed by the Mayoress (Mrs. Cornwall) yesterday afternoon, when a large number of guests were present by invitation. Throughout the proceedings were eminently successful, and, we trust, will mark the inauguration of a successful undertaking.

LONDON COUNTY COUNCIL CONDUIT TRAMWAYS.

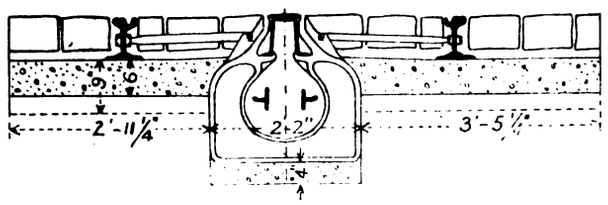
In further reference to the inspection last week of the short length of conduit line such as the London County Council propose to adopt for their tramways, we are now able to give sections of this conduit, and have thought it well at the same time to reproduce some typical sections of other conduits which have been constructed elsewhere. This will enable our readers to compare the details between the various systems, and to see in what respect the conduit of the London County Council will differ from these other conduits which have been worked with more or less success up to the present time. In Figs. 1, 2, and 3 we give typical



SECTION THROUGH INSULATOR PIT



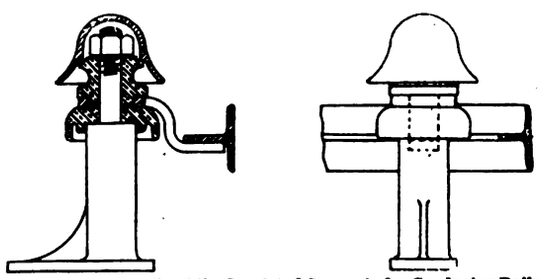
SECTION THROUGH TUBE



SECTION THROUGH YOKE

Figs. 1, 2, and 3.—Sections of the L.C.C. Conduit.

sections through the track and conduit as proposed to be laid by the London County Council under the advice of Dr. A. B. W. Kennedy. In Fig. 1 it will be noticed that the insulators are not shown in the insulator pit. These insulators could be seen in the photograph reproduced in our last issue. Figs. 4 and 5 give the details of their construction. The foot of the cast-iron pillar which supports



Figs. 4 and 5.—Details of the Insulated Supports for Conductor Rails.

the insulators carrying the gunmetal strap for the conducting rails is embedded in the concrete midway between two yokes. The position is such that if one looks down a conduit there will be no part of the insulators projecting into the fairway. Coming now to other types of conduits, we give in Figs. 6, 7, and 8 the sections of the conduits got out by Mr. Clifton Robinson for the London United Tramways Company. It will be seen that in these the insulators are supported from above much in the same way as is done in the American systems illustrated below. The yoke pieces, however, are made to carry the running rails, which can be securely fixed to the same in the method shown. Fig. 9 is a type of conduit used on the Third Avenue Railway in New York. This

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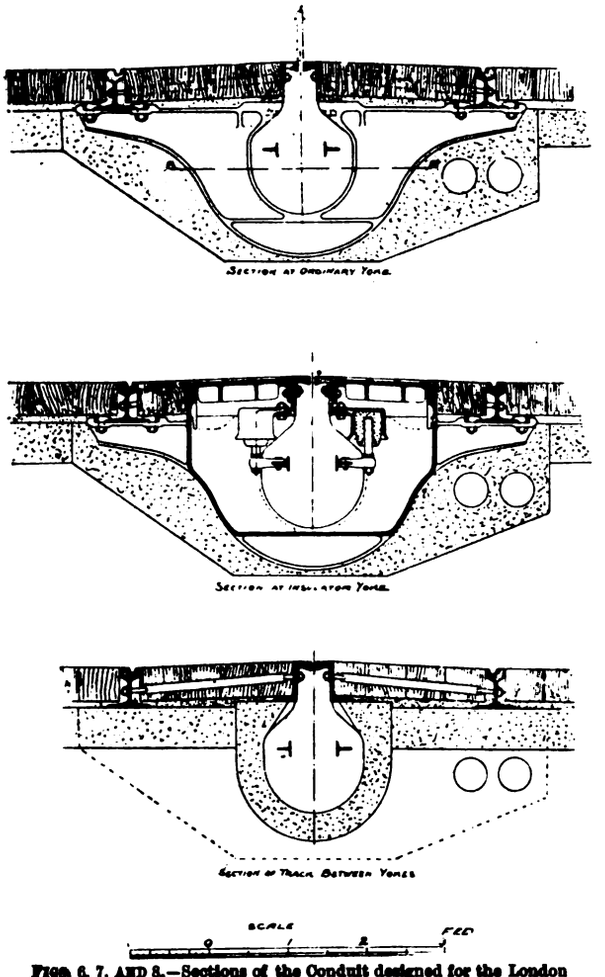
conduit was constructed in 1898, and in it the insulators supporting the conducting rails are attached to insulators which are bolted on to the sides of the conduit rails. Fig. 10 shows a conduit as first constructed for the Lennox-avenue Tramway in New York, in which the insulators were supported from below. The vertical



FIGS. 6, 7, AND 8.—Sections of the Conduit designed for the London United Tramway Company.

supports 8in. in diameter, which are seen in the illustration, were made of soapstone, but these were found not to give satisfaction. They were placed in chambers at the side of the conduit much in the same way as are the insulators in the London County Council system, and the dirt collecting in the bottom of the conduit was found to be forced up round these insulators when cleaning out the conduit, with the result that the insulation gave way. As a result this method of insulation was abandoned, and the method shown in Fig. 11 adopted. Here again, it will be seen, the insulators which support the running rails from above are secured to the conduit rails. In order to remove an insulator, a special key was required to loose the connection between the live conductors and the metal support carried by the insulator. This was not such an easy operation as is the removal or renewal of the insulating supports on the London County Council's system. It will be noticed that here again the running rails are supported on the yoke pieces, which are so formed as to give a strong backing to prevent the rails being forced inwards due to any expansion of the pavement. Fig. 12 illustrates the shape of the yoke pieces on the Paris tramways, while Fig. 13 is the latest type of yoke as employed by the Westinghouse Company. A critical comparison between these various types and the design which the London County Council propose to adopt, will show that the latter is the only example in which the running rails

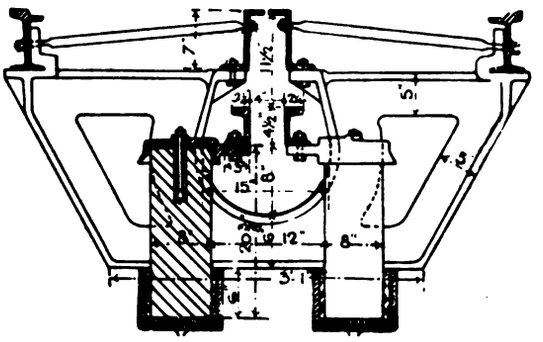


FIG. 10.—The First Lennox Avenue Conduit with Insulators Supported from the Bottom.

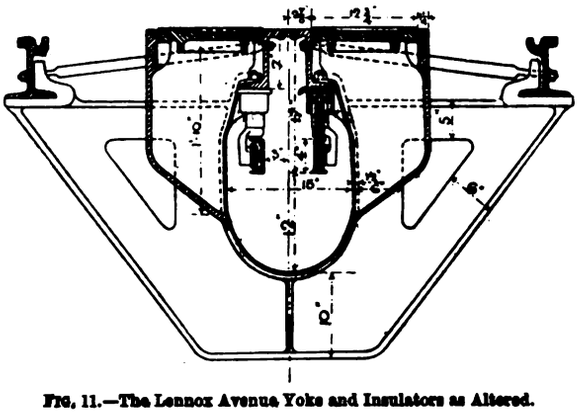


FIG. 11.—The Lennox Avenue Yoke and Insulators as Altered.

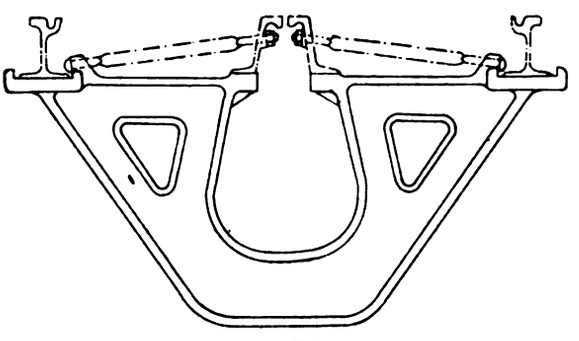
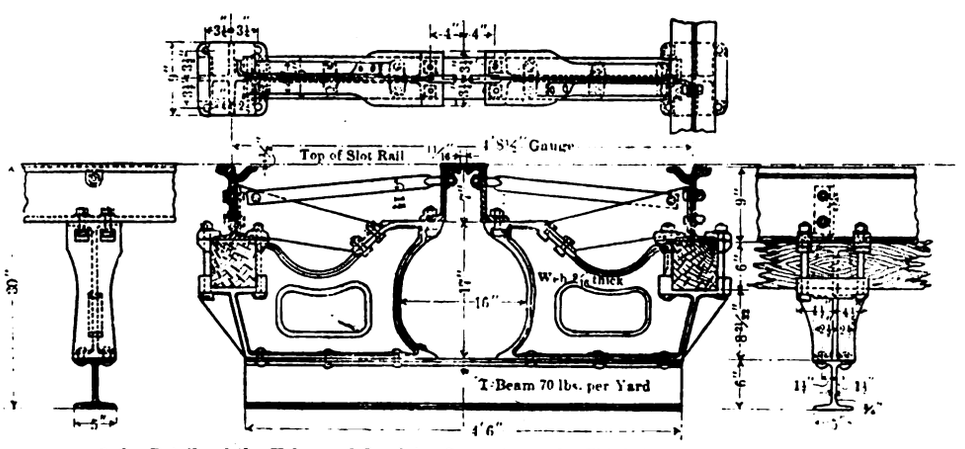


FIG. 12.—View of Yoke used in Paris.



G. 9.—Details of the Yokes and Insulator Supports on the Third Avenue Railway, New York.

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are not carried on the yokes forming the conduit. These rails are tied to the yokes by tiebars, which will prevent the rails from spreading, but which will be of little or no service against compressive forces tending to close the gauge and the conduit slot. The running rails will have a certain hold on the concrete bed, which will enable them to relieve the yokes of a certain amount of such forces, which are caused by the expansion of the pavements. When wood blocks are used for the pavement the forces exerted are very great, and it seems to us that it would be advisable to so form the concrete bed under the track that it can take part of the strains so caused. This could be done by filling in the angle between the 8in. bed of concrete under the rails and the concrete of the conduit.

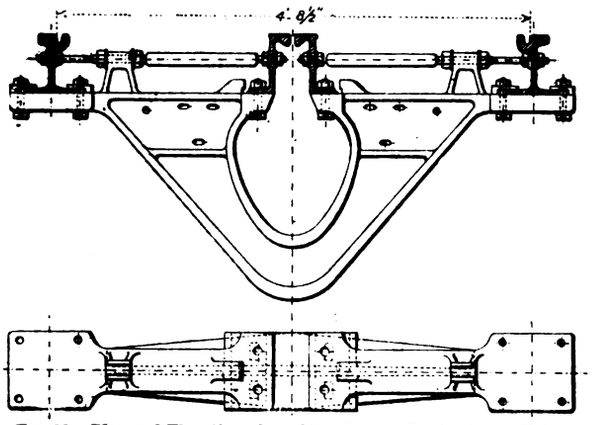

FIG. 12.—Plan and Elevation of the New Type of Westinghouse Yoke.

Another point on which the London County Council design seems to be open to question is that of the clear space between the bottom of the conduit and the two conductor rails. This scales from the sections supplied to us at 4in., whereas the clearance in the other types of conduit is over 6in. in every case. It is clear that these conductor rails could be raised slightly in the first-mentioned duct, and this would give more safeguard against failure of insulation when dirt accumulates in the duct, or when it is being cleaned out. It would, however, be better to take a greater depth from the roadway rather than to prejudice the success of the undertaking.

LIVERPOOL ELECTRICITY ACCOUNTS.

The accounts of the Liverpool Corporation electric supply department, just to hand, show a total expenditure to date on capital account of £1,048,558. Abstracts of the revenue account and balance sheet are given herewith.

REVENUE ACCOUNT.

Expenditure.

Dr.				£ s. d.
Generation of Electricity.				
Coal (including cost of unloading, etc.)	£28	943	19 7	
Oil, waste, water, and stores		3,172	11 0	
Wages at generating stations		7,930	17 8	
Repairs and maintenance: buildings, £311. 5s. 6d.; machinery, etc., £2,405. 18s. 8d.		2,717	4 2	
				42,764 12 5
Distribution of Electricity.				
Wages		1,242	0 8	
Repairs and maintenance of mains		829	9 8	
Repairs and maintenance of meters		538	2 0	
Repairs of machinery at distributing stations		619	0 6	
				3,228 12 10
Rents, Rates, and Taxes.				
Rents		1,817	12 11	
Rates and taxes on buildings, etc.		4,865	6 5	
Rates and taxes on property		23	14 10	
				6,706 14 2
Special Charges.				
Insurances		381	9 9	
Expenses for certification of meters		221	10 0	
Proportion of cost of management of Liverpool Corporation stock		188	1 4	
Stamp duty on ditto		149	6 7	
Repairs and maintenance of property		88	14 9	
Auditor's fees		26	5 0	
				1,055 7 5
Management Expenses.				
Salaries—engineer's department		5,621	9 2	
Contribution to the City fund		2,000	0 0	
Stationery, printing, and advertising		423	2 2	
General establishment charges		491	13 11	
				8,536 5 3
Amount written off for bad debts				43 19 11
Balance carried to net revenue account				47,478 9 8
				£109,814 1 8

Cr.	Income.	£ s. d.
Sales of energy for lighting and power		72,055 13 3
Ditto public street lighting		1,764 3 8
Ditto electric tramways		30,596 17 6
Rental of meters		2,029 6 4
Rents of property		822 11 5
Manufacturing account — sales and repairs, £23,219. 17s. 1d.; less wages and material, £20,674. 7s. 7d.		2,545 9 6
		£109,814 1 8

BALANCE SHEET.

Dr.	Liabilities.	£ s. d.
Loans as per capital account		817,818 15 10
Sundry creditors		51,106 19 3
Surplus and sinking fund		82,499 2 2
Cancelled debt account		18,500 0 0
Bank balance due to the Bank of Liverpool		159,521 13 4
		£1,129,446 10 7

Cr.	Assets.	£ s. d.
Land, building, plant, etc.—amount expended		1,048,558 14 1
Stocks on hand		3,133 6 9
Sundry debtors		41,868 6 0
Investment of sinking fund		35,886 3 9
		£1,129,446 10 7

FORTHCOMING EVENTS.

FRIDAY, FEB. 22.

Institution of Mechanical Engineers.—At 8 p.m., extra meeting. Adjourned discussion on "Light Lathes and Screw Machines," by Mr. John Ashford.

SATURDAY, FEB. 23.

Institution of Electrical Engineers.—Students' visit to the Bankside works of the City of London Electric Lighting Company, Limited.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Sound and Vibrations" (Lecture I.).

Institution of Junior Engineers.—At 2.30 p.m., students' visit to the Willesden station of the Metropolitan Electric Supply Company.

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "Mond Gas, its Production and Use," by Mr. A. Rollason.

London County Council.—At 5.30 p.m., formal opening of the electric light installation for Victoria Embankment and Westminster Bridge.

MONDAY, FEB. 25.

Royal Institution.—At 3 p.m., Prof. J. A. Ewing on "Practical Mechanics" (Lecture VI.).

Society of Arts.—At 8 p.m., "The Bearings of Geometry on the Chemistry of Fermentation," by Mr. W. J. Pope (Lecture III.).

TUESDAY, FEB. 26.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper on "The Use of Storage Batteries in connection with Electric Tramways," by Mr. G. A. Grindle.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "The Rotatory Process of Cement Manufacture," by Mr. W. H. Stanger.

WEDNESDAY, FEB. 27.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the electrical works of the London United Tramways, Company, Chiswick.

THURSDAY, FEB. 28.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper on "Cables," by Mr. O'Gorman, if the discussion of Mr. Madgen's paper be concluded.

FRIDAY, MARCH 1.

Royal Institution.—At 9 p.m., discourse by Mr. Henry H. Cunynghame on "Enamels."

SATURDAY, MARCH 2.

Royal Institution.—The Right Hon. Lord Rayleigh on "Sound and Vibrations" (Lecture II.).

North-East Coast Institution of Engineers and Shipbuilders. General meeting at West Hartlepool.

Institution of Electrical Engineers.—Students' visit to the generating station of the London United Tramways Company, Chiswick.

General Electric Company.—Annual dinner.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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THE PROPOSED VISIT TO BERLIN.

It may seem somewhat premature to discuss a visit proposed to be held next June, but all business men know the necessity of very early knowledge in order to make the requisite arrangements to be absent for a few days from business. For many years past the Iron and Steel Institute has arranged a biennial visit of members to centres of the industry outside the United Kingdom. Hence, whatever may be said to the contrary, the members of that institute have a very accurate personal knowledge of the methods pursued and the organisation followed by foreign ironmasters. It may be taken for granted that the broad principles followed in any great industry are more or less well known to every member of the industry throughout the world—the value of personal examination and conversation is in making men more fully acquainted with details. We have long held that the man is most successful who in his design pays greatest attention to details, and more particularly is this the case in all that relates to electrical engineering. Another point of considerable value in the examination of other folks' practice is that the conditions under which that practice is successful will be seen, and probably instead of indiscriminately praising what has not been seen, it will be realised that the conditions are somewhat different to those that hold in any given case. Thus we have often been asked why British engineers do not avail themselves more of water power, like the Swedes and Swiss, though when the questioners are asked to say where water power is available their geography is at fault. Then the battle of the phases has to be fought, and it is often forgotten that a system of supreme importance under one set of conditions is not so important under another set of conditions. No amount of descriptive or illustrated printed information will replace personal inspection. These views will serve to show why we advocate such visits as that proposed to Berlin. There are other reasons which might be urged. Applied science is cosmopolitan. Civilisation desires to see the progress of the whole world onward and upward, and whatever means are taken to bring the best educated men of different nations together to get them to exchange views and socially to rub shoulders is of value, and tends towards a millennium. But to our immediate object. Our readers know that during the visit to Switzerland a hearty invitation was given to visit Berlin, and Prof. Perry, the president-elect, expressed his wish that the invitation should be accepted. Subsequently a formal invitation was given by our *confrères* at Berlin, and accepted. The provisional programme is of a double character, providing for a visit to Berlin and then to take part in the annual meeting of the Verband Deutscher Elektrotechniker at Dresden. The time required to go through the whole programme will be from June 22 to July 5 or 6. So much has been said of foreign competition that it might be worth while to recall a fact perfectly familiar to all of us. In some way or other a large number of our American friends do find time and money to visit and inspect the works and the factories in Europe. Unless such visits had

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a money value, we may be sure they would not be made; hence why not take a leaf out of the book of those who are supposed to have made such vast strides that we are to be left out in the cold. It might be worth while also for the younger members of the profession to note that the majority of successful men are those who have made it a practice to go about most and to see most, thus gaining experience; and in the long run it is experience that pays.

THE METROPOLITAN DISTRICT RAILWAY.

The electrification of the Metropolitan District Railway progresses about as quickly as is to be expected, seeing that the would-be purchasers of electric plant have not at their present command sufficient means to pay for the new equipment. In the meanwhile a fight as to the best system is going on between the Ganz Company, who sent in the lowest tender, and their next competitor, the British Westinghouse Company. It is a contest between locomotives with alternate-current motors working at about three thousand volts on the one hand, and direct-current motors distributed throughout the train on the other hand. The directors will in the meanwhile have the question of acceleration brought prominently before them, and we trust that they will not sacrifice the economy of running and speed of service when coming to their decision.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ENGINEERS AND PROFESSORS.

SIR,—The difficulty that occurs to everyone who heard the late discussion at the meetings of the Institution of Electrical Engineers, and the applause which greeted the reference not only to "professors" but to "rows of them," was the apparent inability of the meeting to understand the simple question before them

Mr. Mordey had described one solitary test made on one solitary cable. He gave no details of how it was carried out, or what steps he had taken to avoid obvious risk of error. From this single result he drew generalised conclusions, which he apparently intended us to apply to any cable with any dielectric. Even if he had taken all the possible precautions to ensure accuracy, it would have been unwise to apply his result to another indiarubber cable, working at any electric pressure, and it would have been impossible, without further test, to have applied it to, for instance, a paper cable.

Is it unfair to describe his action in laying so crude a compilation, with conclusions for the guidance of engineers, based on so superficial an investigation before a scientific engineering society as (to say the least) very uncomplimentary to the intelligence of his audience? May we not also regard with some indignation his apparent attempt to secure applause by his remarks about "engineers and professors"?

Again, do those who may think that Mr. Mordey has done a service to science by extracting from Prof. Ayrton the result of the valuable investigations which were laid before the meeting on Thursday, consider that the *rôle* of the engineers is to put forward wholly erroneous conclusions for the professors to expose?—Yours, etc., M.I.E.E.

ELECTRICAL ACCESSORIES.

SIR,—In commenting upon the list of approved fittings issued under the system of registration adopted by the Manchester Corporation, you state that "in a number of instances the catalogue prices are given opposite the makers' names." I can only suppose that you have inadvertently written prices for numbers, as in no instance is a price given, though wherever catalogue numbers exist these are inserted for purposes of identification. I should be much obliged if you would make this point quite clear in your next issue, as it would be altogether foreign to the purpose in view, and in my judgment most improper, for prices to be attached to such a list.—Yours, etc.,

Feb. 18, 1901. C. H. WORDINGHAM.

[Mr. Wordingham is correct in his surmise that "catalogue number" was intended, and not "catalogue prices." We think this is clear from the context.—ED. *E. E.*]

INSULATION TESTS.

SIR,—*Re* answer to question No. 342, which is printed in your issue of Feb. 8, and signed "A. H." The primary and first portion of the answer to this question is based upon the formula,

$$F = \frac{d^1 - d^2}{2\,d^2 - d^1} \cdot r^1,$$

F being the resistance of the fault.

I beg, Sir, to call your attention to the fact that this formula is erroneous, and give below the reasoning for the correct deduction of a formula to suit the conditions of the question.

We start with the same hypothesis as "A H." Two readings are taken on instrument A, first with resistance, r, in series, and, secondly, with shunt r_1, which is equal in resistance to r plus the resistance of the instrument, which we will call G.

From this we have—

First reading: $$d^1 \propto \frac{1}{F + (r + G)} \quad \ldots \quad (1)$$

Second reading: $$d^2 \propto \frac{1}{F + \frac{(r+G)\,r^1}{(G+r)+r^1}} \quad \ldots \quad (2)$$

Now, $r + G$ is made equal to r^1. $\therefore$ substituting and dividing (2) by (1):

$$\frac{d^2}{d^1} = \frac{1}{F + \frac{r^1}{2}} \times \frac{F + r^1}{1};$$

$$\therefore \frac{d^2 - d^1}{d^1} = \frac{\frac{r^1}{2}}{F + \frac{r^1}{2}};$$

$$\therefore F = \frac{\frac{r^1}{2} \cdot d^1}{d^2 - d^1} - \frac{r^1}{2};$$

$$\therefore F = \frac{r^1 d^1 - r^1 d^2 + r^1 d^1}{2\,(d^2 - d^1)}.$$

Hence $$F = \frac{2\,d^1 - d^2}{2\,(d^2 - d^1)} \cdot r^1.$$

This is a correct solution to the problem as stated in the answer to question No. 342, and is obviously very different to the formula published, which gave

$$F = \frac{d^1 - d^2}{2\,d^2 - d^1} \cdot r^1.$$

Yours etc., H. PIERSON.

DIELECTRIC HYSTERESIS.

SIR,—In the tests made at Silvertown and Prescot on dielectric losses, instead of arranging all the drums of cable merely in series, we tapped the inner and outer conductors at several points along the length so as to reduce the copper losses in the cable to a negligible amount, and thus get a more exact value of the hysteresis loss.

In testing the laid cable of the County of London Company on Thursday, the 14th inst., it was, of course,

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impossible to reduce the copper loss in this way, and the number given by me at the Institution of Electrical Engineers for the power factor of that cable—viz., 0·033—included the copper loss. Making, however, the proper correction for the copper losses in cable, leads, and instruments, the power factor for dielectric hysteresis alone is reduced, I find, to as low a value as 0·029, a number in close approximation to the 0·028 which we obtained at Silvertown on Feb. 1 on another long indiarubber cable.—Yours, etc., T. MATHER.

THE LONDON COUNTY COUNCIL TRAMWAYS.

SIR,—There is nothing more enthralling than criticism of the truly great. And thus the few faults of England bring a joy to the nations. But the game carries little credit in England, because sins are not concealed. They are easy to find, not being subtle, and it is seen that the faults of a great people are as those of a child. While some nations are committing unheard-of crimes—real mistakes, I may say—England is convulsing the gods by her methods in learning certain new steps. I am thinking of electric traction.

England invented the dynamo, and she told us how to design the motor. She went into the question of electric telpherage at an early date, and in her learned societies she has for long shown her grasp of the theory of motor working. In fact, Sir, what small part could I write down in the space at my disposal of what England has done?

But is there sarcasm lurking in these words? I assure you, Sir, it is but the attribute of a greater chagrin. For, although I am one of the critics on the frontier, my heart is with the inventor of the motor rather than with them who are cock-sure about electric traction. But it is annoying to see her so embarrassed in the practical application of her invention. I suppose embarrassed is the word.

On Thursday last I had the honour of seeing the London County Council's demonstration of the conduit system of electric traction. There you had your car started and stopped as if by magic. The wonderful and invisible force had been harnessed with signal success. Seats inside and out, every luxury, and all the appointments carried out charmingly. The new electric light (which could be turned on and off at will), and all this with no clatter of horses' hoofs nor the harsh tones of an over-persuasive driver. I know that electricity is in its infancy, but that demonstration, Sir——

Seriously, the incident was like a dream of 1886; the same success, the same plans laid to ignite an enthusiasm. It made one feel old; it made one feel that, in view of the perfect commercial success, the suburban success, the urban success, and æsthetic success of the electric tram; in view of the years of happy trial of that same car, say, it made one feel that there were a great viscosity of intellect—an hysteresis of wit somewhere—to be explained away.

On perusing the pamphlet supplied the same spirit was found: ". . . (5) *Going backwards and forwards at will;* and ascending *steep gradients*, if desired, *without diminution of speed*" The same *motif*. I felt that there was some mystery in the attitude of half-doubt conserved since 1886.

But when the speeches began all was explained. It was clear that the gentlemen of the London County Council and of the City were in no way unacquainted with the real state of affairs. They were obliged to teach the sloth mind of a controlling *Demos;* they had to repeat old saws for his enlightenment; and the electric car had to be shown as a sudden triumph in order that the crowd would look up, as it were, and smile.

Mr. Dickinson, the chairman of the wise London County Council, spoke kindly to those who might still be uncertain as to the success of electric traction, and he gained his point. He was followed by Mr. Williams Benn (chairman of the Tramways Committee), who showed reasons and figures, and if anything could move the crowd it was the vision of earnings which he gave. As a representative of the interest which the City takes in matters of municipal progress, Mr. Sheriff Lawrence also spoke of the benefits of electric traction, and gave some interesting and sound advice. In other words, some of the most representative men in municipal affairs and in industrial development in this country had to appeal to the people, not only by the weight of their own approbation, but with tangible proof of long standing, before one could see a glimmer of chance that the electric tram would be acclaimed by the multitude.

Now, in doing what was necessary (a sad necessity) the Tramways Committee did well, except in one particular. Surely, if it is necessary in the twentieth century to go to such ends that backward people may be convinced, it is paramount that everything used in the demonstration should be of a high order of long-tried excellence. How, then, is it that a questionable section of conduit track was shown to the innocents as the best to be had in the twentieth century? I remember the troubles of 1887 and 1888 in—was it Budapest?—when good castings were made according to good drawing-office practice and laid in the streets to stand the stress of time and weather. Nothing was right and nothing was heavy enough. And it took several years to find the proper way to make conduits, simple as they seem.

In the section of conduit shown, few of the results of experience seemed to have been followed. The structure is far too flimsy, and is not, I venture to say, a good design from any standpoint. Obviously, if there is any question about the sort of installation the Council is to have, it should be settled now. With the heavy traffic and the frequent rain in London, and with the predominance of wood paving (which expands and leads to trouble), it is important to instal a lasting sort of railway. In America, bad systems can be put up to-day, can blow up to-morrow, and be superseded the day after by the best thing in the world. *Demos* likes the sense of progress thus attained, and, in spite of all explosions, gets the good thing in the end which is always near.

How impossible were such methods here! After seeing the efforts of the London County Council last week in Camberwell, one feels that a tragedy is afield unless the people have a tried and known thing. A complete proposition should be got from people who have built electric railways and have run them with success.—Yours, etc., M. B.

Feb. 20, 1901.

THERMOSTATIC FIRE-ALARMS.

We have this week been privileged to inspect in the showrooms of the General Electric Company, Queen Victoria-street, E.C., an invention of Mr. Musgrave Heaphy, C.E., in connection with thermostats for giving an alarm of fire. The thermostat, consisting of an ordinary thermometer with a wire fused into the bulb and another wire fused into the stem of the thermometer at the point corresponding to the temperature at which an alarm is required, is an old device, and one which has been largely used with the object of protecting buildings and private houses. The efficacy or otherwise of these fire-alarms is determined very much by the way in which they are fixed, and it is obviously requisite that they should be placed in such positions that a fire in any part of the room in which they are situated should quickly raise their temperature up to the alarm point. The details as to position, however, are usually left in the hands of the electrical engineer who fixes the thermostats. Mr. Musgrave Heaphy's invention was designed with the object of ascertaining if the thermostats when once fixed are maintained in good order. The old method of applying a burning match to the bulb of the thermometer does not commend itself to the person who is particularly anxious to guard against fire, but this has been up to now the usual method of ascertaining whether the thermostat's connections between the mercury and the wires are in good order. It is apparent, also, that this test can frequently not be applied quickly owing to the inaccessible positions of the thermostats and other obvious reasons. Mr. Heaphy's invention provides a source of heat at the thermostat. For this purpose he runs a third wire from the indicator board to each thermostat in the building. This wire ends in a coil of high-resistance material placed near the bulb of the thermostat, but

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the exact details of the arrangement we are debarred from giving at the present, owing to the fact that certain foreign patents have not yet been completed. At the indicator board a multiple-way switch enables a six-volt battery to send a current to the resistance coil of any thermostat. The resistance of the circuit is such that the resistance wire is heated only slightly above the temperature at which an alarm is given. With the apparatus we saw recently at the General Electric Company's showrooms, it took about half a minute for the current to bring the mercury in any thermostat up to the alarm temperature and to complete the circuit. We also found that the temperature of the resistance wire was not sufficiently high to prevent one holding one's thumb on it while the heating-up process was going on. If, then, Mr. Musgrave Heaphy's invention be adopted, the person responsible for the inspection of the fire-alarms has only each day to move the multiple-way switch from one contact on to the next to prove that the various thermostats one by one are in order. We think the idea is an exceedingly good one, and there should be absolutely no difficulty in making the details exceedingly durable. The great advantage of the apparatus is that it not only proves that the mercury contacts within the thermostats are working satisfactorily, but that the wires from the thermostat to the indicator board and alarm bell are also in good condition. The invention prevents false trust being placed on electrical fire apparatus which might be out of order when required to give an alarm. It is only right to say that Mr. Heaphy does not consider his invention, or any other electrical alarm, to be any valid reason for demanding a reduction in the fire insurance premiums for any premises. In our opinion electric fire-alarms are an additional precaution against excessive damage from fire, as they can be made to give a prompt alarm in case of an outbreak. For buildings containing valuable original papers and works of art which cannot be replaced, such precautions become necessities.

THE LANCASTER CORPORATION AND THEIR ELECTRICAL ENGINEER.

[From a Correspondent.]

The attitude of the Lancaster Corporation to their electrical engineer, Mr. Alan Fraser, is being much canvassed in the town, and both among the public and the members of the Council there is a growing body of opinion that Mr. Fraser has not only been shabbily treated, but that the Corporation have distinctly broken faith with him.

The genesis of the affair dates back to the time when the war fever was at its height. Mr. Fraser had been the electrician only about a year when the war broke out. He was, it appears, a member of a southern yeomanry regiment, and when the Government began appealing for mounted volunteers he was one of those who gave in their names for service. He was accepted, and intimated the fact to his committee. Not a single obstacle was placed in his way. The Corporation had already granted a constable unlimited leave of absence, they had taken charge of the colours of two Lancaster regiments at the front, and were full of martial enthusiasm. Mr. Fraser was granted unlimited leave of absence, was given a grant of £1 a week whilst away, and his assistant had 10s. a week extra put on his salary for doing Mr. Fraser's work while he was away. Moreover, Mr. Fraser was given a hearty send-off, the Mayor, we believe, being present, and with the hurrahs of the townspeople in his ears and a few substantial gifts in his pockets from the Corporation staff he set out for the seat of war.

The trouble began six months after Mr. Fraser had been away. The Corporation carried a Bill through Parliament giving them power, among other things, to construct a system of electrical tramways within the borough. Nearly all the specifications for this had been got out by Mr. Fraser before he left Lancaster. When the Bill was passed, and the Council began to think about making a start with the work, a difficulty presented itself. Who was to do the work? Who was to be the engineer-in-charge? At first it was thought that the present staff, with the borough surveyor as engineer, could make a beginning, leaving it to Mr. Fraser to take charge when he returned. But that was altogether unsatisfactory. It would never do to have divided authority. Even if the borough surveyor's staff knew sufficient about tramways to erect stations, lay down extra plant, purchase tramways, etc., it was hardly fair to them or Mr. Fraser that the responsibility should be cut into halves, and that Mr. Fraser should be made responsible for the completion of a scheme with whose initial steps he had had no concern. So this idea was dropped. Another alternative was to appoint a new engineer altogether, leaving it until Mr. Fraser returned to reconcile the two positions, and see how the two engineers could adjust their positions. Strangely enough, it seems to have occurred to nobody that Mr. Fraser had gone away as chief electrical engineer, that he had been promised his place intact on his return, and that any interference with it would be in distinctly bad taste.

However, matters progressed. First, it was decided to appoint a tramways engineer, leaving Mr. Fraser in charge of the lighting station. One difficulty was that the proposed appointment was to be under the borough surveyor, and as he was not an electrical expert it was found that friction would arise. Nobody would be tramway engineer and be placed under the control of a man with no special aptitude for electrical work, however able in his own department as surveyor and water engineer. This was seen when the answers to the advertisement were considered, for the applicants to a man declined to serve under the borough surveyor. Then the committee decided to appoint a separate tramways engineer, supreme in his own department, with Mr. Fraser as lighting engineer. Meanwhile, not a word had been said to Mr. Fraser. The committee had made no attempt to communicate with him. They carried their resolution in committee, and at that stage Mr. Fraser returned and unexpectedly arrived on the scene. The point to be remembered is that he had assisted in the preparation of a tramways scheme, that he had left Lancaster on unlimited leave of absence as chief electrical engineer, and that he returned to find that a new chief engineer had been appointed by the committee; that the tramway work was altogether taken out of his hands, and that the only department left to him was the lighting station. Some of the Council argue that he is where he was when he went away. The answer to that is found in a sentence. He went away first engineer; he returned to find himself second man, the appointment having been made the week before he arrived back in town. The resolution was only carried in full Council after a very acrimonious debate. It excited more bad blood than any other local question of previous years. The fact is that there began to arise in the minds of some members of the Council an uneasy feeling that Mr. Fraser was being shabbily treated, and it was their attempt to revoke the appointment, or at any rate to secure a different status for Mr. Fraser, that led to the anger which disturbed the usual placidity of the Council-chamber.

The situation now, therefore, is this. Mr. Fraser, the old engineer, who did so much to make the work of the Corporation easy in pushing their Bill through Parliament, has been "relieved" of any responsibility in carrying out the details of the scheme. That is the euphemism of the Corporation. A plain man would say he had been supplanted. Of course, in stating these facts, no hostility is shown to the gentleman who has been appointed to the work of laying down the tramways. The idea is to give full publicity to the facts. And on these facts the present writer thinks the reader will ask two questions: First, why could not the whole matter be left over until Mr. Fraser returned? Second, before he was supplanted would it not have been fairer to have first given him an opportunity of saying whether he would care to undertake the work? To some who may still believe in the old-fashioned virtue of keeping to a bargain, there may even arise a third question: Have the Corporation been quite honourable in thus turning their back upon a solemn promise?

[The above, which we have received from a local correspondent, seems to confirm the old adage, "Out of sight, out of mind," and it will not tend to increase the respect with which municipal bodies should be held. Having granted Mr. Fraser leave of absence, the Corporation should certainly have written to him before taking away any of his responsibility. Ed., *E. E.*]

INSTITUTION OF ELECTRICAL ENGINEERS.

Capacity in Alternate-Current Working.

BY W. M. MORDEY.

Discussion.

(Concluded from page 123.)

The discussion on this paper was concluded at the meeting of the Institution of Electrical Engineers on Thursday week last:

The **President** (Prof. J. Perry) first called upon the author to make some observations on what was said at the last meeting.

Mr. Mordey said Prof. Ayrton's criticism on the last occasion amounted to this—that what was new was wrong, and what was old was his. He hoped that the subject might be thoroughly

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thrashed out, so that they might feel at the end of the discussion that they all knew more about it. He wished to make an alteration to the first part of the paper, in which he draw attention to the well-known fact that if you knew your volts, periods of capacity, etc., you could calculate your current, and that instead of measuring capacity by the ordinary methods, you should simply use an ammeter, take the current, and determine the capacity in that way. Prof. Ayrton thought that he (Mr. Mordey) had omitted to give him credit for having known that fact a good many years ago. Of course, he was aware that everybody knew it, but since the last meeting he had been led to look into the matter, as he thought possibly, as all the professors agreed on the subject, it might not be right. He found that in ordinary commercial conditions of distribution the advice he gave to central-station engineers was not wise. He found that the variation might be from 200 to 300 per cent. on a given capacity, the cause being that the ordinary assumption was that the current depended upon the E.M.F. being a sine function. There was not one word said in the warning given them by Prof Ayrton as to the enormous correction that might have to be applied in the use of the formulæ given in the paper, which, he assured them, had been used for many years. He (Mr. Mordey) was somewhat surprised to find that under the ordinary conditions of distribution that rule was not applicable with any degree of accuracy, unless the E.M.F. curve was a sine function. He wished to point out that this introduced a new definition of power factor. If the current varied for a given curve, the power factor might vary in the same proportion.

Dr. Perry here asked Mr. Mordey to leave the rest of his remarks until he was replying.

Mr. C. P. Sparks referred to the statement of Mr. Mordey that capacity in cables was a serious drawback to alternating current work. It was true that capacity was a disadvantage at times of very light load, but this could be largely neutralised by energising a minimum number of cables. In most extra high pressure stations there were two or more feeders leading to every distributing station, and extra mains could be connected as the load rose, thus reducing any inconvenience due to the leading capacity current to one-half or one-third maximum amount as the case might be. As most of the apparatus connected to the system, with the exception of the incandescent lamps, was of an inductive nature, the capacity of the cables became a positive advantage, and improved the load factor. The capacity current and its power factor varied with the character of the dielectric of the cable and the form of wave curve given by the alternator. The instance given by Mr. Mordey was for a rubber dielectric, in which the capacity and power factor were abnormally high. Had a paper dielectric been used in place of rubber the capacity current would not have been more than 30 to 40 per cent., thus decreasing any inconveniences from capacity to about one-third for every mile of cable in circuit. Since the date when the cable tested was ordered and set to work paper had almost entirely replaced rubber as a dielectric for such purposes. This was not only due to its lower capacity, but also to its very much lower price and greater durability. Mr. Mordey also alluded in his paper to the low efficiency of a large alternator running to supply the capacity current. Up to now, with the limited number of extra high pressure stations in England the length of cables had in no case been such as to make the capacity current too much to be supplied by the smallest unit, and although the greater economy might have been reached by using still smaller units at times of light load, it was necessary in case of a sudden demand to have some reserve of power in the working plant. Under these circumstances little advantage would be felt in any existing station if the capacity current was balanced by means of chokers at times of light load, so as to cut down the size of the unit. The figures on which Mr. Mordey had based part of his paper—viz., those relating to the loss of energy in dielectric hysteresis in this concentric rubber cable—were founded upon tests carried out in March last, when the current was reduced from 6 to 1·6 amperes by means of choking coils. Further tests relating to loss of energy followed, the watts being taken with both choker and cable in circuit and on the choker alone. The energy shown was 2,015 watts, or within 24 watts of the test made separately with leading and lagging currents on the choker and cable independently. With regard to the instrument used for measuring the energy, similar instruments had been subjected to tests, the standard of comparison being a Kelvin electrometer wattmeter, specially arranged for alternating-current energy measurements at low power factors, erected under the supervision of the late Dr. John Hopkinson. In testing against this standard it was found that the particular wattmeter used could be adjusted to read true watts on a periodicity of 100 working on an inductive circuit, the pressure being supplied by an alternator giving a sine curve The same instrument read energy within 1 per cent. when connected with an inductive circuit of 50 periods Thus under these conditions there was no periodicity error. He understood that on the last occasion when the paper was discus ed, Prof. Ayrton severely criticised the figures given by Mr. Mordey, taking exception to the loss of energy given, and predicted that if tests were carefully made the loss of energy would be found to be about one-tenth of Mr. Mordey's figure. Since then he (Mr. Sparks) had supplemented the figures previously taken by some other system of measurement. The method chosen was measuring the difference of power required to drive a motor-generator driven by a direct-current motor. The result was that the power factor observed on the cable was ·069, which was considerably lower than the figure obtained by Mr. Mordey—viz., ·124. Two tests were taken on two separate occasions, this result being the mean. Since making these measurements he had received a letter from Prof. Ayrton offering Dr. Mather's services in making an independent test on the particular length of cable referred to by Mr. Mordey. These experiments were made that morning, and he had just received a copy of the results obtained from Prof. Ayrton. The tests were made by energising the 5½-mile length of main from a transformer situated at the Peckham sub-station at a pressure of 2,250 volts. The inflow of current to the main was 6·8, showing that the transformer was giving approximately a sinusoidal wave. The current into the choker, which he understood consisted of 80lb. of copper wire with no iron core, was 6·6. The actual current required to supply the main and choker was 2·7. The energy was measured by means of a Ganz wattmeter. The ammeters were hot-wire instruments, the pressure being measured on the electrostatic voltmeter, and the periodicity being taken with a periodicity recorder. The wave-form was examined with Mr. Duddell's oscillograph. The energy taken by the cable alone, measured with the wattmeter, was 522 watts, and the energy in both cable and choker was 798 watts. Deducting from this the C^2R losses in both they got 503 watts. The test was then made with the choker in series with the cable, when the energy was found to be 703 watts; deducting a C^2R loss in the choker of 281, the energy taken by the cable was 482 watts. The current flowing into the cable was approximately that given by the formulæ for sine curves, and the curve was checked by being examined on the oscillograph. The power factor in each of these cases was ·034, the power lost per mile with the cable at 100 periods, 2,225 volts, being 96 watts. In conclusion, Mr. Sparks considered that the thanks of the society were due to Mr. Mordey for having pointed out the importance of dielectric hysteresis, which, although undoubtedly known to some, had not had the attention of the many. He was aware that by using other dielectrics a lower power factor might be obtained; but from tests on other dielectrics it was clear that on the best cables the power factor was about 1½ times the amount suggested at the last meeting by Prof. Ayrton, while it was possible, as was shown by the figures he had given, in exceptional cases to find a power factor of 3½ times the amount. Under special conditions a power factor as high as ·07 on the observed current of the cable could be obtained, or ·16 on the calculated. It was interesting to see how far these dielectric losses influenced the efficiency of the transmission system. Assuming that the cable was capable of transmitting 600 kw., and was 12 miles long, assuming also that there was a 10 per cent. load factor, and that the cable worked at 6,000 volts, he calculated that of the whole energy transmitted some 2·1 per cent. would be lost in dielectric hysteresis with paper-insulated cables, and about 8·3 per cent. if rubber insulation was employed of the same character as on the cable tested by Mr. Mordey.

Dr. J. A. Fleming referred to the question of dielectric losses in the cable. Mr. Mordey had given them no details in his paper of the experiments to prove the correctness of the wattmeter by which his figures were obtained. At the time the Ferranti cables were laid the question which concerned most people interested was, how much of the 600 h.p. which apparently went to the line was real horse power. In order to ascertain this, the engineer of the station, Mr. P. W. D'Alton, proceeded to take indicator diagrams from one of the engines when running light. He then switched in one cable, and again took indicator diagrams, repeating the operation as he increased the number of cables connected to the alternator driven by the engine. Speaking from memory, Dr. Fleming thought that each cable between Deptford and London took from 10 to 12 actual horse-power, which was equivalent to a power factor of about ·02. Mr. Mordey had been misled by his wattmeter. He would suggest to Mr. Mordey that he should re examine this question, employing another wattmeter or some other method of measuring.

Dr. W. E Sumpner confined himself to two points, one being the power factor and the other relating to a matter which Mr. Mordey had left out of account altogether. The author had given a number of figures as to the watts lost in the cables, but in no case had he referred to the load current, or to the proportion which the capacity current bore to the load current. That proportion depended upon one thing which Mr. Mordey had not mentioned—viz., the percentage drop in volts which was allowable in the line. Taking the case of a 5½ mile cable of $^{37}/_{18}$ under like conditions to those mentioned in the paper, and assuming a drop in the line of 4 per cent., then the capacity current came out at nine amperes The load current would be 77 amperes, as compared with a capacity current of nine amperes. In other words, the load current was more than eight times the capacity current, and, taking Mr. Mordey's figures, the loss in the dielectric was only 1½ per cent. of the full load. Taking the power factor as ·02, which he (Dr. Sumpner) believed to be correct, the loss in the cable was only ¼ per cent. of the full load. How was it that the author had arrived at his result? His point was that it was quite possible for a wattmeter to read absolutely wrongly. In ordinary condensers the power factor was ·02, which corresponded to a current leading 88·4deg. in front of voltage. In fact, this was only about 1½deg. less than the right angle. If, then, the lag in the voltage coil of the wattmeter exceeded 1½deg., the reading of the wattmeter became negative. He should like to know if it was not the fact that Mr. Mordey used a transformer in connection with the voltage circuit of his wattmeter. A transformer would make more than the difference referred to in the lag—*i.e.*, 1½deg. He had experimented with a condenser, measuring the power required for it by means of a wattmeter in connection with a transformer, and by altering the load on the transformer, and the connections of the same, had succeeded in getting readings which varied the power factor as follows: + ·40, + ·02 − ·07, − ·43, − 1·6. He noticed that the author had said that his wattmeter as described in the paper was not independent of the frequency, which really meant that he had a lag in the voltage coil, otherwise it would have been

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independent of the frequency. In fact, he thought that Mr. Mordey's wattmeter might be useful to measure what one knew, but useless to measure anything which was not known.

Mr. J. Swinburne thought the author had brought prominently before the society certain things which were known to many people, but if they were to cut out every paper which would not stand the tests of the Law Courts they would have very little to read. As to measurement in capacity in terms of current, it was an old thing in engineering. Prof. Ayrton had said it was his suggestion, but it was in practice long before. With regard to the dielectric losses, he did not think they had been fully appreciated lately. The whole credit of drawing their attention to this matter was due to Mr. Mordey, whether his figures were accurate or not. About 10 years ago he himself pointed out, in a paper before the Physical Society, the great loss in dielectric hysteresis. It was said then that his experiments were impossible, but the results turned out to be right. As regards condensers, Prof. Ayrton had mentioned some early condensers, but the power factor struck him as being very much higher than he (Mr. Swinburne) found them to be. The condenser could be made now with a very much smaller waste of power than Prof. Ayrton made out. Concerning dielectric hysteresis, Maxwell had pictured a dielectric which lost power as consisting of condensers and resistance in series. It must be remembered that the dielectric loss was intimately connected with the refractive index as regarded light. As to actual loss in cables, he thought that must vary from cable to cable, and he did not believe that even in one make of cable it would be constant. It depended greatly upon the moisture in the cable. There was one way of getting out of the difficulty of dielectric hysteresis, and that was by using a low frequency. There was no difficulty in making wattmeters accurate. They could be easily checked on two-phase circuits.

Dr. T. Mather considered that the power factor of ·124 was far above the average. Even if that were the result on the cable used by Mr. Mordey, he should have tested other cables before he brought general conclusions forward. They must conclude that the author was inaccurate, and his figures ought not to be applied to any general case. In his opinion the use of iron in a choker was a mistake. Through the kindness of Mr. Sparks, he had that day carried out experiments on the actual cable which Mr. Mordey had tested. He used three methods of ascertaining what the power factor required by the cable was, and the mean of the three, which agreed very closely, showed that the power factor was ·033. Other experiments on cables made by the British Insulated Wire Company showed the power factor of ·024, while another cable (indiarubber covered) had given the power factor of ·028. It would be seen from his tests that Mr. Mordey's power factor was 400 per cent. too high. He had also experimented with a choking coil with no iron core, in order to reduce the current going into the cable and also to assist in the measurement of power taken. By connecting the choking coil in series with the cable, a low-voltage supply current with a very small difference in phase between the voltage and current had been obtained. In this case the wattmeter was working under its best conditions. It was well known that the current taken by a cable varied with the wave-form. He quoted figures from tests made at the Central Technical College to show the increase in the ratio of 73 to 49 in the current taken by a condenser when the alternator supplying the current was changed.

Mr. O'Gorman said there was a great discrepancy between the various classes of cables, and therefore experiments on one condenser were no guide whatever of the effects obtained with another. In a cable made of a uniform dielectric the fall of potential was quite regular. If the first part of the dielectric were made of pure indiarubber, the fall of volts was exceedingly great in that layer. He found as the result of experiments that the loss should be 26 times greater with a rubber cable than it would be in a perfectly homogeneous dielectric. The loss depended upon the distribution of potential in the dielectric, and that explained the extraordinary discrepancies between various classes of cables. In fact, the loss varied as the square of the potential gradient. Paper cables had the advantage in having liquid dielectrics.

Mr. W. E. Gray remarked that they had heard that cable makers did not know much about making cables any more than dynamo makers knew how to make dynamos. Be that as it might, there certainly were great differences in the several classes of cables manufactured. When dealing with the question of dielectrics there were many things to be taken into consideration. The quality of the cable was one, and that depended upon the process of manufacture followed as to the capacity given. But no one, he believed, could make a cable which would be perfectly stable. It was possible to build a cable which would not vary in capacity any more than in insulation. He was prepared to say that Mr. Mordey tested a certain form of cable, and that Mr. Mather and Prof. Ayrton tested another form of cable, and this would account for the difference in the results.

Prof. Threlfall considered that if a cable could be made without any moisture in its dielectric, it would reduce the loss to less than 10 per cent. of its ordinary value. That could only be done by using pure celluloid paper prepared by drying it at a temperature of 130deg. C. under vacuum. There had been much said about dielectric hysteresis, which Mr. Steinmetz was said to have discovered in 1892. If Mr. Steinmetz's paper were looked up, it would be found that he had only suggested that the loss he had observed might be dielectric hysteresis. As a matter of fact, most of the loss was due to leakage. Again, Mr. O'Gorman was wrong in saying that the loss varied as the square of the potential gradient. He (the speaker) had proved that it varied between the 1·6 power up to the square of the gradient, and that the higher value could only be obtained by using absolutely pure material.

Mr. T. H. Minshall referred to some experiments which he had carried out at Croydon, with the intention of proving that Mr. Mordey's figures were much too high. He found it was impossible to make a commercial test of capacity unless you had some means of making perfectly certain that you were using a sine wave-form of E.M.F. The next thing was to measure the power taken by the cable. He thought that the discrepancies which occurred in this direction were due to the fact of the insulation resistance not being taken into account. He proceeded to give figures obtained on a cable at Croydon which had insulation of only half a megohm, and on which a power factor of ·1 was obtained. He had tried to vary the result by different means of measurement, but always got practically the same result. He believed in working with a low insulation resistance, and the figures given by him showed that the loss in consequence of the low insulation resistance was much about the same as the loss in dielectric hysteresis.

Mr. Mordey, in reply, said he was very glad the last speaker had given him a little encouragement, and that Mr. Sparks and himself were not the only people who had found that there were appreciable losses in cables through dielectric hysteresis. If all the professors in the world were to tell him that there was no loss in dielectric hysteresis, he should be perfectly certain that they would be wrong. He had received a letter from an old member (Mr. Gisbert Kapp) saying that he agreed with him, and it was a confirmation that that gentleman found that the cables on light load became appreciably warm, which must mean a power factor of ·3 or ·4. Even the figures given by Prof. Ayrton confirmed him up to a certain point. The cable makers had asserted that they often had experiences of cables which on light load got quite warm simply due to dielectric hysteresis. They had had an exceedingly useful discussion, and he hoped for the sake of the industry that he would be found to be wrong in the figures he had given. He must say, however that he had never claimed for one moment that the power factor he found in the cable tested was of universal application.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

353. In designing a shunt regulating resistance for a large dynamo, how should the resistance be proportioned between the different contacts of the regulating switch in order that each movement of the latter shall give, say, one volt variations throughout its entire range?—PLUMER.

354. Describe a suitable arrangement of wood strips, to take the place of steel guard wires for protecting trolley wires, to be strong enough to withstand the fall of a bunch of telephone wires, such as occurred at Liverpool lately. Give sketches showing method of carrying.—T. R.

ANSWERS.

Question No. 347.—Describe the connections of a switchboard and an effective type of synchroniser for three-phase generators supplying motor circuits. Is there any method of starting up the motors as a whole from the generating station?

Best Answer to No. 347 *(awarded* 10*s.)*.—Paralleling alternators require special precautions to avoid strains upon the machines, and two conditions must be fulfilled. They are: (1) the two machines must have the same voltage and frequency; (2) at the moment of switching them into parallel the instantaneous voltages of the two machines must be equal and of the same sign.

It is easily seen that if a_1 a_2 and b_1 b_2 are corresponding terminals of the machines (see sketch), there will be only zero potential difference between a_1 and b_1 or a_2 and b_2 when the E.M.F. of the two machines are identical in frequency and phase, even though the voltmeters between

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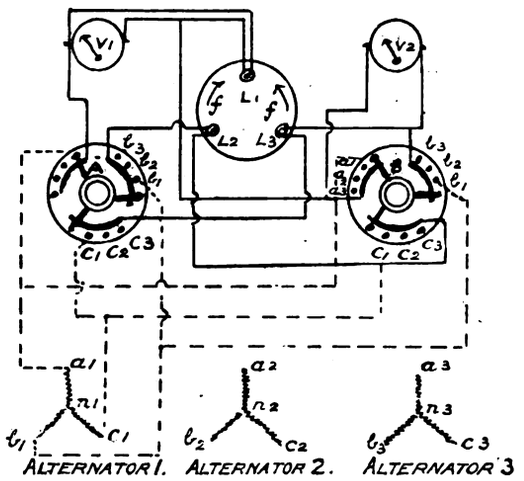
the terminals of the machines read alike. If the machines are switched in parallel without being accurately synchronised, the result will be a sudden rush of abnormal current through these armatures. A simple method of detecting when the machines are in synchronism or not is by connecting a_1 and a_2 and b_1 and b_2 by means of incandescent lamps. This device forms a good indicator as to whether there is a difference of phase or not between the E M.F.'s of the machines, but does not indicate which machine is running the quicker.

The Siemens and Halske synchroniser gets over this difficulty. The phases, a_1 b_1, b_1 c_1, c_1 a_1, of the first alternator are connected to the terminals, a_1 b_1 c_1, of two triple-pole switches, A B, which are themselves coupled in parallel. The phases of the other two alternators are respectively connected to the terminals, a_2 b_2 c_2, a_3 b_3 c_3, of two other switches. The lamp device is still used, but now there are three terminals to each machine, and three lamps are used as indicators between corresponding terminals of the machines already connected to the 'bus bars and the incoming machine. The extinction of the three lamps does not occur simultaneously, but successively, and if the lamps are mounted in a triangle, as shown in the diagram at L_1, L_2, L_3, the order of extinction will travel round the triangle in a clockwise or counter-clockwise direction, according as the incoming machine is slower or quicker than those already on the 'bus bars. The direction of the order of extinction of the lamps tells at once whether the incoming machine is running too quickly or too slowly. Suppose it is desired



to parallel machine 2 with machine 1, which is already connected to the 'bus bars. The first thing to do is to see that the voltages of both machines are alike by means of the voltmeters. Having done this, the switch B is left on the terminals, a_2 b_2 c_2, and the switch A is placed on the terminals, a_1 b_1 c_1, of the alternator 1. The direction, f or f_1, of the order of the extinction of the lamps is then noted; if the order is f, the incoming alternator has to be accelerated, and if the order is f_1, it has to be retarded. The main switches are closed at the instant that the lamp L_1 is dark, when the rate of extinction shows that the speed of the machines is almost exactly the same. To increase the sensibility, a voltmeter, V_1, is between the terminals of the lamp L_1, and should register zero voltage at the instant of switching on.

In reply to the second part of this question, it would be necessary in case of motors of large size to have a special starting device in order to prevent the abnormally large currents which circulate in the field and armature coils from burning up the insulation. Small motors may, however, be started without fear of any damage to the coils.—F. B. A.

Question No. 348.—How would you arrange connections so that an ordinary double-pole throw-over switch can put two dynamos in series or in parallel? When the switch is on the top contacts the machines to be in parallel, and when on the bottom in series.

Answer to No. 348 (*awarded* 7*s.* 6d.).—The two dynamos referred to may be considered the same size, for they must give the same voltage to work in parallel, and the same current to work in series. As the question does not state whether they are series, shunt, or compound wound, all three cases must be considered. Two shunt-wound machines when running in series have a tendency to reverse one another if the field winding of each is connected across the armature belonging to the same machine; and,

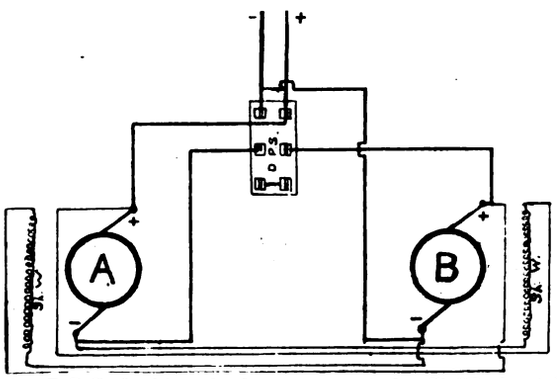


FIG. 1.—D P S, double-pole throw-over switch; Sh W, shunt field winding; A and B, armatures of dynamos.

though they can be run in series so connected, better results can be obtained by having the field of each excited by the other, as then, if the current is reduced in the shunt of one, the voltage of the other which has caused this reduction is reduced also, but if this should take place with the shunts connected in the ordinary way, as soon as the current is reduced in the shunt it drops the voltage of the machine that is tending to maintain the current in it. This drop causes a further reduction of current in the

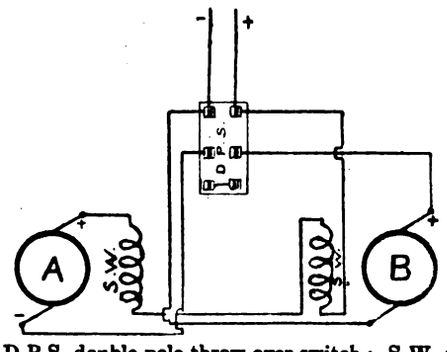


FIG. 2.—D P S, double-pole throw-over switch; S W, series field winding; A and B, armatures of dynamos.

shunt, and, finally, a complete reversal of polarity. Fig. 1 shows connections desired for shunt-wound dynamos, in which it will be seen that one machine, A, excites the field magnets of the other, B, and that B excites the field magnets of A for reasons just explained. If the throw-over switch is closed upwards, the two dynamos are in parallel, and if it is closed downwards they are in series.

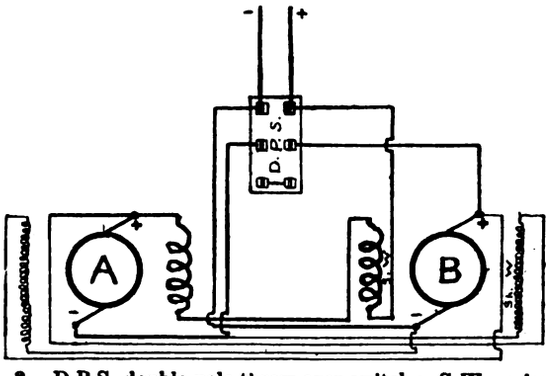


FIG. 3.—D P S, double-pole throw-over switch; S W, series field winding; Sh W, shunt field winding; A and B, armatures of dynamos.

The two dynamos must be run before either can excite. If one should be accidentally shut down, no harm will be done if the two had been running in parallel, as the voltage of both will drop as the one slows down. Fig. 2 shows the connections if the dynamos are series-

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wound. It will be seen that no equalising wire is used, which is the best and most usual method of running series or compound-wound dynamos in parallel, but it cannot be used under the conditions given, as the throw-over switch would have to have a third pole to allow this. To prevent one dynamo reversing the other when they are running in parallel, the field magnets of both are excited by the current from one armature only; this will ensure the fields being the same strength and the same polarity, though it will cause the machine, A, that excites the magnets to do a little less work, owing to its internal resistance being increased and that of the other decreased.

The connections for two compound-wound machines are a combination of the two just described for the series and shunt machines, and are shown in Fig. 3. It will be seen that the difficulty of not being able to use the equalising wire is got over in the same way as in the case of the series dynamo, and to prevent any liability to reverse the shunt current, the shunt windings are connected as described for the shunt dynamos.—A. J., SWANSEA.

Answer to No. 348 (*awarded* 7*s.* 6*d.*).—Figs. 1 and 2 refer to throw-over switches, the pivots, A, of which are used for contacts; Figs. 3 and 4 to switches with independent contacts. The connections for both types of

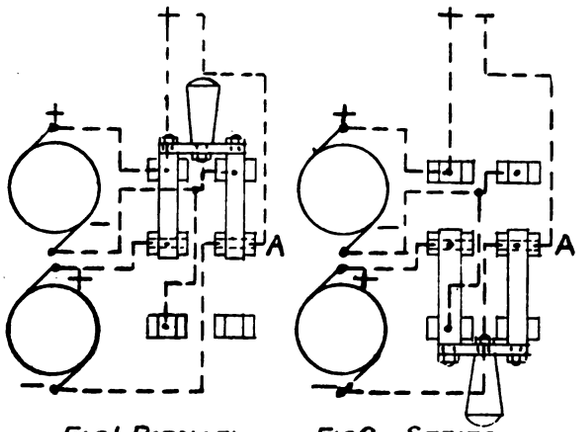


FIG 1. PARALLEL. FIG 2. SERIES.

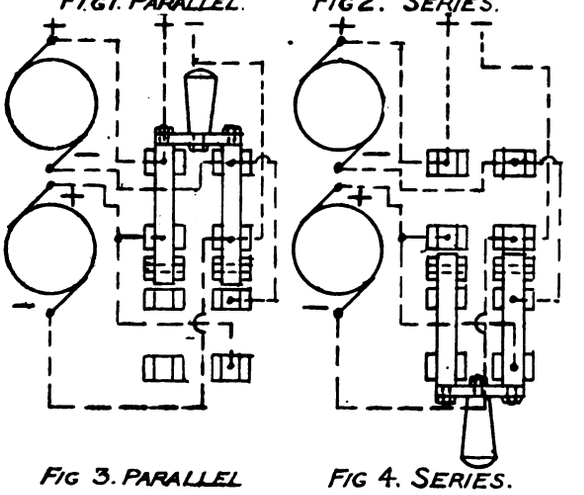


FIG 3. PARALLEL FIG 4. SERIES.

switch can easily be traced from the diagrams. When the switches are on the top position, they will also act as a simple single-pole switch when either dynamo is working singly.—W. A. J.

Answer to No. 348 (*awarded* 5*s.*).—The only proviso that must be made in connection with the scheme of connections shown herewith is that some of the lugs or back contacts of the double-pole throw-over switch must be capable of taking two conductors each of sufficient size to carry the main current of one dynamo. Granted this condition, the arrangement can be as shown in the sketch. A, B, C, D, E, F represent the six contacts of the throw-over switch; D_1, D_2 represent the two dynamos. The connections are shown by the thin lines, the blades of the switch by the thick lines. Fig. 1 shows the switch in position for parallel running, while Fig. 2 represents the dynamo in series. The direction of the currents in each case is shown by arrows. It will be seen that on lugs A and D two connections must be made, while contact F is in reality superfluous.—J. A. S.

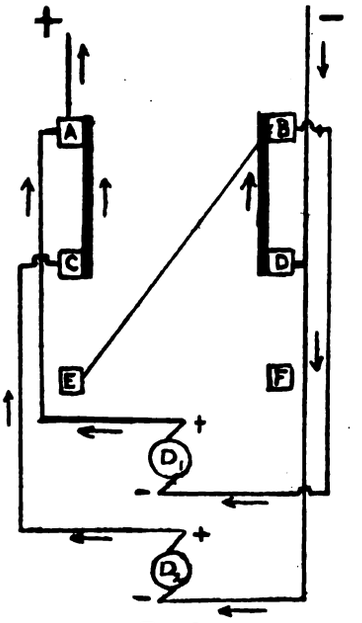


FIG 1.

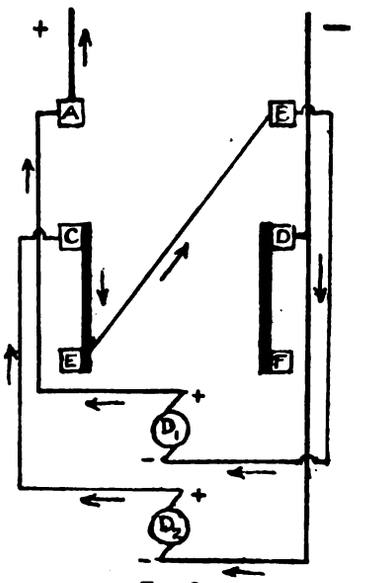
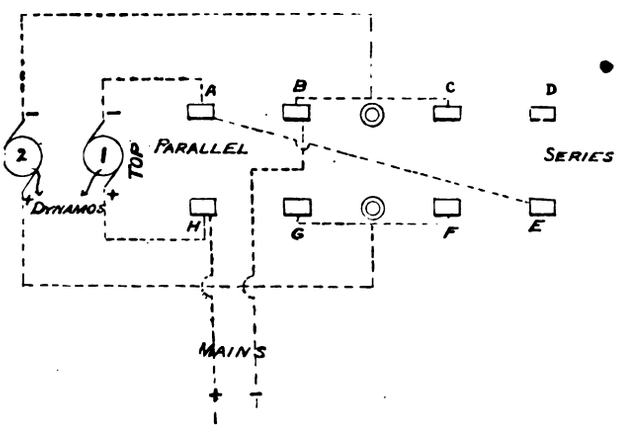


FIG. 2

Answer to No. 348 (*awarded* 5*s.*).—A good method for connecting two machines in parallel or series with a double-pole switch is shown in the sketch, where 1 and 2 are the dynamos, and *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h* are the contacts.



To avoid complication the levers of the switch have not been shown. It will be observed that the contacts A E, B C, and F G are connected together, which is done at the back of the switch, by means of copper strip. To connect the two machines in parallel, it is easily seen that by throwing the switch over to the side marked "parallel," the currents from the two machines will take

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the following courses—namely, from the positive of No. 1 machine on the contact, H, to positive main; at the same time it can flow from the positive of No. 2 machine to G through the lever to H, also to positive main. From the positive main it goes through the lamps, or whatever there is in circuit, on to negative main to B, where it divides, part going to the negative of No. 1 machine through the lever, and part to the negative of No. 2 machine through the connecting wire. When it is required to connect the two machines in series the switch must be thrown over to the side marked "series." The current then flows from the positive of No. 1 to H on to positive main, then to negative main on to B, from B to the negative of No. 2 machine through the machine to G, through the lever to E, from E to H, on to "negative" of No. 1 machine.—R. F. W.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

The half-yearly meeting of this Company was held on Thursday week at the Westminster Palace Hotel, S.W., Mr. James S. Forbes (chairman) presiding.

In moving the adoption of the report, the **Chairman** said the accounts only too sadly fulfilled the forecasts he gave at the last meeting of the Company. As he had said before, the present state of affairs was almost entirely attributable to the working of the "twopenny" tube. During the half-year they had lost in round figures 101,000 first-class passengers, 272,000 second class, and 964,000 third-class passengers, the loss in money being £2,000, £3,225, and £10,121 respectively. With regard to season tickets, they had lost 1,700 of their subscribers, representing £4,168. The total loss all round was £19,000. The working expenses, on the other hand, had only increased by £1,200, due chiefly to the high price of coal, and he was sorry to say that during the current year they would have to pay somewhat more for coal than for the last six months. The deplorable falling off in the traffic and the revenue was solely due to the causes explained at the last meeting, but the questions involved must not be solved in panic. The diversity of advice as to the best means of retrieving their position was so great that they must only be influenced by it to the extent which the circumstances and experience in the conduct of the affairs justified. Electrical traction, of course, was the saving grace if it could be brought about, as they trusted it might, but there were some other measures they might take which would require a great deal of skill and knowledge—viz., the reduction of fares, uniform class, etc. He foresaw that on some parts of the line they would have to do this on account of competition. More than 40 per cent. of their traffic was contributed from places beyond the "District" line proper, and it would be rather a serious matter to reduce the fares at places, say, like Hammersmith. If they did, they stood to lose a great deal more than they gained. The Central London Railway Company were not troubled with these matters, as they had only six miles of line and nothing beyond. After paying the interest on the debentures and the rent charges, there was a very small balance—so disagreeably small that it would not even pay the dividend on the guaranteed stock. Instead of paying 4 per cent., they could only pay at the rate of £2. 6s. 8d. per annum on the half-year. The question was, how was the money to be raised to mend this state of things? He himself was prepared to take a very drastic course—viz., to raise the money over the heads of everybody who would be benefited in the end. They had drawn up a Bill with that intention. Of course, the Board had the sanction of the shareholders to raise £500,000 worth of ordinary stock and £166,000 of debentures, but founded on the market value that would not raise nearly enough money. Unless they resorted to artifices such as lump sum contracts etc., where was the other money to come from? But if they did that, it would be because the shareholders were not wise enough to take the proper course—to raise the money over the heads of everybody who would be benefited by that money. The results of the working of the Central London Railway were not so extremely brilliant to the investor as to make him believe that there would be a very great run of money to support the designers of the many proposed electrical railways in London. The Metropolitan District Company would have to do the best they could to defeat the schemes which would compete with their system. He moved the adoption of the report and accounts.

Mr. L. H. Isaacs seconded.

Mr. S. C. Noble asked for information as to whether or not the Board intended to proceed with Clause 8 of the Company's Bill, which provided for the reduction of the preference shareholders' dividend from 5 to 3½ per cent., and to make it non-cumulative, where it had been up to now cumulative.

The **Chairman** said the directors could do nothing in the matter until a Wharncliffe meeting had been held, which was a parliamentary institution for the express purpose of putting it beyond the power of the directors to carry on any measure affecting the interest of the shareholders without their consent. The preference shareholders must make sacrifices with the others. If they drifted on as they were, and did not equip the railway electrically, things must go from worse to worse. They were advised by eminent gentlemen like Sir Wm. Preece in the matter, and they had got to determine the system of electric traction to be adopted. There were nine different systems suggested, but the directors had a preference as to one of these systems, because it was insisted upon by their technical advisers as being the best. They must have a system which would be applicable both to their line and to that of the Metropolitan Company. Their experts advised them that the system for which they had shown a preference was a great advance on any other system. The Americans said it was not. That was the sort of conflict going on.

Mr. Perks, M.P., said he did not take such a pessimistic view of the situation as some. The only alleged novelty of the system which had been so strongly advocated in the Press was that the initial cost was somewhat smaller as well as the cost of working. They could not afford to experiment with a system which would in the end turn out not to be the best, and he was glad to see that the directors had not committed themselves as to the one to be ultimately adopted.

In reply to a shareholder, the **Chairman** said the case was not so bad that they would have to go into the hands of a receiver and then to arbitration.

The report and accounts were adopted unanimously, and the dividends recommended in the report declared.

Mr. Isaacs and Dr. George Wyld having been re-elected directors, the proceedings closed with a vote of thanks to the chairman.

The report for the half-year ended Dec. 31, 1900, states that the dividend for the remaining four months of the half-year will be at the rate of £1. 10s. per cent. per annum. On the occasion of the recent special meeting to authorise the raising of capital for the "electrisation" of the Company's railways, the causes which have led to the deplorable falling off in the traffic and revenue were fully set forth, and were properly attributed almost wholly to the competition of the Central London Railway and the novel principles upon which that company has started its business. The questions involved must not be solved in panic. Apart from the vital question of adopting electric traction, there may be found means of qualifying in favour of the older companies the severity of the competition now existing. It need hardly be said that the subject is one involving the Board and management in great anxiety and responsibility, and that much caution is requisite to ensure that any proposed remedy may not be worse than the disease. Having regard to the resolutions passed at the extraordinary meeting, the directors believe that it may not be necessary to proceed with the financial clauses of the Bill deposited by the Company, but as it contains further powers with regard to the electrical working and some minor matters it may be found necessary to submit it to the proprietors in Wharncliffe meeting at a future date. Numerous Bills have been deposited in Parliament by various promoters for the construction of electric railways, some of which if sanctioned would seriously affect the District Railway.

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The third ordinary general meeting of the proprietors of the Company was held on Friday last at Winchester House, E.C., Mr. Herbert S. Leon (chairman) presiding.

In moving the adoption of the report and accounts, the **Chairman** said he thought, taking it altogether, they would not be dissatisfied with the balance-sheet for the year; they might, in fact, mildly congratulate themselves upon it. It must be noticed that the present figures were for only 12 months, as compared with 15 months on the last balance-sheet. As to the business of the Company during the last 12 months, it had increased by 6,279 8-c.p. lamps, which represented 57 new customers. There remained still in the markets about 100 new shops to be lighted, and, believing as they all did in the vast superiority of electric light over other illuminants, they had every hope that these hundred shops would in the course of time come on the list. These shops would be profitable customers, inasmuch as they would be long-hour consumers. They had so placed their present machinery that they could take them all on without any increase to their capital outlay. In fact, they were a bit ahead of their requirements at the present time, and were ready for any reasonable demand. At the end of 1900 they spent something like £3,000 on a new boiler, dynamo, and new engines, all of the latest improvements. They were practically all in working order now, and they hoped they would get through the summer at a considerable decrease in working expenses. The necessary money was secured by issuing 3 800 second debentures, raising this issue to 8,000. This did not appear on the balance-sheet. As regarded the future policy of the Board, it would be to limit any further issue of new capital to works which would show a direct and immediate profit to the Company. If they could not see this, it was their intention to maintain their equipment from revenue. In the balance-sheet there was placed £1,000 to depreciation, and the policy of the Board was to maintain, if not increase, that sum. This, he thought, must appeal to everybody as a sound policy, and it was not only the surest way to maintain the machinery in the highest state of efficiency, but it also afforded a lasting foundation for their financial credit. He should like to see the depreciation fund stand at no less than £10,000 in cash. During the year the cost of coal had been £4,155, as against only £2,600 for the previous period. It was a regrettable incident, because it had occasioned very heavy working expenses. As far as one could foresee, the price of coal would be somewhat lower in 1901, and he was glad to say they had made no unfavourable contracts in this respect. The gross profits amounted to £4,459.

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9s. 3d., and but for the very high price of coal a much better result would have been obtained. Although the directors were unable to declare any dividends, the proprietors might rest assured that the business of the Company was being built up on a very safe and solid foundation. This year the directors had claimed their right, and taken a portion of their fees, which he was sure they would agree was perfectly fair. They intended to popularise the Company in the market, and unless this were done there was a very poor chance of future prosperity for them.

Mr. E. Schenk seconded.

In reply to questions, the **Chairman** stated that the new machinery had not replaced any of the old. It was additional. On the question of the directors' fees, he was quite willing that anyone should take his place as chairman of the Company, and with it his £200 a year. He declined to work any longer for nothing.

The report was then adopted.

Mr. J. Browne Martin having been re-elected a director, the proceedings closed.

NATIONAL TELEPHONE.

From the directors' report for the half-year ended Dec. 31, to be presented to the meeting on 21st inst., it appears that the income for the half year amounts to £732,093, as compared with £663,523 for the corresponding period of 1899, being an increase of £68,570. The working expenses for the half year amount to £404 653, as compared with £359,303 for the corresponding period of 1899, being an increase of £45,350. The net result for the half-year (after deducting the Post Office royalties, amounting to £71,609) is a profit balance of £255,831, as compared with £240,044 for the corresponding period of 1899, being an increase of £15,787. The rentals carried forward for unexpired terms of running contracts amount to £696,568, as compared with £631,590 at the corresponding period of 1899, or an increase of £64,978. Out of the available balance of £204,698 shown by the net revenue account the Board recommends dividends at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, and 5 per cent. per annum on the ordinary shares. The Board also proposes to transfer £85,000 to the reserve fund, and to carry forward £5,698. The sum of £468,548 has been expended on capital account during the half-year in the erection of 11 794 additional exchange and private lines, and in the construction of underground lines. In the year 23,490 additional exchange and private lines have been erected—a larger number than in any previous year. Of these, 16,776 have been for subscribers on the message-rate system, paying a low annual charge in respect of the cost of installation, and the addition of a sum of 1d. for each call made. So far as this experiment has gone, it has had the effect of reducing the average receipt per subscriber without any commensurate reduction in the working expenses. The working expenses on the whole have considerably increased, owing largely to an exceptionally heavy outlay in repairing damages caused by snowstorm in the early part of the year. The effort to popularise the telephone may possibly justify the message-rate business when it has been further developed. The policy of the Company in the face of possible competition must be to maintain the effort to attract new subscribers and increase as far as practicable the universality and efficiency of its services.

CENTRAL LONDON.

The report of the directors for the half-year ended Dec. 31 states that the amount expended on capital account during the half-year was £158 416. The railway was opened for public traffic on July 30, and the revenue derived from that date to Dec. 31 amounted to £119,890. The working expenses, which were seriously increased by the abnormally high prices of fuel and materials which prevailed during the same period, amounted to £70,434 (58¾ per cent. of the receipts), leaving as net profit for the five months £49,456. The total net revenue amounts to £49,576, and after providing for interest on debenture stock there is an available balance of £39,152. The directors recommend that a dividend be paid on the share capital of the Company for the six months now under review at the rate of 2½ per cent. per annum. To this dividend the various classes of shares will be entitled at the following rates of distribution: undivided ordinary shares at the rate of 2½ per cent. per annum, preferred half shares at the rate of 4 per cent. per annum, deferred half shares at the rate of 1 per cent. per annum. There will remain £3,527 to be carried forward. The number of passengers carried on the railway from the date when it was opened for public traffic to Dec. 31, 1900, was 14,916,922. A Bill has been deposited in Parliament to authorise the construction of a loop extension from the Bank Station and an additional station in Liverpool-street, also for a small loop at the Shepherd's Bush terminus to enable the Company to provide for the carriage of a much larger number of passengers by a more frequent service of trains running in a continuous circuit.

EASTERN TELEGRAPH.

An extraordinary general meeting of this Company was held at Winchester House on Wednesday for the purpose of confirming a resolution passed at the meeting on the 28th ult. as to the alteration of a certain article of association. A motion to this effect was carried.

WATERLOO AND CITY RAILWAY.

At the half-yearly meeting of this Company on Thursday week, **Sir Wyndham S. Portal**, who presided, in moving the adoption of the report, said the receipts had considerably increased, and the working expenses were less than the 55 per cent. limited by the working agreement. He considered that was a satisfactory state of affairs. After paying 3 per cent. on the ordinary stock, there remained £76. 19s. to be carried forward. The passengers carried during the six months numbered 2,038,000, an increase of 268,000. There was also a steady increase in the revenue, and he believed the future of the line would in all respects be satisfactory. In reply to a question, the chairman stated the Company had nothing in prospect with regard to extending the system. All the other electric lines were entirely separate from the City and Waterloo Railway.

The report was agreed to, and a resolution was passed for the declaration of a dividend at the rate of 3 per cent. per annum on the ordinary stock. The retiring directors, Colonel Campbell, Mr. A. F. Govett, and Mr. F. J. Macaulay, were then re-elected.

LIVERPOOL OVERHEAD RAILWAY.

On Tuesday the half-yearly meeting of this Company was held at Liverpool, Mr. Richard Hobson, deputy-chairman, presiding.

In moving the adoption of the report, the **Chairman** said the gross revenue receipts amounted to £43,964 and working expenses to £29 187. During the half-year over 5,500,000 passengers had been carried, which was a considerable increase on the corresponding half of the previous year. This was due to the opening of the electric tramway line at the north end, which had proved a valuable feeder to the railway. The traffic on the railway itself was rather below the corresponding period of 1899, when the receipts were considerably augmented in consequence of the departure of troops for South Africa. The expenses had gone up by a large amount owing to the enhanced price of coal and most other materials, the coal bill being exactly double that of a year ago. A good deal had also been spent in keeping the railway in a high state of efficiency.

The report was adopted.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The half-yearly meeting of this Company was held in Manchester on Tuesday.

Mr. George Richardson, who presided, pointed out that there had been a slight increase in the cost of maintenance over the previous half year. Engine power had increased by about £600, rents were a little less, but rates and taxes were about £250 more. An extra receipt this year was £362 for sale of current. This arose in consequence of the breakdown of the Corporation tramways and the Company were called upon to supply the current, upon which they made a satisfactory profit. The dividend was down 1 per cent., but they were not the only tramway or railway company which had had to submit to a reduced dividend. There was a probability of such building extensions being developed between Blackpool and Fleetwood as would lead to their gaining a residential traffic, and so earning a more even revenue.

The report was adopted.

After a dividend at the rate of 9 per cent. per annum had been declared, the chairman and deputy-chairman were re-elected directors of the Company, and the proceedings closed.

EDINBURGH STREET TRAMWAYS.

The fifty-ninth ordinary meeting of this Company was held in Edinburgh last week, Mr. R. Vary Campbell, chairman, presiding. The report and accounts having been adopted, a special meeting was held to authorise the issue of additional capital in pursuance of the powers of the Company's special Act of 1892.

The **Chairman**, in moving the resolution, said the amount of share capital which the Company were authorised to raise was £75,000, with a fourth more by way of mortgage if required, which was ample, even if the Company were to introduce electricity over their system. The amount of this share capital which the directors advised to be now authorised was £15,000. They might have seen from the newspapers that there had been some negotiations with the Corporation of Leith as to the possibility of introducing electric traction. They (the directors) had their report upon that from a skilled engineer, and he might say a very favourable report. Whenever it was matured and entirely ready, the scheme would be submitted at a special meeting, provided the directors were satisfied.

Mr. Peter Taylor seconded, and the resolution was adopted.

DUBLIN UNITED TRAMWAYS.

The half-yearly meeting of this Company was held in Dublin on Tuesday.

Mr. W. M. Murphy (the chairman), in moving the adoption of the report, said the directors had declared the same dividend as this time last year—namely, 6 per cent. on the ordinary shares—but the aggregate profits to be carried forward were less by £3,702. The United Tramway system showed an increase of £12,639 in the receipts for the half-year. The Southern District Company's accounts for the Dublin and Dalkey line showed an increase of £1,119 in the traffic receipts. The Chairman, in con-

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clusion, pointed out that the net profits of both made a total of £53 722 for the half-year.

In the course of a discussion which followed, it was suggested that there should be an amalgamation to simplify the accounts, and an observation was made that the fares were too cheap and might be raised.

A **Shareholder** also complained that the expenses were too great. The report was ultimately adopted unanimously.

APPOINTMENTS VACANT.

Electrical Engineers.—Bath Town Council, £350 per annum, Feb. 28. Details in our advertisement columns.—Isle of Thanet Electric Tramways and Lighting Company, to take charge of power station, Feb. 27. Full particulars in our last issue.

Accountant Clerk, Institution of Electrical Engineers, £200 per annum, March 9. Details in our advertisement columns.

Motor Inspector, Bradford, must have had first-class experience in fixing and running direct-current motors of all sizes, and be able to carry out repairs, 34s. per week of 50 hours. Details in our advertisement columns.

Foreman Electrician, must be accustomed to taking charge of men, have practical knowledge of wiring of ships and houses for incandescent lighting. Details in our advertisement columns.

Draughtsman wanted by a firm of consulting engineers, 25s. Details in our advertisement columns.

Mechanician wanted by a firm of meter manufacturers. Details in our advertisement columns.

Electrical Engineer and Manager, Lincoln Corporation, to take entire charge of the electricity works, £300 per annum, March 11.

Shift Engineer, Manchester Corporation, March 4.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

King's Lynn.—The electrical engineer has been directed to invite tenders for the supply of 150 tons of anthracite and 80 tons of steam coal.

Manchester.—The Tramways Committee invite tenders for the electrical equipment of 87 cars. Tenders by March 4. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for supplying and fixing trolley wires and attachments. Tenders by March 8. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for the supply, delivery, and erection of a traction switchboard. Tenders by Feb. 28. Details in our advertisement columns.

Hastings.—Tenders will shortly be advertised for the supply and erection of the necessary boiler power, feed pumps, etc., which it is estimated will cost about £4,494. 10s.

Ploesti (Roumania).—The Municipality invite tenders for the laying down and working of electric tramways for 30 years. The provisional deposit is £2,000. Tenders by April 3.

Sofia.—The District Finance Department require tenders for various telegraph and telephone materials, amounting to about £2,800. The deposit is 5 per cent. Tenders by March 8.

Southampton.—The Corporation invite tenders for insulated electric cables, frames, and covers, including excavation and reinstating of roadways. Tenders by March 11. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for supplying and fixing trolley wires and attachments. Specifications, etc., may be obtained at the City Engineer's Office, Municipal Buildings, Leeds. Tenders by March 8.

Cardiff.—The Corporation invite tenders for the erection of an electric tramway power station at Roath, Cardiff. Specification, etc., may be obtained at the office of Mr. W. Harpur, M.I.C.E., borough engineer. Tenders by Feb. 28.

Wallasey.—The Urban District Council invite tenders for the overhead equipment of about 10 miles of tramways and for the supply and erection of section boxes and the bonding of rails. Tenders by March 4. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for cast-iron pipes, with the necessary drawing-in boxes and wires, and supplying insulated conductors and drawing the same into the pipes. Tenders by March 8. Details in our advertisement columns.

Alcaraz (Albacete, Spain).—The Municipal Authorities invite tenders for the installation and working for 20 years of electric lighting. An annual payment of 23 pesetas will be made per 10-c.p. lamp. The provisional deposit is 276 pesetas. Tenders by Feb. 28.

Cardiff.—The Corporation invite tenders for steam-pipes, exhaust pipes, injection and overflow pipes, feed pipes, drain pipes, engine-house flooring, and switchboard gallery and central service gangway. Tenders by March 18. Details in our advertisement columns.

St. Pancras.—The Guardians invite tenders for the installation of an electric fire-alarm system at the St. Pancras infirmary, Dartmouth Park-hill, N. Specification, etc., may be obtained at the office of Mr. Alfred A. Millward, clerk, Town Hall, Pancras-road, N.W. Tenders by Feb. 28.

Stockport.—The Gas and Electricity Committee invite tenders for supply and erection at their electricity works, Millgate. Stockport, of a condensing plant capable of dealing with 20,000lb. of steam per hour. Specifications can be obtained from Mr. S. Meunier, engineer. Tenders by March 6.

Bournemouth.—The Corporation invite tenders for the supply of three steam dynamos and two steam-driven surface condensers, and other works in connection therewith. Specifications, etc., may be obtained of Mr. F. W. Lacey, M.I.C.E., borough engineer, Municipal Offices, Bournemouth. Tenders by March 2.

Luton.—The Town Council invite tenders for wiring for electric lighting purposes the Council-chamber, town hall, free library, corn exchange, and baths. Sketches of designs and full details of the proposed works to be given. Further information can be obtained of the Borough Engineer. Tenders by March 4.

Coventry.—The Sanitary Committee invite tenders for the work required in connection with the electric lighting of the new buildings at the infectious diseases hospital. Specification, etc., may be obtained at the office of Mr. J. E. Swindlehurst, city engineer, St. Mary's Hall, Coventry. Tenders by March 4.

Huddersfield.—The Corporation invite tenders for motorcarts suitable for conveying about five tons of coal from the local collieries to the electricity works. Further particulars may be obtained from the borough electrical engineer, Mr. A. B. Mountain, Electricity Works, Huddersfield. Tenders by March 5.

Bradford.—The Corporation invite tenders for the works required to be done in erection of a generating station at the electricity works, Valley-road, Bradford. Specifications, etc., may be obtained on application at the office of the Clerk of Works at the Electricity Works, Valley-road, Bradford. Tenders by March 5.

Bristol.—The Electrical Committee invite tenders for the erection of the superstructure of the Avonbank electricity works, Feeder-road, Bristol. The work comprises a large amount of steelwork, as well as brickwork and concrete work. Specification, etc., can be obtained at the office of Henry Williams, Esq., architect, 24, Clare-street, Bristol. Tenders by March 12.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, Newhampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston-street, Cleveland-road, and Bilston-road, to the borough boundary, amounting to a route length of about 4½ miles, mainly double track. Specification, etc., may be obtained on application at the Borough Engineer's Office, Town Hall, Wolverhampton. Tenders by Feb. 26.

Bray (Ireland).—The Urban District Council invite tenders for the supply and erection of: (Section A) boiler-house plant—one Lancashire boiler and accessories; (Section B) engine-house plant—(1) one 150-kw. high-speed steam alternator, and (2) one 25-kw. rope-driven alternator and accessories, for the municipal electricity works. Specification, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by March 14.

RESULTS OF TENDERS.

Hastings.—The tender of Parsons and Co., at £5,005. 10s., has been accepted for a 500-kw. alternator.

Bolton.—The Electricity Committee have accepted the tender of Glover and Co. for the supply of cables.

Whitehaven.—The tender of Messrs. J. Walker and Son has been accepted for the wiring, etc., of the electric light station.

Tynemouth.—The Town Council have accepted the following tenders: Siemens Bros., London, engine and dynamo for the electric works, £4,832; Yates and Thom, Blackburn, boiler, £1,070.

Harrogate.—The Town Council have accepted the tender of Messrs. Holdsworth and Sons, of Bradford, at £2 395, for two Lancashire steam boilers, with saddle gangway, economiser, and settings.

Bradford.—The Tramways Committee have accepted the tender of Messrs. Blackwell and Co., Limited, London, at £6,204, for the complete electrical overhead equipment of over five miles of tramway.

Brighton.—The tender of Messrs. Pedrette and Co., of £35,760, is recommended for acceptance for (1) concrete foundations for the Corporation's power-house at Southwick; (2) wharf and timber piling; (3) timber dam and concrete weir.

Eastbourne.—The Electric Light Committee have accepted the tender of Messrs. J. E. Johnson and Son, 90, High Cross street, Leicester, at £9,100, for the erection and completion of a proposed electric lighting station, with administration block.

West Ham.—Messrs Ferranti's contract for plant has been accepted, and also the tender of Messrs. Veritys, Limited, 31, King-street, Covent Garden, W.C., at £1 321, for two 25 b.h.p. oil-engines, two 15 kw. dynamos, one battery of accumulators, switchboard, etc., at Dagenham Hospital, Essex.

Sunderland.—Mr. B. Thomas, Cornbrook Telegraph Works, Manchester, is the successful contractor for the switchboard, and the Chatteris Engineering Company, Limited, Chatteris, Cambs, for the travelling crane. The tenders for condensing

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plant and battery will come before the Lighting Committee on March 1.

Walsall.—The Town Council have accepted the tender of the Walsall Electrical Company, Limited, at £6. 7s. 6d., for connecting the Pleck sub-station with the generating station in Wolverhampton-street by telephone; also the tender of the Smethwick Boiler Covering Company, Limited, at £14. 16s. 11d., for covering the new boiler and steam-pipes.

Southampton.—The Town Council have accepted the following tenders: F. Osman, for the construction of tramways from the Docks Station to the Avenue, viâ St. Mary-street, and for the reconstruction of the existing tramway in Canute-road, £10,344; Robert W. Blackwell and Co., for the overhead electrical equipment of lines (St. Mary-street section), £2,079. 18s.; George F. Milnes and Co., Limited, for the supply of car bodies and trucks, £326. 10s. per car, subject to Challenger seats being substituted for Burns seats; and British Westinghouse Company, Limited, for the supply of motors and electrical equipments, £253. 15s. per car.

Bromley (Middlesex).—The following tenders have been received for sundry work in connection with the installation of electric light at the Poplar and Stepney Sick Asylum:

C. Cooper and Co.	£4 075	0	0
Speedy, Enon, and Co.	3,493	10	0
G. Weston and Co.	3 488	0	0
J. C. Christie	3 345	0	0
F. A. Glover and Co.	3,262	0	0
Strode and Co.	3 193	0	0
J. Bolding and Sons, Limited	2 899	15	0
R. Dawson and Co., Limited	2 876	0	0
V. E. Middleton	2,734	10	0
J. J. Roche and Co.	2,596	0	0
Frigell Bros. and Louis	2,550	0	0
National Wiring Company	2,540	0	0
H. F. Joel and Co. and T. Potter and Sons, United	2,439	0	0
Young and Marten, Limited	2 359	0	0
C. Peacock and Co. (accepted)	2,039	0	0
Whittaker Bros., Limited	1,756	19	6

BUSINESS NOTES.

TRACTION.

Rochdale.—The Town Council have approved the terms of the tramway agreement with Heywood.

Chatham.—The work of constructing the proposed electric tramways will be commenced shortly.

Keighley.—The Corporation are about to purchase the Keighley tramways undertaking for the sum of £8,900.

Seaton Carew.—A start has now been made with the construction of the tramway from Hartlepool to Seaton Carew.

Portsmouth.—The work of constructing the permanent way of the Corporation tramways was formally commenced last week.

Swindon.—It was stated at the monthly meeting of the Town Council that the overhead system of traction is to be adopted.

Garston.—The Urban District Council have determined to oppose the Manchester and Liverpool Electric Express Railway Bill.

Surrey.—The County Council have decided to oppose the London United Tramways Bill for the protection of county interests.

British Electric Traction Co.—Issue has been made this week of 30,000 six per cent. cumulative preference shares of £10 each at £11. 10s. per share.

Central London Railway Co.—The directors of this Company announce an issue of £876,000 4 per cent. debenture stock at the price of £118 per cent.

Gateshead Tramways Co.—A meeting of this Company was held on Wednesday at Gateshead for the purpose of confirming the Bill now before Parliament.

Southampton.—The specification for the construction of tramways in St. Mary-street and the reconstruction of the existing tramway in Canute-road has been approved.

Bushey.—The Parish Council have been asked by the promoters to give their consent to the Watford and district tramways scheme. The details are to be considered at a special meeting.

Dumbarton.—At the Town Council's meeting last week the Clerk reported that the applications of the electrical power companies had been ordered to be dealt with by way of private Bill.

Walthamstow.—At a public meeting convened by the District Council a resolution was carried that the meeting approved of the efforts of the Council in promoting an electric tramway scheme.

Holme Cultram.—The Urban District Council have notified the County Council that whatever scheme for electric tramways gave them communication with the West would be acceptable to them.

Wood Green.—At a special meeting of the Council held last week in connection with the East Middlesex Electricity Bill, it was agreed that the Council take no further proceedings in the matter.

East Suffolk.—At a meeting of the Roads and Bridges Committee of the County Council on Tuesday a resolution was passed that "every motorcar shall in future carry a number in front and a number behind."

Prestwich.—The District Council have approved the draft agreement with the Manchester Corporation as to the laying down and working of electric tramways in the Prestwich district by the Corporation.

Manchester.—The Corporation have carried out the greater part of the work of relaying the tramway lines for electric traction on the routes to Cheetham Hill and to Hightown, which altogether cover several miles.

Continental Electric Railway.—The electric railway from Fayet to Chamounix, which is 12 miles long and has several tunnels and earthworks will be inaugurated on July 1, having been completed within two years.

Flintshire.—The County Council have decided to oppose the Bill of the Chester Corporation for powers to lay down an electric tramway from the boundary of the borough to the Stone Bridge at Saltney unless the road be widened.

Huddersfield.—Major Druitt, Board of Trade inspector, has again inspected that part of the Lindley section of the electric tramways with which he had been dissatisfied, and the new cars were started at the end of last week.

Twickenham.—The District Council have refused at the present time to consent to the Middlesex County Council becoming the purchasing authority under the London United Tramways Bill. The Council have sealed a petition against the Bill.

Bury.—The Corporation have notified the Rochdale Corporation that, after due consideration of the question, they are of opinion that it would not be desirable to act in conjunction with the other authorities in the taking over of the existing tramways.

Sheffield.—Although tramcars have been running successfully to Owlerton for some weeks, the formal sanction of the Board of Trade is still required. On Tuesday Major Pringle, R.E., one of the Board's inspectors, inspected the track, to which he raised no objections.

Leicester.—At the last meeting of the tramways company some discussion took place with reference to the decision of the Corporation to purchase the undertaking, and the hope was expressed that the matter might be amicably arranged without resort to litigation.

Ashton.—The Town Council have resolved to proceed forthwith with the construction of the proposed tramways within the borough. The recommendation of the Tramways Committee that the undertaking be carried on wholly by the Corporation and not leased was adopted.

Newcastle.—At a meeting of the Tramways Committee last week it was stated that the Walker Council Board had resolved to accept the offer of the Newcastle Corporation as to running the tramcars to Walker. The committee decided to purchase a turbine for £170 for pumping purposes.

Paddington.—It is rumoured that a scheme of municipal tramways in the borough would meet with approval by a large number of the members of the Council. At the last meeting it was decided to oppose the West and South London Junction Railway and the London United Tramways Parliamentary Bills.

Perth.—On Tuesday a meeting of the Town Council in committee was held to consider the proposal to purchase the tramway system. It was agreed to recommend the Council to offer £20,000 for the system, failing the acceptance of which to make the necessary application to the Board of Trade for arbitration.

Bolton.—The tramway system, which has been in the hands of the Corporation a little more than 12 months, is developing so rapidly that the new car-shed, erected at a cost of about £20,000 for the accommodation of 70 cars, will be too small when completed. Already 59 cars have been delivered, and 22 are still on order.

Leigh.—The Town Council have decided to obtain statutory powers to enable them to construct and work tramways within the borough; and to request the South Lancashire Tramways Company to withdraw from their Bill such clauses as relate to tramways within the borough other than along the main road to Bolton.

Hackney.—The General Purposes Committee in their report recommend that the most strenuous opposition be offered to the City and North East Suburban Electric Railway Bill, and that the North-East London Railway Bill be also opposed; further, that the proposed London County Council tramway along Amhurst-road be approved.

Scarborough.—The Town Council have unanimously resolved to apply for a provisional order empowering them to construct electric tramways in the town. The total cost is estimated at £79,545, of which £70,011 represents the cost of the proposed tramways, and £9,534 the cost of the new street, street widening, generating station, and car sheds.

Edinburgh.—The Corporation have decided to ask the National Electric Traction Company to transfer the powers granted to that company under the Portobello and Musselburgh Tramways Order, 1900, for the construction of a tramway from the termination of the Corporation's present line at Joppa to the city boundary at Magdalene Bridge.

City and South London Railway.—The estimated cost of the subway at Islington to connect the Royal Agricultural Hall with the authorised extension of the line is put down at £40,592, but provision is made in the Bill for the creation of £200,000 additional capital for the purposes of this subway and for the general purposes of the company's undertaking.

Blackpool.—It is believed that the Fylde Water Board's mains are being more or less injured by the electric current from the

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Corporation and the Blackpool and Fleetwood tramways. A committee of the Board having considered the question, recommend the diversion of the mains in some places, and a basis of settlement is expected to be shortly come to.

North Shields.—Although the Board of Trade inspection has taken place, the new electric tramway to Whitley is not yet open to the public. The reason assigned for the delay is that whereas the new power station was able to supply sufficient electricity for the inspection, a regular service could not at once be guaranteed. Within the next few days the trams will probably be running.

Southend.—The Corporation have come to terms with the Leigh Urban District Council as to the construction of the tramway in their district. A further effort is to be made to obtain borrowing powers to the extent of £2,600, the cost of providing new motor-cars and making the necessary alterations for the current to be received at the pier direct from the generating station in London-road.

London United Tramways.—Tests in regard to the possible effect of the electric current for the tramways at Kew upon the scientific instruments at the observatory are still being made. No arrangement has yet been come to with the observatory authorities, but it is confidently expected that this will be effected shortly. Just at present it is unlikely that cars will be run for the public.

Kingston.—The Town Council have addressed a communication to the Surrey County Council, suggesting that the County Council should unite with them in resisting the London United Tramways Bill, and that the County Council should themselves, in consultation with the local authorities concerned, obtain tramway or light railway powers, either by Bill or by order, as may be found the more expedient.

Hampton (Surrey).—The District Council still refuse to give their consent to the tramway company's Bill unless the company widen the Hampton-road in accordance with the plan submitted. The County Council are to be asked what terms they would be prepared to offer to the District Council in the event of the latter consenting to their request that they be allowed to become the purchasing authority.

Dundee.—A conference took place on Tuesday between a committee of the Town Council and a committee of the Dundee and Arbroath Joint Railway Company in regard to the opposition raised by the railway authorities against the Corporation Bill in connection with the tramway extension in Ferry-road. The railway representatives gave no undertaking as to how they would act, and the conference came to a close for further consultation.

Municipal Tramways.—At a conference on the subject of municipal tramways convened by the Educational Arsenal Co-operative Society recently, the following resolution was adopted: "This conference of co-operators and others heartily approve of the principle of municipal ownership of tramways, and pledges itself to support the London County Council in seeking to acquire and work the same, believing such action to be in the best interest of the people at large."

Hyde.—At the last meeting of the Town Council it was stated that application had been made to various members of Parliament, including Mr. E Chapman (the member for the Hyde division) to allow their names to be used as "backers" of the Bill for a joint scheme of electric traction for Hyde Dukinfield Stalybridge, and Mossley, and that Sir James Kitson, Mr. Ridley, and Mr. Platt-Higgins had consented, but that Mr. Chapman found himself unable to back the Bill unless he was assured that by doing so he would not be bound to all its provisions, some of which he objected to.

Barrow.—At present there are absolutely no arrangements for carrying on a tramway service for any length of time, as the official of the Board of Trade, who is in the town, declines to do more than grant a one-day license at a time. Another inspection of the permanent way has been made. So far the Corporation decline to pay the price—£30,000—asked for the tramways, on the ground that before very long they would have to go in for a complete electric service, and that this would entail great cost. The Trades Council have formed a committee to approach the Town Council and urge them to purchase.

Liverpool.—The Council intend to petition against the Manchester and Liverpool Electric Express Railway Bill for the purpose only of obtaining protective clauses. As a result of the recent electric wire accident claims for compensation for personal injuries have been made. The Tramways Committee have resolved that they cannot be entertained. At the adjourned inquest upon the bodies of the two men killed by the accident, expert evidence was given to the effect that the only effective method of averting the danger was to place the telephone wires underground. It was stated that the Telephone Company are doing this in Liverpool as rapidly as possible.

Birmingham Tramways.—From a detailed estimate of the cost of the proposed tramways extensions deposited in the Private Bill office by the City of Birmingham Tramways Company, Limited, it appears that the aggregate length of these extensions is just over 1¼ miles, which is made up of five short junction lines. The total cost of constructing the lines is put down at £14,172, but provision is to be made in the Bill to empower the Corporation of Birmingham to construct four out of the five extensions provided that the Corporation within three months serves a notice on the company stating its intention to do so. In the event of the Corporation constructing these tramways, a lease of them is to be granted to the company. In view of the proposed system of overhead traction to be laid down along the Bristol-road route a report is to be prepared as to the existing telegraph and telephone wires crossing the road, and the fullest precautions will be taken to protect the system against any accident of the kind reported from Liverpool.

Berlin.—The Grand Tramway Company of Berlin, which operates no less than 257 miles of track in the German capital, and employs 7,145 men, carried 236,000,000 passengers last year, as against 188,000,000 in 1899. The methods of working are the overhead trolley system of electric traction (453 cars), the electric storage battery method (420 cars), and horse cars numbering 1 371. The storage battery cars will probably be discontinued at an early date, and the horse cars will also be abandoned when the direct-current system has been introduced throughout the tramway network. Although the working expenses increased owing to higher wages and shorter working hours, and absorbed 59·65 per cent. of the receipts, the net profits for the year amounted to £289,893, as compared with £267,896 in 1899. After paying £89,440 to the Berlin Municipality and other local authorities, in accordance with existing agreements, the company is able to pay a dividend of 11 per cent. for 1900, as compared with 10½ per cent. in the previous year.—*Financial Times.*

Big Electric Railway Scheme.—A gigantic scheme for a direct electric railway route from East to West of England is reported to be on foot. The *Manchester Evening Chronicle* states that the promoters have in view the building of an entirely new railway from Harwich to Porth Dinlleyn in Wales, and another railway connecting with this at Leicester from Hull, the total cost of which, with necessary appliances and dock accommodation at Porth Dinlleyn, is estimated at about 20 millions sterling. The authors of the scheme are Messrs. Bennett and Ward-Thomas, consulting electrical engineers, of Manchester and London, and the promoters are a syndicate of London financiers, who have a preliminary capital of £50,000. The motive power will be provided from electrical stations placed at intervals along the route, and will be communicated to the train through the medium of a trolley wire or rod, on precisely the same principle as that used in overhead electric tram traction. The promoters think that a speed of 100 miles an hour, which would enable people to travel from Harwich to Porth Dinlleyn (which is near to Nevin) in under three hours, will be sufficient for their purpose. Negotiations which have up to the present been carried out indicate the probability of support from most of the county councils concerned, the Hull Corporation, and several of the railway companies.

London County Council.—At the Council meeting on Tuesday the Finance Committee reported, in regard to the tramways scheme, that the estimate of £623 500 provided for the reconstruction of lines between the Tooting terminus and the termini at Westminster, Waterloo-road, and Blackfriars Bridge, and also for the provision of a generating station which will be sufficient to supply power for the whole of the lines on the south of the Thames. The Highways Committee recommended that the expenditure be authorised for the purpose named. The recommendation was adopted. The tenders for the supply of boilers, etc., required for the generating station were opened. The Council have resolved that petitions be presented, if necessary, against the following Bills: Railway Bills—Metropolitan Tottenham and Hampstead Junction, Brompton and Piccadilly-circus (Extensions), Central London, Charing Cross, Euston, and Hampstead (No. 1), Charing Cross, Euston, and Hampstead (No. 2), Charing Cross, Hammersmith and District Electric, City and Brixton, City and North-East Suburban Electric, City and South London, Islington and Euston, King's-road, North-East London, Piccadilly and City, West and South London Junction; Tramway Bills—Bexley Tramways, London United Tramways. The Parliamentary Committee reported that in some cases it might be necessary for the Council to oppose on questions of principle, but in several instances the Council's opposition would only be carried on with a view to obtaining the insertion of clauses. An inspection was held last week at the tramways depôt, Camberwell New-road, of an electrically equipped car and a length of permanent way, similar to that to be laid down for the South London lines.

LIGHTING AND GENERAL.

Royal Tour.—The "Ophir" is to be fitted with a set of wireless telegraphy apparatus.

Dewsbury.—The Electric Power Bills for Yorkshire will be opposed by the Corporation.

Beckenham.—The question of extending the electric light in Beckenham-road is being urged.

Morecambe.—The Alhambra electric lighting dispute is still being carried on by the Council.

Paddington.—The Borough Council have decided to oppose the Metropolitan Electric Supply Bill.

Trowbridge.—The maximum price has been fixed at 6d., the Urban District Council consenting.

Paisley.—Mr. C. F. Parkinson, Morecambe, has been appointed electrical engineer of the borough.

Manchester.—Mr. G. F. Metzger, of Bath, was at Wednesday's meeting of the City Council appointed chief electrical engineer.

Taunton.—Application is to be made for sanction to raise a loan of £17,800 for extension of the Corporation's electric light works.

Leamington.—The Board of Trade have fixed March 1 next as the date for the commencement of the Electric Lighting Order, 1900.

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Weston-super-Mare.—The Urban District Council are earnestly considering the question of lighting the Marine-parade with electricity.

Arbroath.—The Town Council on Tuesday decided that the Corporation should themselves carry out the work of introducing the electric light.

Keighley.—Mr. W. Mackintosh, from the Southport Corporation electricity works, has been appointed to the post of assistant electrical engineer.

Berwick.—We understand that the electric light company are in communication with the Harbour Commissioners with regard to ground for a station.

Harrogate.—The Corporation last week received the electrical engineer's report, and resolved that a third of the net profits be placed to reserve fund.

Pudsey.—A report has been obtained as to the cost of the electric light, which, however, put the expenditure at £25,000 for 65 lights, and was thus found too expensive.

Driffield.—Another attempt is being made to obtain telephone communication for the town, and seems likely to meet with success. Dr. Brand is the moving spirit.

London Gazette.—Mr. R. M. Burgess, chartered accountant, 38, Albion-street, Leeds, has been appointed trustee in the estate of T. A. Flather, 406, Meanwood-road, Leeds.

Tynemouth.—At a recent special meeting of the Town Council it was stated that they had got so many customers for electricity that it would be necessary to enlarge the power station.

Metropolitan Electric Supply Co.—The directors recommend a final dividend for the year ended Dec. 31 of 6s. per share on the original shares and 9d. per share on the new shares.

Ashton.—The Council have asked Mr. Hammond to attend a special meeting of the Works Sub-Committee to be held on an early date to discuss his report and the sub-committee's report also.

Tottenhall.—The District Council have consented to the application of the Midland Corporation for Power Distribution, Limited, for a provisional order for the supply of electrical energy in the district.

Chelsea Electricity Supply Co.—The transfer books of the preference shares and ordinary shares will be closed from Feb. 26 to March 6 (both days inclusive) for the preparation of dividend warrants.

Hastings.—Application is to be made for sanction to the borrowing of £9,500, particulars of which appear in other columns. The existing lighting at the White Rock baths is to be improved, at a cost of £72.

Chatham.—We understand that arrangements have been made for an expert from London to finally report upon the valuation of the electric lighting company's undertaking, which the Corporation are anxious to purchase.

Midsomer Norton.—Mr. Preece recently visited the district, in company with Mr. George Pearson, the surveyors and chairmen of both urban councils, *re* the proposed electric lighting, and his report is expected shortly.

Gateshead.—The Gateshead Electric and Mechanical Supply Company, Limited, has secured the contract for the electric lighting of the large confectionery works of Messrs. Edward Bone and Co., Gateshead-on-Tyne.

Jedburgh.—At a special meeting of the Town Council on Tuesday the agreement between the Council and Messrs. Crompton and Co., London, for the installation and maintenance of electric light in Jedburgh was agreed to.

Brompton and Kensington Electricity Co.—A dividend for the half-year ended Dec. 31 at the rate of 7 per cent. per annum, making with the interim dividend 6 per cent. for the year on the ordinary shares, is recommended by the directors.

Penzance.—A lengthy report on the proposed installation of electric light has been submitted to the Town Council. The scheme involves an expenditure of close on £30 000. Consideration stands postponed until the report has been circulated.

Portsmouth Telephones.—The following notice of motion has been given with regard to the proposed municipal telephones: "That the committee be instructed to have specifications prepared, advertise for tenders, and report to the Council."

Electrical Engineers (Dublin Section).—At a meeting of this society, at the Royal Dublin Society, on Feb. 21, at 7.30 p.m., a paper was read by Mr. Arthur Jacob, member, on "The Electrical Equipment of the Dublin United Tramway Company's System."

Newton Abbot.—An engineer employed by the Electric Supply Company visited Newton Abbot on Saturday for the purpose of selecting a site for the proposed electricity works, which are about to be erected in accordance with the provisional order granted to the company.

W. T. Henley's Telegraph Works Co.—Subject to audit the directors recommend a dividend on the ordinary shares for the past year at the rate of 20 per cent. (less income tax) less the interim dividend of 4 per cent. paid on Sept. 1 last, payable March 1, 1901.

Pacific Cable.—The Victorian Government are communicating with the Governments of Queensland and New Zealand with a view to forwarding a combined message to the Pacific Cable Board, suggesting a joint undertaking with the Eastern Extension Telegraph Company.

Woolwich.—The Electrical Engineer has reported to the Electricity Committee that he has arranged with the contractors to commence laying in the underground mains at Plumstead, weather permitting, in March next.

Stock Exchange.—The Stock Exchange Committee have ordered British Columbia Electric Railway Company's 20,000 ordinary shares of £10 each, fully paid, Nos. 1 to 20,000, and £250,000 4½ per cent. first mortgage debentures of £40 each, Nos. 1 to 6,250, to be quoted in the official list.

Sale of Plant.—The Electric Lighting Committee of the Hull Corporation are prepared to receive offers for four Willans-Siemens direct-coupled steam dynamos, together with spare armatures and other parts, switchboards and accessories. Particulars appear in another column.

St. Albans.—Mr. Hammond has been engaged as expert in connection with the electric lighting provisional order and to advise the Corporation upon the advisability of lighting up by electricity "on their own," or as to which of the three schemes before the committee was the best.

Burton.—The quantity of electricity sold during the past month was 32,600 units, showing an increase of 3,622 units in the corresponding month of last year. Notice has been given of a resolution in respect to an alteration in the price of electrical energy for power and heating purposes.

Evesham.—It has been resolved by the Gas Committee that a system of electric lighting, if introduced, should be in the hands of the Town Council, but that the information at present received does not warrant the committee in recommending the Council to incur the expense of an installation at present.

Partick.—A local paper says the streets are in a bad state just now owing to the operations connected with the laying of telephone wires and electric cables. It may be here mentioned that the Partick councillors did a good stroke of business in their negotiations with the National Telephone Company.

Calverley.—At a special meeting of the District Council on Monday several notices of application for the supply of electrical energy were discussed. A deputation was appointed to obtain further information from the applicants and from neighbouring councils as to the steps they were taking in the matter.

St. Marylebone.—The Lighting Committee are considering the whole question of street-lighting in the borough. They have sanctioned a notice from the Metropolitan Electric Supply Company as to the laying of a 5in. cast-iron pipe along the west side of East-street, from south side of Dorset-street to No. 19.

Lewisham.—The Borough Council have decided to inform the London County Council that it was desirable that a further conference should take place between the representatives of the County Council and the metropolitan borough councils on the subject of generating stations for the supply of electricity in bulk.

Grimsby.—The Lighting Committee on Monday decided that the streets should be lit with electricity after March 31, and that in the meantime the arc lamps now ready and others as they became necessary should be lighted from 7.30 p.m. to 10 p.m. on Thursdays and Sundays, and from 7.30 p.m. to 11 p.m. on Saturdays.

Heywood.—Borrowing powers have been obtained to the amount of £15,000 for the electricity works. An invitation to visit and inspect the electric lighting installation at the county lunatic asylum at Prestwich has been accepted by the Electric Lighting Committee. The vestibule at the electricity station is to be lined with glazed tiles at the height of 4ft. 6in.

Islington.—The former Electric Lighting Committee has been renamed Lighting Committee, and is now constituted as follows: Councillor S. Lambert (chairman), the Mayor (W. J. Crumphy, Esq., J.P.), Aldermen W. Beale and W. Matins, and Councillors P. Gast, J. D. Moore, J. A. P. Usher, W. H. Whadcoat, G. T. Wilson, A. Myers, F. G. Watkinson, L. Wilkins, and A. G. Wylie.

King's Lynn.—The engineer in his last report stated that six additional applications for current had been received during the month, the total number of lamps now applied for being 7,877 of 8 c.p. or equivalent, an increase of 238; and that street lamps had been fixed in Friars-street, Dilke-street, Paxton-terrace, Highgate House, Globe Cottages, All Saints'-street, and Austin-street.

Ormskirk.—A letter from the Ormskirk Urban District Council enquiring whether the Board of Guardians would be prepared to take a supply of electricity for lighting and motive power at the workhouse in the event of the Council being in a position to supply it on terms to be arranged, is before a sub-committee of the Guardians. The opinion appears to be in favour of a separate plant for the workhouse.

Electric Lighting Boards.—The directors of the Company of this name announce that a special demonstration of their electric lighting boards and strips was given recently before the Czar of Russia and several other Royal personages and members of the Government at St. Petersburg. Considerable interest was expressed in the system, the Czar himself personally manipulating the lights on the boards.

Bolton.—There are now 22 churches, chapels, and schools installed with electric light in Bolton supplied by the Corporation, and on Sunday the installation was utilised for the first time at Folds-road Independent Methodist Chapel. The work of installation has been done by the Bolton Corporation fittings department, under the supervision of Mr. Robert Baker, gas and electricity fittings superintendent.

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Hampstead.—An artesian well has been sunk by the Hampstead Borough Council at their electric lighting works, Lithos-road. It is reported that at a cost of £600 the well has been sunk 500ft. and a yield of 600 gallons of water per hour obtained. It has been decided to proceed for another 100ft., at a cost of a further £160, in the hope that a yield of 4 000 gallons an hour can be obtained. This will save £500 per year, and ensure a permanent supply.

Cable Communications Committee.—A meeting of the Cable Communications Committee was held on Tuesday at St. Stephen's House. There were present Lord Balfour (chairman), the Marquis of Londonderry, the Earl of Hardwicke, the Earl of Onslow, Major-General Sir J. Ardagh, Rear-Admiral R. N. Custance, Mr. Roland Wilkins (secretary), and Mr. J. H. Lindsay (assistant secretary). The evidence of Sir Edward Sassoon, M.P., was taken.

Southampton.—The Guardians have decided to reduce the ratable value of the electric lighting works from £2 560 to £800 subject to the consent of the justices at the special rating sessions. The Council intend to apply for sanction to borrow £4.000, the cost of the new engine, foundations therefor, and other works connected therewith. The maximum load for the year was recorded on Christmas Eve, on which day it reached 630 kw., exclusive of the trams, which averaged 200 kw.

Heathman and Co.—We are informed that in consequence of increased business new factory buildings have been erected by this firm, the makers of the well-known telescope ladders, behind 72, Rectory-road, Fulham, to which they have removed their chief offices and the whole of their machinery and workmen. They will continue their west central show and sale rooms at 37, Endell-street, Long-acre, W.C., and their northern show and sale rooms at 7, Pentonville road, Angel, N.

Tunbridge Wells.—We learn that the municipal telephones established at Tunbridge Wells have been warmly supported. The subscribers are in excess of those on the books of the National Telephone Company, and further support has been promised. The municipal telephones are cheaper by about £2 a year. The National Telephone Company are now introducing the party system, under which subscribers are charged 2d. a day, and are otherwise endeavouring to meet the opposition of the Town Council.

Edison and Swan United Electric Light Co.—A payment on account of the dividend of the current year will be made at the rate of 5 per cent. per annum, less income tax, on the "A" shares of the Company, in respect of the half-year ended Dec. 31, 1900. This will work out at 1s. 6d. per share on the partly-paid £5 shares, £3 paid, and 2s. 6d. per share on the fully-paid £5 shares, less income tax. The payment will be made upon the register as it stood on Feb. 19, and the dividend warrants will be posted on March 1.

Court of Common Council.—On Thursday the City Lands Committee recommended the payment of £356 11s. for one quarter's gas supply at the Guildhall and other civic institutions, and of £743. 6s. 8d for three quarters' supply of the electric current at the Guildhall Attention was called to the large amount of the bill for electric lighting purposes, and it was explained that the Corporation paid 8d. per unit, and was bound to pay that amount, and they only received the benefit of 2d. per unit on a very small quantity of the current used at the Guildhall.

Whitehaven.—The electrical engineer has been authorised to obtain cable for carrying out repairs. Messrs. Babcock and Wilcox are making good progress with the erection of the new boilers at the electric light station. The chairman, vice-chairman, and Alderman Dees have been appointed a sub committee with power to arrange for the settlement of all claims as to raising of Ennerdale Lake. Mr. P. J. Watts, formerly electrical engineer to the Corporation, and now assistant electrical engineer to the Manchester Corporation, has been appointed borough electrical engineer.

Wire Cutting.—Robert Connolly, 31, labourer, on Wednesday obtained six months' hard labour for stealing, in December last, nearly 2,000 yards of telephone wire value £3. 10s., belonging to the National Telephone Company. Counsel said that the theft of wire from public places was of very frequent occurrence, and the matter was a serious one, as, in addition to the loss of the wire, communication was stopped from point to point. Mr. Hutton said the prosecuting company was highly satisfied with the work of Sergeant Scholes in tracing the man, and asked the Court to commend him.

Loftus.—The Bill which the Cleveland and South Durham Electric Power Supply Company intend promoting in Parliament is just now engaging the attention of the local authorities in the district, and some of them are not prepared to let it pass through the House undisputed. The Loftus Urban District Council appear to favour the measure on the ground that there is a need for electricity being introduced into the district even for lighting purposes, although the Bill contains a clause to the effect that the company shall not distribute the energy, as an illuminant, to private consumers.

Worksop.—The Clerk stated at Monday's meeting of the Urban District Council that he had been in communication with the promoters of the Derbyshire and Notts Electric Power Company's Bill, and had arranged for an interview, the result of which, he hoped, would be the insertion of a clause providing for the exclusion of the urban district of Worksop from the operation of the Bill. The present loan in connection with the electric lighting scheme will provide for the lighting of the main road from the station to the park gates; if there are demands from other parts of the town other steps will be taken to supply it.

Shields Bridge.—The Parliamentary Committee of the South Shields Corporation have considered the Bill which proposes to establish communication between North and South Shields by means of an aerial bridge. The Town Clerk, in a report to the committee, states that the promoters sought power to work the bridge by electricity, and it was proposed to confer upon the Corporations of South Shields and Tynemouth the power to supply the electric energy, to be used either within or beyond the areas of supply of the Corporations. The present boundary of supply is mid channel, and he (the town clerk) did not advise the committee to consent to such a clause being inserted.

Hampstead.—The Borough Council have adopted a recommendation of the Finance Committee with reference to the letter from the London County Council intimating that they were prepared to issue an order sanctioning the borrowing by the Council of the sum of £17 229 for further extension of plant at the electric lighting station as follows: "That the Council do agree that the cost of all plant and machinery covered by the loan of £17 229 which it may be necessary to renew or replace during the currency of such loan—viz., 42 years—shall be defrayed out of a sinking fund to be provided for that purpose or out of maintenance account."

Carlisle.—At the last Council meeting attention was called to the reports which had appeared in the newspapers as to the discovery at Blackpool whereby the danger arising from telephone wires on the streets might be done away with, and it was agreed that the surveyor and electrical engineer visit Blackpool to see the invention in operation. It was stated that a deputation had waited on the Works Committee of the Health Committee from the Telephone Company to see if they could get permission to put the wires underground. The Works Committee had no objection, but wished to get a proper and complete plan. So far as the committee were concerned, they would like to see the wires put underground.

Hackney.—The Electric Lighting Committee have considered the report given in full in our issue of Jan. 25. To the total of £262 740 the following is added: balance left unsanctioned, £373; extra cost of raising floor of buildings by 3ft., £420; extra cost of lining engine-house with crystopal tiles, £750; office lay by, etc., £3,150; general charges, £307—making the full amount £267 740, and it is recommended to increase the capital expenditure by £25,000. In view of the fact that materials under the engineering contracts are now being delivered on the site, it has been deemed desirable to appoint Mr. L. L. Robinson as clerk of works, who, on behalf of the engineer, will superintend the laying down of the plant at the generating works.

Huddersfield Telephones.—The Corporation are making every effort to secure inter communication between the subscribers to the municipal exchange and the subscribers to the National Telephone Company in the local exchange area. The following are the places included in the Huddersfield telephone area: the borough, Milnsbridge, Golcar, Slaithwaite, Marsden, Stainland, part of Elland, Rastrick Brighouse, Hartshead, part of Mirfield, Kirkheaton, Kirkburton, Farnley Tyas, Shelley, Skelmanthorpe, Shepley, Honley, Holmfirth, Netherton, South Crosland, and Meltham. All the Corporation departments are to be connected with the new exchange, and, in addition, 400 of the most important manufacturers, merchants, and tradesmen have promised to adopt the municipal system.

Vibration.—Vibration is in the air, in more senses than one. It appears that the recent cases against the Central Railway serve as an inducement to litigation elsewhere. Last week a case came before the Sheriff's Court in Aberdeen, where an indictment was sought against the proprietors of the Cults electricity station on account of vibration caused by the beats of their machinery, the noise of which was complained of. Considering that the same machinery has been going since 1894 the neighbours might have had time to become accustomed to the noise. When the case came before the sheriff-substitute he found that the working of the engines was such as to cause the pursuers material discomfort and annoyance, and to seriously restrict and diminish the use or enjoyment by them of their respective properties adjoining the station, and that it had diminished the value of their properties. He also found in law that the noise was a nuisance, and appointed the defenders to lodge a minute stating what measures they were willing to adopt to abate it. On appeal, Sheriff Crawford affirmed these findings, and in respect it was stated at the bar for the defenders that they did not intend to adopt measures for abating the nuisance, granted interdict. The defenders appealed, and the Court expressed opinion—without pronouncing any interlocutor—that the sheriffs were right on the question of fact that there had been a nuisance, and continued the case in order that the defenders might consider whether they could abate the nuisance by means of remedial measures. The same may be said of any machinery. Any noise is a nuisance and until every nuisance becomes actionable we shall have to grin and bear those which are not intentionally objectionable.

Swansea.—A serious conflict of opinion has arisen, says the *Western Mail*, between Mr. Manville, consulting electrical engineer to the Swansea Corporation, and Mr. Cawthra, the resident engineer, on the question of whether the Harbour Trust could be supplied with electric light at a certain price, and at a meeting of the committee on Friday both gentlemen strongly gave expression to their views, Mr. Cawthra stating that 1½d. per unit would result in loss and Mr. Manville that 1¼d. would result in profit. We learn that the Electric Lighting Committee have decided to recommend that the lighting of the docks should be

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done by the Corporation at its present cost to the Harbour Trust, and that what this cost actually is shall, if necessary, be decided by arbitration.

Accident.—At Batley Carr, near Leeds, on Saturday the district coroner, Mr. Maitland, held an inquest on the body of William Woodcock, 25, who met with his death in a singular manner on the previous Thursday at the Chickenley Heath Colliery. While at work with a "tub," the latter left the rails, and, the ironwork coming in contact with the electric switch box, he received a fearful shock, the wire being charged with 500 volts. He was found lying on his side near the tub of coal; a fellow-workman on going to his assistance was knocked down by the electric shock, and could do nothing. A third workman said he also received a shock. It was shown that for 20 minutes Woodcock, who was found dead, had been receiving the full current through his body. Accidental death was the finding of the jury.

Carnarvon.—At a recent meeting of ratepayers a resolution was carried expressing approval of the attitude adopted by the Town Council in opposing the application for an electric lighting provisional order by Mr. Peterson. It was explained that the members of the Council were unanimously in favour of the construction of a tramway to Dinas Dinlle, and it was on the express understanding that it would be carried out with the electric lighting scheme that they promised Mr. Peterson their support. Since then, however, Mr. Peterson had declined to entertain in the proposed agreement any of the terms suggested by the Council as a safeguard, and his application for a provisional order contained no reference to the proposed electric tramway. The Town Clerk said that Mr. Peterson was now asking £1,000 for the provisional order in the event of his getting it.

Notting Hill Electric Lighting Co.—An extraordinary general meeting of the Company will be held on Feb. 27, at 5.30 p.m., for the purpose of passing a special resolution to confirm a Bill the Company is promoting in Parliament with the view of obtaining compulsory powers of purchase over two sites near the south-west boundary of the Company's area of supply. The land is required for a transforming station, but owing to the freeholder refusing his consent to the erection of a building to contain the transforming machinery, the directors have been compelled to apply for these compulsory powers. Should the special resolution be passed, it will be necessary to confirm it at a further meeting, and it is proposed to hold this on the same day as the ordinary general meeting on March 19 next, when the directors' report and the accounts for last year will be presented to the shareholders.

Hull Telephones.—At a recent meeting of the Hull Guardian Society, Councillor Brown (chairman of the Hull Telephone Committee) said the National Telephone Company could not reduce their charges because they were compelled to build up a reserve fund of £11,000,000 by the end of 1911. Ninety-eight out of every 100 messages were local, and therefore the question was not a national one. The Postmaster-General said, "If you take the question up in Hull we will give you every facility for working it, and we will hand our wires now in the town to you." The Post Office also said "If the municipality does not take it up, we will." Alderman Crook said the Corporation had no right to take up any industry unless it had a monopoly. It had no right to be a competitor. They could not borrow money at less than 4 per cent., and it was worse than madness to run into the expense of £70,000 or £80,000 in face of the possibility of the National Telephone Company coming down with their charges. The Chairman said that much would depend upon the number of subscribers.

Ballymena.—Mr. V. H. McCowen's scheme for electric lighting has been submitted. The motive power would be both steam and water, steam being used during the hours of heavy consumption, and water for carrying the night load and charging storage batteries. The three-wire low-tension continuous-current system, with storage batteries, had been recommended, current generated at a pressure of 500 volts, and supplied to consumers at 240 volts. The plant would be duplicated, and capable of supplying 3,000 8-c.p. lamps. The mains laid in the scheduled streets would have a capacity of 30,000 8-c.p. lamps, and, as before stated, the system could be increased to that amount with the addition of feeder mains and motive power and dynamos. The estimated cost of an 8 c.p. lamp per year of 700 hours would be 8s. 9d., or 7d. per unit. The estimated income of the scheme when the 3 000 8 c.p. lamps alluded to are connected would be about £1,500, and the outlay for producing same about £1,465, which would leave a balance of profit of £35. However, as the scheme provides for an additional outlay of, say, £2,500, the output of the current could be doubled and the price per lamp and unit very much reduced. The whole plants and mains were planned with the very latest and most improved machinery, mains, and appliances. A *plébiscite* of the town is to be taken as to whether gas or electricity should be adopted by the ratepayers.

Hove.—At a recent meeting of the Lighting Committee a letter was read from the Hove Electric Lighting Company, Limited, Mansion House-buildings, London, E.C., with reference to an interview which Mr. Smith had had with the surveyor (Mr. H. H. Scott) respecting casing for carrying the company's main underground where it was not possible or convenient to use the culvert system. Mr. Smith had pointed out the difficulties the company experienced in getting the Crompton-Davis casing at all at any price. A report was read on the subject from the borough surveyor, and it was resolved that consent be granted to the company to use a modified form of iron casing in lieu of Crompton-Davis casing, subject to the details being approved by the surveyor, and also subject to an endorsement being placed on the original deed of transfer at the cost of the company. The committee did not consent to the suggestion of using troughing or cast-iron pipes. The committee are proceeding with the lighting scheme as fast as they can, and the whole town will, it is expected, be completed by the end of the year. Referring to the application of the Hove Electric Lighting Company to the Board of Trade on the subject of a change in the voltage, it appears that the committee look at the matter in the same light as the Works Committee, who, when the company wanted to change the voltage to 220 instead of 110, stipulated that no change should be made except with the consent of the consumer. The company are now seeking to get that stipulation altered, so that practically the consumer would have to take the increased voltage whether he liked it or not. The application is not likely to be granted.

London County Council.—The Council on Tuesday agreed to lend the Bermondsey Council £21 140 for the erection of buildings for electricity purposes. The Highways Committee reported that the generating station erected by the Council on the Victoria-embankment for the purposes of the electric light installation for that thoroughfare and Westminster Bridge would be formally opened by the Chairman of the Council on Feb. 23. After the formal opening of the station the electric light will be switched on to some of the parapet lamps on the embankment, and they hoped to have the whole installation completed within a few weeks from the present date. They had directed that each member of the Council should have sent to him a card of admission to the ceremony. The Corporation of the city of London and of the Council of the city of Westminster had been invited to attend. One hundred and twelve applications were received for the appointment of resident foreman for the generating station, and the committee recommended that Mr. John Micklethwaite Harrison be appointed. The chief engineer had reported that the staff for the generating station should consist of two shift engineers and three cleaners and greasers, and two lamp-trimmers. After conferring with the chief engineer, the committee found that it would be sufficient if one shift engineer and two cleaners and greasers be appointed at once, and that the appointment of the others stand over for the present. They recommended that Mr. S. Macnaught be appointed as shift engineer. Sanction was given to the County of London and Brush Provincial Electric Lighting Company's notice, under the Wandsworth Order, 1892, of intention to lay low-tension mains along Tooting Bec-gardens.

Glasgow—The second annual festival of the employés of the Glasgow Corporation electricity department was held in the city hall on the 13th inst. Lord Provost Chisholm presided, and Bailies Maclay and Wilcock, Messrs. W. A. Chamen (chief engineer of the department), J. C. Ward (mains superintendent), R. B. M'Coll (chief clerk), Mr. Poole (chief station engineer), and Mr. Fuller (chief electrical engineer, Ayr), were also present. The Chairman, having expressed his pleasure at being present, referred to the letters that had been addressed to the newspapers complaining of the state of the streets, and said the question had been asked, Who was responsible for the upturning of the streets? If the truth must be told, they had the culprits before them; but he was prepared to say that, so far as he could gather, the department had done their work as rapidly and as effectually as could reasonably be expected of them. The Glasgow Corporation was credited with being one of the most advanced and enterprising corporations in the kingdom, if not in the world, and undoubtedly the success of the various works carried on by the Corporation was due to the employés in the various departments. He did not disparage the value of the great engineers they had at the head of the departments; they were men of high character and outstanding ability; but not one of them, nor all of them combined, could carry on their work without the cordial and loyal assistance of the men who were alongside them, and who carried out their instructions with an energy, loyalty, and intelligence which showed that they were no mere machines, but that their heart and soul was in their work The electricity department was practically in its infancy; there was before them a vast future. He should like the next great discovery in electricity to be made by some subordinate in the department, who would thus show that though he might be in the humblest position he had nevertheless set his mind to study the question. A concert and dance followed.—*Glasgow Herald.*

LEGAL INTELLIGENCE.

WORKMAN'S COMPENSATION CLAIM.

At the Liverpool County Court on Monday an important case under the Workmen's Compensation Act was decided by his Honour Judge Collier, who held that a tramway for electric or other motive power does not come within the Act.

The applicant was a labourer named John Henry Lowther, living in Hector street, Liverpool, and he sought compensation from the Bootle Corporation, by whom he was employed, for the loss of his left eyesight, consequent upon an accident on May 14, 1900, when he was engaged cleaning setts in Rimrose-road, Bootle, a piece of chipping striking him in the face with the result named. The applicant's average weekly earnings were £1. 1s., and he had received from the respondents £19 19s., being 19 weeks' wages. He now asked for half his weekly earnings for as long as his Honour might direct, or for a lump sum in settlement.

Mr. W. H. Quilliam was for the applicant, and Mr. Cuthbert Smith, instructed by Mr. J. R. Clarke, for the respondents.

His Honour, on a technical point, held that a mere intimation to the respondents that the applicant might, under certain circum-

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stances, proceed to litigation, which might refer as well to the Employers' Liability Act as to the Workmen's Compensation Act, cannot be held to be a claim under the latter Act; and he therefore awarded that no claim for compensation having been made by the applicant within six months from the accident, he was not entitled to compensation. His Honour, proceeding, said that he was reluctant to decide the case on a merely technical point, and he had considered whether the applicant was entitled to compensation on other grounds. Having alluded to the circumstances in which the accident happened, and to the nature of the employment, his Honour said Section 7 of the Act provided that the Act shall apply only to employment by the undertakers as hereinafter defined "on or about a railway or engineering work." There was no doubt that the respondents were undertakers within the meaning of the Act, but he held that the tramway lines which were to be laid down did not come within the definition of the word "railway" in the Act. As to whether the applicant was employed by the respondents "on or in or about an engineering work," his Honour, proceeding, said the applicant was dressing stones which had been taken up from the street, and were to be laid down again when the tramlines had been placed in position. His connection with the tramway was remote, but he (the judge) thought that the employment came within the words "on or in or about" the tramway. Then came the question, Was the tramway an engineering work within the meaning of the Act? To arrive at a decision upon that point he must quote the definition of the expression "engineering work" so far as it applied to the present case. "Engineering work means any work of construction or alteration or repair of a railway, harbour, dock, canal, or sewer." He thought that the latter part of the definition relating to machinery did not apply. The question, therefore, according to his view, was reduced to the point—was the tramway being constructed by the respondents a railroad within the meaning of the Act? It was to be observed that there was in the same section a definition of the word "railway." In the definition of the words "engineering work," the word "railroad," a word seldom used in this country, was employed, so he assumed that it might be assumed that a "railroad" was something different from a "railway," but the word "railroad" was never applied to tramlines. Tramlines or tramways were quite well known in 1897, and if the expression "engineering work" was intended to apply to them, he could not think that the Legislature would have omitted to name them, and would have taken the roundabout and unintelligible course of calling them railroads He, therefore, found that the applicant's employment was not one to which the Act applied, and he awarded accordingly.—*Liverpool Courier.*

HARNESS BELTS.

Mr. C. B. Harness, late managing director of the Medical Battery Company, residing at Macaulay road, Clapham, applied on the 18th inst. at the Wandsworth County Court for his discharge

Mr. Achieson, assistant official receiver, stated that the receiving order was made against the debtor on Oct. 11 last. The liabilities amounted to £8,289, and the assets were nothing, and nothing had been realised.

A **Representative** of the proprietors of the *Electrical Review* opposed the application, they being creditors to the extent of several hundreds of pounds, costs of one or two notorious successful actions in the law courts.

His Honour suspended the bankrupt's discharge for three years.

NEW COMPANIES.

The registration of the following companies has been announced during the week:

John S Vaux and Co., Limited (Sunderland)—Capital, £5,000, in £1 shares. Object: to acquire the business of John S. Vaux and Co., and to carry on the business of marine, electrical, and mechanical engineers, etc.

Cleveland and Durham County Electric Power Company, Limited (Middlesbrough).—Capital, £25,000. Object: to produce, store, and supply electrical energy and power and electricity of all kinds for all purposes in the North Riding of Yorkshire and in Durham.

Pile-Bloc Battery Company, Limited (Charing Cross-road, W.C.).—Capital, £25,000. Object: to adopt an agreement with T. F. Harvey, H. C. Harvey, and E. P. Harvey, and to carry on the business of electricians, mechanical and electrical engineers, manufacturers of and dealers in pile-bloc and other batteries and electrical apparatus and appliances, etc.

Rock Bronze, Limited (Manchester). — Capital, £6,000. Objects: to acquire the business carried on at Rawtenstall, Lancs., by the Antifriction Bronze Company, Limited, and to carry on the business of rock bronze manufacturers, mechanical and electrical engineers, machine makers, founders, etc.

Howard Conduit Company, Limited (Manchester).—Capital, £20,000. Object: to acquire the benefit of an indenture of license made between A. H. Howard and W. T. Glover and Co., Limited, to make, use, and exercise a certain invention for improvements in and apparatus for the manufacture of pipes or conduits for electrical conductors, or for conveying liquids or gases, or for analogous purposes.

Kerbey Bowen Electric Syndicate, Limited.—Capital, £20,000. Object: to take over the freehold yacht-building and electric works on Eel Pie Island, Twickenham, and to carry on the business of ship and launch builders, engineers, electricians, electrical engineers, etc.

City and Suburban Electric Carriage Company, Limited.—Capital, £500. Object: to carry on the business of cycle, velocipede, carriage, vehicle, launch, and flying-machine builders, electricians, etc.

Designograph Company, Limited.—Capital, £10,000. Object: to acquire certain inventions by H. Mackintosh, of 23, Bank-street, Bradford, or any other inventions, and to carry on the business of designers, dealers in designs, machine makers, opticians, electricians, etc.

Braby and Tomlinson, Limited.—Capital, £10,000. Object: to acquire the business heretofore carried on at 15, Hart-street, Bloomsbury, W.C., by Messrs. Pritchetts and Gold, and to carry on the business of electrical, etc., engineers, electricians, etc.

C. Lindley and Co., Limited.—Capital, £60,000. Object: to acquire the business of merchants and manufacturers of engineers' stores carried on at London, Bradford, and Sheffield by Richard H. N. Lindley under the style or firm of C. Lindley and Co., and to carry on the business of electrical and mechanical engineers, electrical or other railway and tramway contractors, manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other appliances and apparatus.

Okonite Company, Limited.—Capital, £120,000. Object: to acquire the undertaking and assets of the Okonite Company, Limited (in liquidation), to manufacture and deal in insulated and other wires and cables capable of use for telegraphic, telephonic, and other purposes, and for electric lighting and the conveyance of electricity, and to carry on the business of manufacturers of and dealers in okonite and other insulating materials and things used in connection with electricity, etc.

Walter Scott and Middleton, Limited.—Capital, £250,000. Object: to adopt an agreement between Walter Scott, John T. Middleton, and Charles T. Scott of the first part, Thomas T. Middleton, and the Company to carry on the businesses heretofore carried on by Walter Scott and Co., and to construct, equip, develop, administer, and control public works and conveniences of all kinds, including railways, tramways, docks, harbours, wharves, canals, electrical and other works, etc.

Beck and Moss, Limited.—Capital, £2,500. Object: to acquire the businesses carried on at Hanley by William Moss, Beck and Moss, and Larsen and Co., and to carry on the business of electric metallurgists, electrotypers, electroplaters, enamellers, fitters, electrical and general engineers, etc.

Plumpton Bros. and Co., Limited.—Capital, £100. Object: to carry on the business of electrical engineering in any form whatever, etc.

Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited.—Capital, £1,200,000. Object: to adopt an agreement between La Companhia Primitiva de Gas de Buenos Aires and H. Ward, to acquire gas or electric light works in the River Plate and other countries in South America or elsewhere, and to carry on the business of manufacturers, generators, and suppliers of gas, electricity, and other illuminants and force, engineers, engine and machinery builders, gas and electric stove makers, wharfingers, contractors, etc.

Woodcock and Co., Limited (Plymouth).—Capital, £25,000. Object: to adopt an agreement with W. T. F. Rowe, James Skewes, and Josiah Skewes, and to carry on the business of brass and iron founders, mechanical and electrical engineers, hardwaremen, etc.

London and Provincial Electric Construction Company, Limited.—Capital, £75,000. Object: to apply for, obtain, promote, and deal with Acts of Parliament and provisional or other orders or other authorities or licenses relating to the incorporation of a company or companies for the construction of underground or overground railways or tramways to be worked by electricity, to oppose any Bills or applications, to adopt an agreement between Louis Bernt of the one part and Elliott G. Mason (for the company), to construct, equip, maintain, and work by steam, electricity, cable, or other mechanical power any railways and tramways, and to carry on the business of railway, tramway, omnibus, and van proprietors, electricians, electrical and general engineers, etc.

PROVISIONAL PATENTS, 1901.

FEBRUARY 11.

2900. Improvements in and relating to fusible cut-outs for electric circuits. H. M. Salmony and Co., Limited, 11, Southampton-buildings, Chancery-lane, London. (Elektrizitäts Actien-Gesellschaft, vorm W. Lahmeyer und Co., Germany.) (Complete specification.)

2909. Improvements in or relating to overhead trolley wires or conductors for electric traction overhead, electric cables, telephone, telegraph, or like wires. Augustus Wyvill Hancock, John Leighton, and Robert Hacking, 111, Hatton-garden, London.

2933. Improvements in electrodes for secondary batteries or accumulators. Carl Adolf Wilde, 22, Southampton-buildings, Chancery-lane, London.

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2877. Trolley guard wire safety device. Donald Smeaton Munro, 58, Kelvingrove-street, Glasgow.

2940. An improved system for transmitting messages, particularly telephone messages. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Louis Warren Southgate, United States.)

2941. Improvements in thermo-electric batteries. Lucian Gottscho, 18, Southampton-buildings, Chancery-lane, London.

FEBRUARY 12.

2962. Improvements in guards for electric trolley wires. Arthur Henry Gledhill, Trinity Works, Halifax.

2982. Insulater for electrical conduction wires. Morton Harloe, 60, Woodstock-road, Finsbury Park, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 19, 1900, being date of application in United States.) (Complete specification.)

3015. Improvements in electrical alarm and other like apparatus. Edwin Whiting and Robert Carr Myddelton, 115, Cannon-street, London.

3026. Improvements relating to closed conduit electric railways. Léon Dion, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3030. Improved method of and means for holding and connecting the wires of telephone receivers and the like. Francis George Bell and Max Byng, 165, Queen Victoria-street, London.

3035. Improvements in or relating to trolley or like current collectors for electric tramways and the like. Francis Edward Shaughnessy and George Johnston Thomas, 6, Lord-street, Liverpool.

3036. Improvements in or in connection with trolley or like current collectors for electric railways and tramways. Artemus Boutelle Eupham, 6, Lord-street, Liverpool.

3047. Improvements in apparatus for regulating pressure in electric mains connected to storage batteries. John Somerville Highfield, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3081. Electric generater. Joseph Stretch, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 13.

3087. Improvements in electrical starting and regulating switches. Arthur Henry Hickley, 10, St. George's-crescent, Liverpool.

3111. Improvements in systems of electrical distribution. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc, Act, 1883, Sec. 103, July 14, 1900, being date of application in United States.)

3112. Improvements in systems of electrical distribution. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 14, 1900, being date of application in United States.)

3113. Improvements in rotary field magnets for electrical machines. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883 Sec. 103, July 14, 1900, being date of application in United States.)

3123. Improved insulating conduit for the conductors of electric tramways. Paul Christian Seguy, 53, Chancery lane, London.

3127. Improvements in guards or protectors for trolley wires and other electric conducters. Simon Cristol, 6, Lord-street, Liverpool.

FEBRUARY 14.

3164. Improvements in electric ignitions for gas-engines and motors. Richard Hoyle and Silvestre Wilson, 4, St. Ann's-square, Manchester.

3177. Improvements relating to electrical traction systems. Egerton Goolden Pulford, 10, St. George's-crescent, Liverpool.

3179. Apparatus for governing the output of dynamos when driven at different speeds. Horace James Jordan Hummel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3181. Improvements in or applicable to dynamos and other electromagnetic machines. Felix John Howitt and P. R. Jackson and Co., Limited, 70, Deansgate, Manchester.

3190. Improvements in apparatus for controlling or breaking electric circuits. Andrew Thomas Smith, jun., and Percy Ruskin Allen, 55, Chancery-lane, London.

3192. Improvements in electric furnaces. Philippe Jurie, 70, Chancery-lane, London. (Complete specification.)

3206. Equalising appliances for interconnected polyphase currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

3221. Improvements in safety appliances for electric trolley wires or cables. William James Nash, 6, Lord-street, Liverpool.

3297. Improvements in telephone installations having a central microphone battery. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

3225. Portable X-ray apparatus. Augustus Rosenberg, 53, Chancery-lane, London.

3264. Improvements in or relating to electric ignition devices for explosion engines. Wilhelm Maybach, 111, Hatton-garden, London.

FEBRUARY 15.

3247. Improvements in or relating to safety guards for overhead electric wires. Thomas Warburton Redford, 57, Dorset-street, Bolton.

3250 Improvements in and relating to call registers for telephones. William Henry Turner, Burnley.

3281 A new or improved light ampere-meter for electrical measurements Herbert Ernest Hart, 73, St. Stephen's-road, Upton Park, London.

3284. Improvements in protectors for sparking plugs of petroleum motors with electric ignition. Robert James Paton, 18, Fulham place, Paddington, London.

3288. Improvements in or applicable to dynamos and other electromagnetic machines. Felix John Howitt and P. R. Jackson and Co., Limited, 70, Deansgate, Manchester. (Complete specification.)

3291. An anti-vibration base-frame for explosion and other motors, dynamos, and other mechanism, appliances, or apparatus. George Middleton, 8, Quality-court, Chancery-lane, London.

3310. Improvements in and relating to electrical ignition devices for internal-combustion engines. Tom Bousquet Browne and Francis Leigh Martineau, 70, Chancery-lane, London.

3313. Purifying beverages and liquids by means of manganates under influence of the electric current. William Phillips Thompson, 322, High Holborn, London. (Société Mangano Electrique pour la purification des eaux et des boissons, France.) (Complete specification.)

3321. Improvements relating to Rontgen-ray apparatus. James Mackenzie Davidson, 323, High Holborn, London.

FEBRUARY 16.

3350. Improvements in and relating to protectors for trolley wires of overhead driven electric tramways. James Townsley Pearson, St. James's Hall, Burnley.

3353. An improved safety guard to be applied to the trolley wires used for actuating electric tramcars. William Henry Cottam, 4, St. Ann's-square, Manchester.

3370. Improvements in battery electrodes. John Liddle, 154, St. Vincent-street, Glasgow. (The Globe Electric Company, United States.) (Complete specification.)

3376. Improvements in electric arc lamps and electrodes therefor. Charles Andrew Lee, 56, Paulton-square, Chelsea, London.

3386. Improvements in electrical heat radiators. John Coley-Bromfield and William Herbert Milnes, 33, Cannon-street, London.

3387. Device for automatically breaking circuit of trolley wires. Amos E. Barber, 222, High Holborn, London.

3388. Improvements in magneto-electric igniters. William Phillips Thompson, 6, Lord-street, Liverpool. (Joseph Boiron, France.) (Complete specification.)

3390. Improvements in switches or cut-outs for overhead electric wires. William Thomas Smith, 6, Bank-street, Manchester.

3391. Improvements in secondary batteries. Richard Frederick Yorke, 19, Holborn viaduct, London.

3397. Improvements in commutator brushes. Siemens Bros. and Co., Limited, Robert Dumas, and Charles Rowland Palairet, Birkbeck Bank chambers, Southampton-buildings, Chancery lane, London. (Complete specification.)

3398. Improvements in or relating to overhead trolley wires for electric traction, overhead electric cables, telephone, telegraph wires, or the like. Augustus Wyvill Hancock, John Leighton, and Robert Hacking, 111, Hatton-garden, London.

3401. Improvements in apparatus for use in the electro-deposition of metals. Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

3402 Improvements in apparatus for use in the electro-deposition of metal upon tubes. Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

3411. Improvements relating to electric accumulators. Michel Pisca, 45, Southampton-buildings, Chancery-lane, London.

3413. Improvements in and relating to electric motor starting, regulating, controlling switches and like apparatus. Hugh Hirst and William White, 165, Queen Victoria-street, London.

3416. Improvements relating to the construction of electrodes containing zinc for use in electric batteries and method of producing and employing the same. Wilhelm Erny, 18, Buckingham-street, Strand, London.

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3417. Improvements in galvanic batteries. Wilhelm Erny, 18, Buckingham-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on March 9.

1900.

3124. Methods of and apparatus for manufacturing coils for use in connection with electrical instruments. Weston.

3264. Armatures of electric motors, specially applicable for use in meters for electric currents. Perdrisat.

3834. Electric generators and motors. Storer. (Date applied for under International Convention, July 28, 1899.)

4921. Electrical method for securing uniform time in clocks. Grant.

5786. Electric cables. Nisbett.

6616. Apparatus for forming a silence chamber for telephonic purposes and the like. Dewar and Sherman.

6826. Switches for electric currents. De Janisch.

6923. Loud-speaking telephones. Dussaud.

7356. Electrical incandescence lamps. Schattner and Harmer.

8668 Electric arc lamps. Interstate Electric Company and Melzer.

9552 Electric arc lamps. Bremer.

11547. Fittings for overhead trolley systems of electric tramways. Hill.

11824. Telegraphy and apparatus connected therewith. Bull.

19099. Electrodes for accumulators of electricity. Myers.

20186. Electrically and pneumatically controlled air brakes for railway and like vehicles. Abel. (Siemens und Halske Aktien Gesellschaft.)

21629. Tachometers. British Thomson-Houston Company, Limited. (Haskins.)

21217. Electric current regulators. Justice. (Erie Exploration Company.)

22233. Electric railways, tramways, and the like on a sectional conductor system. Kandó.

23100. Galvanic batteries. Allison. (Waterbury Battery Company.)

23107. Galvanic batteries. Allison. (Waterbury Battery Company.)

23387. Manufacture of braided cords or cables for electric lighting and like purposes. Schürmann.

23394. Electric brake systems. British Thomson-Houston Company, Limited. (Case.)

23743. Electric battery cells. Tiquet.

23890. Insulating and protective coatings especially applicable to electric conductors. Peust and Apel.

1901.

688. Construction of telephone cables. Tremain.

840. Electric safety fuses. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Feb. 16	520	515	+ 5	25,302	21,984
Birmingham Trams.	,, 16	3 954	3 622	+ 331	26 867	—
Blackburn Corp'rat'n	Jan. 13	1 191	—	—	2 724	— *b*
Blackpool Corporatn.	Feb 14	164	98	+ 66	29 354	21,592
Blackpool-Fleetwood	,, 16	136	99	+ 37	950	970
Bolton Corporation..	,, 17	1,236	—	—	9,194	—
Bradford City Trams	,, 17	771	314	+ 457	5,122	2,330
Bristol Tramways Co.	,, 15	3,374	2 217	+1 157	—	—
Carlisle Tr'mw'ys Co	,, 2	106	—	—	558	—
Central London Ry.	,, 16	6,131	—	—	42 838 *a*	—
City & South London	,, 17	2 040	1,160	+ 880	14,039	7,899
Cork E. T. and L. Co.	,, 14	328	*169	+ 159	2,171	1 901
Dover Tramways ...	,, 16	141	147	— 6	1 069	1,028
Dublin & Lucan E.R	,, 16	71	47	+ 24	490	357
Dublin U.T., elec. cars	,, 15	3,102	2,710	+ 392	—	—
Dublin S.D. Electric	,, 15	672	529	+ 143	—	—
Dundee Tram Co. ...	,, 13	439	333	+ 106	—	—
Glasgow Corporation	,, 16	7,800	7,780	+ 20	—	—
Halifax Corporation	,, 18	688	467	+ 221	35 048	27,546
Huddersfield Corp'n.	,, 16	600	544	+ 56	31 880*b*	29 349
Hull Corporat'n E.S.	,, 16	1 428	625	+ 803	62 746*b*	—
Liverpool Corporat'n	,, 9	7,599	5,912	+1,687	47 098	39 008
Liverpool Overhead	,, 17	1.424	1,243	+ 181	10,337	10,140
Portsmouth Corpn...	,, 16	519	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	,, 17	2,792	—	—	—	—
Southampton Trams	,, 14	531	301	+ 230	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways.	,, 8	325	213	+ 112	2,028	1,316

* Traffic was stopped for two days due to heavy snowstorm.
a From July 30, 1900. *b* Since April 1, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	11-12
——— 40,001-70,000	5	..	11-11½
——— 6 per cent. Cum Pref., 1-40,000	5	..	5½-6½
——— 5 per cent. Mortgage Debentures	100	—	100-105
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
——— 6 per cent. Cum. Pref., 1-50,000	1	—	⅛ ¼
——— 4½ per cent. First Mortgage Debentures	108	—	85-90
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½ 4¾
Brush Electrical Engineering, Ordinary	2	—	1⅝ ⅞
——— Non. Cum., 6 per cent. Pref.	2	—	2⅛ 2⅜
——— 4½ per cent. Debenture Stock	100	..	106-110
——— 4½ per cent. 2nd Debenture Stock	100	—	101-105
Callender's Cable, Debentures	100	—	109 113
——— Ordinary	5	—	13½ 14¼
——— 5 per cent. Pref.	5	—	5¼ 5½
Crompton and Co.	3	—	3¼ 3½
——— 5 per cent. Debentures	—	—	100-105
Edison and Swan United, Ordinary	3	—	1½-2
——— 5 per cent. Debentures	5	—	3¾-4¼
——— 6 per cent. Deb. Stock, Red.	100	—	98-90
——— 5 per cent. Second Deb. Stk., Prov. Certs.	—	—	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1⅝-2⅛
——— 7 per cent. Cumulative Pref.	2	—	2½-3
——— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
W. T. Henley's Telegraph Works, Ordinary	5	—	15½-16½
——— 4½ per cent. Preference	5	—	5½-6
——— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21½
——— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	41-45
——— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	11-12
——— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	—	10½-11½
——— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7½
——— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅞-1
——— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	—	70-75
Bournemouth and Poole, Ordinary	10	—	12½-13½
——— 4½ per cent. Cum. Pref.	10	—	10-11 xd
——— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7⅞-8⅛
——— 7 per cent. Preference	5	—	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¾-7⅛
Charing Cross and Strand	5	..	9½-10⅛
——— 4½ per cent. Cum. Pref.	5	—	5¼-5⅝ xd
Chelsea Electricity Supply	5	—	6¾-7
——— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	7-8
——— 6 per cent. Cumulative Pref.	10	—	13-14
——— 5 per cent. Debenture Stock	100	—	122-127
——— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	..	101-103
County of London and Brush Provincial, Ordinary	10	—	8¼-9⅛
——— 6 per cent. Cum. Pref.	10	—	11½-12½
——— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	100	—	106 109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5⅛
——— 4½ per cent. First Mort. Deb.	100	—	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7½-8¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10½
London Electric, Ordinary	3	—	1½-2
——— 6 per cent. Pref.	5	—	4-5
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	12½-13½
——— ,, 35,001-98,769	5	—	7-8
——— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
——— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1⅛-1⅜
——— £5 Shares	5	—	7-7½
——— £4½ Shares, New	4½	—	5⅜-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	170-190
——— 4½ per cent. First Shares Mortgage Debentures	$100	..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
——— 4 per cent. Debenture Stock	100	—	80-90
South London, Ordinary	5	—	2¼-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15 xd
——— 7 per cent. Pref.	5	—	8½-9½
——— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
——— 20,001-109,437	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9-9½
——— Pref. Half-Shares	5	—	4½-5⅛
——— ,, ,, deferred	5	—	4-4½
City and South London, Consolidated Ordinary	100	—	46-50
——— Ordinary	10	—	4-5
——— 4 per cent. Debenture Stock	100	—	115-120
——— 5 per cent. Pref. Stock '91	100	—	132-137 xd
——— ,, ,, '96	100	—	127-132
Liverpool Overhead, 5 per cent. Pref.	—	—	13½-13¾
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9⅜-10½
British Electric Traction, Ordinary	10	—	13¾-14½
——— 6 per cent. Cm. Pf. 30,001-60,000	10	—	11½-12½ xd
——— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅜-5⅛
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4½-5
——— 5 per cent. Deb. Stock, Red.	100	—	104-107
——— Prov. Cert., all paid	10	—	9⅜-10½
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
New General Traction, Ordinary	5	—	4⅛-5⅛
——— 6 per cent. Cum. Pref.	10	—	16-17
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10⅝
——— 5 per cent. Cum. Pref.	10	—	11½-13⅛
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½ 12½
——— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11 xd
——— 4½ per cent. Debenture Stock	100	..	106-108
Telephones.—			
National Telephone, Ordinary	5	..	3¾-4
——— 6 per cent. Cum. First Pref.	10	..	13-14
——— 6 per cent. Cum. Second Pref.	10	—	11-13
——— 5 per cent. Non. Cum. Third Pref.	5	..	4⅜-5⅛
——— 4 per cent. Deb. Stock, Red.	100	..	98-101
——— 3½ per cent. Deb. Stock, Red	100	—	94-97
Oriental Telephone and Electric Company	1	—	¾-1⅛

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NOTES.

Electrical Engineers Volunteers.—We are pleased to see that the services of the officers of the Electrical Engineers (R.E.) Volunteers who went to the front have been recognised. An order has just been made that the complimentary army rank corresponding to that which they held in the field is to be conferred upon them.

Institution of Electrical Engineers.—The secretary informs us that, through the kindness of the Institution of Civil Engineers, an extra meeting has been arranged for Thursday, March 7. If the discussion on Mr. Madgen's paper is concluded at this week's meeting, Mr. O'Gorman will read his paper on "Insulation of Cables."

London Chamber of Commerce.—The prize distribution in connection with the recent examinations under the commercial education scheme of the above chamber of commerce will take place at the Mansion House on Monday next, March 4, at 2 p.m. The prizes are to be presented to the successful candidates by the Right Hon. C. T. Ritchie, M.P. The "China" dinner will be held at the Trocadero Restaurant on the 20th inst.

Surface-Contact Rails.—We understand that recently the electric tramways in Paris worked on the surface-contact system have given considerable trouble due to leakage. The company owning these lines used salt to keep the same free from ice, with the result that there was a very considerable leakage over the surface of the roads. Actions for damages are talked of in consequence, as a number of horses and men were subjected to more or less severe shocks.

Trans-African Telegraph Line.—Considerable progress has been made with the laying of the African and Trans-Continental telegraph line. The surveying party, which recently arrived at Ujiji, Lake Tanganyika, report that the survey is pegged out to Karema, 150 miles north of Kituta, and the preliminary survey between Karema and Ujiji is being made. The line, which at present has been laid for about 60 miles north of Kassanga, will then go up from Ujiji, round the south-east coast of the Victoria Nyanza, cross the Uganda Railway, skirt the country west of Lake Rudolph and then follow the Abyssinia, work round slightly to the west, and so on to the Nile.

Probable Government Ownership of Canadian Telegraphs.—The Canadian Parliament will shortly have to consider the advisability or otherwise of purchasing the telegraph lines of the Great North-Western Telegraph Company and of the Canadian Pacific Railway Company. The Government will raise the question at an early date, and it is expected that the scheme will meet with the approval of the majority, having regard to the fact that the two concerns duplicate each other in almost all the important centres of Canada, and under Government ownership therefore the working expenses could be considerably reduced. The purchase price is put at between five and six millions sterling.

The Yorkshire Power Bills. — The Bradford Chamber of Commerce, after considering the matter at a special meeting last week, have decided to adopt a neutral attitude towards the two rival schemes for supplying Yorkshire with electric power. The solicitors to the scheme of the South Yorkshire Electric Power Company sent a letter contending that the provisions contained in their Bill were much more favourable to the consumer than those contained in the Electric Power (Yorkshire) Bill. Further, they asked that a deputation might be allowed to wait on the Chamber to explain the scheme in detail. It was, however, determined not to take any further action in the matter, an amendment that the Chamber should approve the principle of the two schemes being defeated

Magnetic Observatories.—From extracts which the *Electrical World* publishes of a report by the superintendent of the United States Naval Observatory at George Town, near Washington, we gather there are only two magnetic observatories which up to the present have been rendered useless in consequence of stray currents from electric tramways. We also understand that some two or three magnetic observatories are either planned or in actual course of construction in situations in which they should be free from magnetic disturbances for many years to come. The superintendent in question, however, calls for protection for his own observatory from the stray currents set up by the tramway systems near Washington. We are afraid, however, that here again the magnetic observatory will have to give place to the convenience of the public.

Enclosed Arc Lamps.—We understand that another combine in the United States has resulted in the Marks patents for enclosed arc lamps being acquired by the General Electric Company. As has previously been the case for so many electrical inventions in that country, a dispute between two rival concerns over the validity of the patents owned by one has resulted in the combination of the two firms. We see it stated in certain of our American contemporaries that the General Electric Company agreed to buy the Marks patents because they decided that they were valid and had value. Up to the present these patents have not been fought in the English courts, and their owners have not shown any great eagerness to put them to a trial. In spite of this a number of licensees are paying royalties under agreements by which they are debarred from ever taking the initiative in contesting the validity of the patents in question.

Birmingham Tramways Bill.—In a report which has just been laid on the table of the House of Commons the Examiners of Private Bills explain why the Birmingham (City) Tramways Bill was referred to the Standing Orders Committee. In view of the fact, the report runs, that when the latest alteration in the Standing Order applicable to the case was drafted, the invention of the system of electrical traction was not contemplated, the Examiners were of opinion that the words "when such Bill contains powers authorising any alteration or disturbance of the surface of any street or road" were limited in their application to the case of constructing an underground railway, and did not relate to the tramway; therefore, if anything ought to be done further for the protection of the public, or the owners and occupiers affected in view of the powers of the company to place posts and so on in the road, it would have to be done by amending the Standing Order.

Rontgen Society.—On the conclusion of the formal business of the ordinary meeting of this society to be held at eight o'clock on Thursday, March 7, smoking will be permitted and refreshment provided in the shape of tea and coffee. It is to be an exhibition evening. Skiagrams, negatives, and any objects of interest will be welcomed, but only such apparatus can be exhibited as possesses some special novelty, and has not been previously shown to the society. A lantern will be provided, and members are invited to bring slides of interest, a maximum of 12 slides for any individual member being the limit. Dr. G. B. Batten and Mr. George Sutton have promised to show a new rectifier for transforming alternating currents into direct currents, while Dr. E. Reginald Morton will show another for the same purpose. A 15in. spark semi-portable coil with Hedgehog core will be exhibited by Mr. Bowron. Other apparatus of interest include a coil of entirely new

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design, a regenerating tube of new design, a new ward outfit, and a set of normal skiagrams. Mr. J. Macintyre, the president, will preside.

Steam-Turbines.—In the early days of town-lighting by electricity the area of the city of Newcastle-upon-Tyne was divided into two portions, over one of which the Newcastle-upon-Tyne Electric Supply Company had powers to supply electric light. The other area was placed in the hands of the Newcastle and District Electric Lighting Company, and the station of this company was equipped completely with Parsons steam-turbines. The success of these works has been largely responsible for the introduction of steam-turbines elsewhere. As was to be expected, the rivalry between the two companies in the same town was exceedingly keen, although they were not actually in competition in any part of the town. We are now informed that an order has been given by the Newcastle-upon-Tyne Electric Supply Company to Messrs. Parsons and Co. for a steam turbine-alternator, which conclusively shows that the engineers of the first-named company have been assured as to the success of the machinery used by their rivals. The output of this new alternator, which is for three-phase working, will be 1,500 kw., the voltage between any two pairs of wires will be 5,750, while the frequency will be 40 complete periods per second. We gather from particulars supplied that this new plant will be worked condensing, and that the air-pumps for the condenser will be driven by electric motors.

Berlin Tramway Accidents.—With a view to reducing the large number of fatal and other accidents which have lately occurred on the Berlin electric tramways, many reforms are proposed to be made on the system. This is the outcome of the official enquiry just concluded, which was undertaken by the Minister of Public Works and the Minister for Home Affairs in conjunction with the police authorities and the tramway company. For instance, brakes are to be introduced on the cars, and to this end a series of experiments with different types of brakes will be carried out. In the case of a passenger boarding the rear platform of a motorcar which is hauling a trailer car, the company has been asked to submit proposals for providing the space between the car and the trailer with a safety contrivance. The object of this would be to prevent passengers from falling between the two cars. Further, it is suggested that the speed of the cars should be somewhat reduced, especially on curves, at crossings, and where children may be playing, and that strict attention should be paid to the instruction of the drivers and conductors in the fulfilment of their duties, this being regarded as a guarantee for a reduction in the number of accidents. We understand that the majority of the accidents complained of occurred with independent vehicles driven by accumulators, and not with tramcars running on a definite track. In the latter circumstances, of course, the risks are considerably reduced.

Tramway Accident.—The jury's verdict respecting the tramway accident at Birmingham, by which a boy lost his life, was "accidental death," but the coroner added to the verdict certain remarks as to the protection of the public by means of fenders to be placed in front of the engines. Our readers will know that the Birmingham tramways are driven by means of steam-engines, and it was under one of these that the boy was killed. The space between the engines and the track is, we gather, exceedingly small, and the tramway company have guards fixed to reduce the clearance to the minimum. The rest of the evidence given at the inquest was to the effect that the car was going very slowly, and that the boy ran in front of it, being knocked down in the middle of the track. The question now arises as to how far it is possible to devise a fender which shall not cause more accidents than it prevents. The clearance between the track and the fender has to be exceedingly small if a child cannot be drawn in. The great objection to most of the fenders which have been devised up to the present is that they project a considerable way in front of the car. In consequence of this, when the tramcars are going round curves the fenders are not over the tracks, and they are also in the way of people trying to cross. The whole question is one which has to be considered on broad lines, and we believe that no one more than the engineers to the Board of Trade recognises the great difficulty there is in the design of a really efficient fender.

Telegraph Services.—One test which can be applied of the efficacy of the telegraph system of any country is that of the number of messages which are sent by it per annum. Inefficient service or high rates will keep down the number of messages, and the actual number sent per head per annum gives a very good means of ascertaining the final results. For the last year for which the Post Office report has been issued there were just over 90 million messages sent. With the population of the British Isles this comes out at about 2¼ messages per head, while the average cost per message was only 7½d. In the United States, on the other hand, somewhere about 80 million messages are sent per annum, but in view of the larger population the average is only about one per head. A point in connection with this is that the average cost in the United States is something like 1s. 3d. per message, or 100 per cent. higher than the average cost in the British Isles. It would not be fair to conclude at once that this higher cost is due to the fact that the telegraphs in the United States are owned by companies, whereas in England the telegraph system is owned by the State. This, no doubt, is a feature in the cost question, as the companies earn and distribute a considerable profit each year. Another point which enters into it, however, is that the 80 million messages sent in the United States per annum require a much greater total length of wire owing to the bigger area served. In view of the above figures, we, as a nation, have every reason to be proud of our telegraph system as it exists at the present time, but even now there is room for improvement, and we trust that the Post Office engineers will continue their efforts to increase the output which can be obtained from a given number of line wires.

Smoke Nuisance.—When the electric lighting of a town is in the hands of a corporation, a summons for smoke nuisance becomes almost a departmental matter. We are informed that at Bolton recently the Corporation, as owners of the electric light station, were summoned by their own medical officer of health because an order which was made on Sept. 15, 1900, for the abatement of the smoke nuisance arising from the chimney at the electricity works had not been complied with. According to the evidence brought forward by the medical officer of health, the chimney in question ejected thick black smoke for eight minutes consecutively on Jan. 9. The electrical engineer to the Corporation claimed that the department was being conducted with all due care, and that devices to prevent smoke nuisance had been erected since September last. He also added that a contract for a new chimney shaft was to be let in the course of a week. Under the present circumstances he could not see what more could be done, as the works had to supply the public with electrical energy under penalties. Our readers will notice that it is only about four months since the previous summons was heard, and from the evidence given we gather that the

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electrical department have been looking into the matter, and are making improvements which will prevent the nuisance complained of. We think, therefore, that the chairman of the police court was hardly warranted in the caustic remarks he made. He said, for instance, the worst of the defendants was that if he fined them it was only fining one department of the Corporation to put the money into the hands of another department. On the advice of the town clerk the unlucky electric lighting department was finally let off with half a sovereign fine and costs, with the alternative of seven days' hard labour. We presume that this alternative would rightly have fallen on the chairman of the Electric Lighting Committee.

Uniform Tramway Gauge.—On the question of a uniform gauge for electric tramways, Mr. T. M. Healy last week in the House of Commons asked the President of the Board of Trade whether his department had considered the desirability of prescribing a standard gauge in future Acts, so as to enable towns to be electrically connected in this country, as in America, without break of gauge. The reply of Mr. Gerald Balfour was in these terms: "The Board of Trade are fully aware of the importance of a uniform gauge, and when opportunity offers press their views on the subject upon promoters. I think it would be a mistake, however, to insist on the adoption of the standard gauge as an absolutely invariable rule; in hilly districts and in towns with very narrow streets it is sometimes desirable to adopt a gauge less than the usual 4ft. 8½in." The same subject engaged the attention of a meeting of the executive council of the County Councils Association on Thursday week, when the two following resolutions were passed: "(1) that, while in the opinion of this committee it is generally desirable to have a uniform gauge of 4ft. 8½in. for both light railways and tramways, the committee have not sufficient evidence before them to justify them in recommending that a uniform gauge for light railways and tramways should be prescribed by law; (2) that application be made to the Board of Trade to allow county councils to be heard in any case where the main roads in their area are affected by a tramway and light railway, whether such main roads are maintained by urban authorities or not." While we quite agree with the remarks that a uniform gauge of 4ft. 8½in. cannot be always insisted upon in view of narrow streets and local conditions, we do think that where new lines have to be constructed in small towns within easy reach of large tramway systems with which these new lines may ultimately become connected, it should be a *sine quâ non* that they should be made of the same gauge so that through traffic may be possible.

Telephone Competition.—Some three years ago, it may be remembered, the Bell Telephone Company of America caused a great deal of astonishment by announcing that its service would be given all subscribers free in certain towns. The object of this movement was to crush a home company in Huntington, W. Va., who were formidable rivals of the Bell Company. The only result the manœuvre had, however, was to give the Bell subscribers in that town, as well as two others in the United States, a telephone service gratis, for, contrary to expectations, the home company were not affected in the least. In fact, their number of telephones increased, one reason being that the home company is owned largely by the residents. In consequence of the competition of another home company the subscribers of the Bell telephones in New Philadelphia, Ohio, are also reaping the benefits of a free service. Turning to our own affairs on this side of the Atlantic, we find that the Post Office has become the competitor of the National Telephone Company. As explained by Mr. J. S. Forbes, the chairman, at the meeting of the shareholders the other day, the Government have the power to grant licenses outside the Metropolis, whereas the company has a short life, 1911 being the end of their license. In fact, this was the main topic discussed at the meeting, and the general opinion seems to have been expressed that the Government are treating the company very unfairly. The chairman said they had "made their bed with the Government, and they must, to a certain extent, suppress their indignation." However, it was decided to fight the Post Office competition, one shareholder suggesting that a petition should be presented to the Houses of Parliament, and the Crown if necessary, setting forth their alleged grievances. In the end the Board were authorised by resolution to convert 590,000 fully-paid (issued) and 10,000 (unissued) ordinary shares into preferred and deferred stock, and to issue 200,000 of the unissued ordinary shares as preferred shares. On the subject of telephones, we notice that Mr. Gaine, the general manager of the National Telephone Company, has received from Lieut.-Colonel Arthur Davidson, the King's equerry-in-waiting, the following gratifying message: "I am commanded to inform you that the telephone service at Osborne was very well and efficiently conducted last month under circumstances of exceptional pressure, and I am commanded to thank you for the arrangements which were made which secured this satisfactory result."

Electrical Theory.—A clever article on electricity by Prof. Elihu Thomson is given in the New York *Sun* for Feb. 10. On the question of electrical theory the professor asks: "Has science any answer to make to the question, What is electricity? We think not," the article proceeds, "nor has it any answer to make to the question, What is energy? The most that science can possibly expect to do is to extend our horizon and permit us to acquire a deeper knowledge of the intimate relations of things. We speak of the ether as the electrical medium, and we acquire more and more knowledge of its properties and actions as the years go by. Facts are gradually being accumulated by workers in all departments of science, and there must follow generalisations which will bring into harmony the present discordancies where they appear. It will probably be found that the electrical properties of the ether are the fundamental ones on which the universe is built, and that the properties of matter which we speak of as mass, weight, inertia, cohesion and elasticity, etc., are dependent upon or have their origin in the ether properties. Perhaps, just as light and radiant heat have been shown to be electrical vibrations, gravitation and the other properties may follow. True it is that electrical laws are most simple, most definite. Electrical measurements can be made with the utmost accuracy and delicacy. Indications these are of its fundamental and universal character." The author goes on to point out that in order to account for the passage of light, radiant heat, magnetism, and other forces through space, science has need of what is called the ether, a medium filling all space and propagating waves of heat and light, as well as magnetic disturbances and gravitation. The sun radiates to the earth luminous waves and heat waves. Moreover, it has been shown that whenever there is a great cyclonic storm upon the sun, the earth sympathises or receives influences which disturb the compass needle. "What, then," asks the author, "is the nature of this ether of space? To this question no complete answer can as yet be given, except to say that it is the electromagnetic medium. It is as unlikely that the mystery of the material universe will ever be completely solved as it is that we can gain an adequate conception of infinite space or time. But we can at least extend the range of our mental vision of the processes of Nature as we do our real vision into space

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depths by the telescope and the spectroscope. There can now be no question that electric conditions and actions are more fundamental than many hitherto so regarded."

Tramway Management.—While in Great Britain the construction of electric tramways is considered mainly from the fact that they will enable the working classes to live further from their work, and hence obtain more healthy homes, we have not yet had to consider so much the question of making traffic in order to pay dividends. In the United States, on the other hand, practically all the electric tramways, or the street railways, as they are called, are owned by limited companies, and these have the question of dividend always before them. We notice, for instance, in the *Street Railway Journal* a list of 34 street railway companies who own or control parks in the vicinity of the town in which they run the service. The object of these parks is to increase the return of the tramways in question, and the management not only run the cars to the parks at reduced fares, but also provide the amusements which are to attract the people. In the same issue of the above-mentioned journal there is an article by Mr. H. S. Cooper, as to how to make the non-paying roads pay. He divides the traffic on such lines up into five classes. The first is the fixed or regular traffic and the people who use the lines morning and night in order to go to and from their work; the next is those people who occasionally use the lines; and the third is the extraordinary or rush traffic, such as occurs in connection with football matches, etc., which demand a great temporary increase in the number of cars on a particular road. The fourth deals with the pleasure traffic on holidays, Sundays, and fine evenings, on which days people travel either for the pleasure of the ride or to get to some pleasure resort such as referred to above. This class of passenger, according to the author, can be largely increased by the owners of lines by the provision of adequate attractions at the ends of the roads. The last class is that created by special fares or privileges. The author's great contention, in considering how each of these various classes of traffic can be increased, is that no reductions in fares should be made until the effect of such reductions has been well considered. Whereas the decrease in fares gives satisfaction to the public, much harm is done if afterwards the fares have to be raised. At the same time he contends that although rushes, such as to athletic games, do occur, they are so infrequent as not to warrant a considerable reduction in fares. For the pleasure traffic, however, he urges that the fares ought to be kept as low as possible, and that they should be issued in combination with the various attractions at the end of the journey.

Central London Railway Competition.—As showing one of the results of the competition of the Central London Railway on the District and Metropolitan Railways and the omnibus companies, the following facts and figures will be found interesting. Taking first the number of passengers carried on these two railways, in the second half-year of 1900 there was a decrease of 2,967,000 on the Metropolitan Railway as compared with the corresponding half-year of 1899, while on the District there was a decrease of 1,230,000 in the number of passengers carried. This represents in money £26,000 and £19,000 respectively, which on a half-year's working is enormous. Turning to the two omnibus companies—the London General and the London Road Car—during the same period, in the case of the first-named an increase of 2,459,000 in the number of passengers carried was made, the advance in receipts being £3,000. As to the Road Car Company, although the number of passengers carried shows an advance of 96,000 on the corresponding half-year's working, there was a decrease in receipts of £2,000. While the General Omnibus Company exhibits a fair advance in the number of passengers carried, the increase in the receipts is proportionately very small, showing that the long-distance journeys were not so well patronised as heretofore. Except in the case of the District Railway Company, whose receipts have remained almost unvaried for some years past, the normal condition of the other companies was one of growth until the "tube" competition was experienced—in the case of the two omnibus companies, indeed, of very rapid growth. Some idea of the damage inflicted by the competition may be gained from the following figures: the average advances recorded in the number of passengers carried and the receipts in the five second half-years 1895-99 inclusive, are: Metropolitan Railway, 786,000 passengers = £8,200; District Railway, 120,000 passengers = £800; London General Omnibus Company, 6,236,000 passengers = £33,000; and London Road Car Company, 2,084,000 passengers = £11,200. From these figures, then, it will be seen that the average increase shown by these four companies in a second half-year is nearly 9¼ millions in the number of passengers carried and over £53,000 in receipts. In place of this satisfactory state of things, there was in the second half of the year 1900 a loss of nearly 1¾ millions in number and £44,000 in receipts. From this short statement of the financial position of the four companies in question, it is clear that the monopoly of the London traffic by two or three enterprises is no longer maintained. Competition has been introduced which is heartily welcomed by the general public, as affording them a better and cheaper means of communication between the different parts of the Metropolis.

Electric Traction in Germany.—It appears from the annual statistics of electric railways published in the *Elektrotechnische Zeitschrift*, that at the end of the past year there were in operation in Germany about 1,900 miles of electric railways, having a total length of track of 2,800 miles, as compared with 1,430 miles and 1,980 miles respectively for the previous year. The rest of the figures given take us only up to Sept. 1, 1900, when the aggregate output of the generators installed for working 2,660 miles of track amounted to 75,608 kw., as compared with 52,509 kw. for 1,760 miles of track in the previous year, or an increase of 44 per cent. On the other hand, the buffer and station batteries installed up to the same date show an increase of only about 25 per cent., as against 164 per cent. for the previous year, the total capacity of the accumulators amounting to 16,890, compared with 13,532 kw. on Sept. 1, 1899. Adding the output of the generators and accumulators, respectively, together, it will be seen that there is a total available output for working the lines of 92,498 kw. According to statistics published in the *Elektrotechnische Zeitschrift* last year relative to central electric lighting stations in Germany, there was installed in the same on March 1, 1900, an equivalent of 191,646 kw. in generators and 38,412 kw. in accumulators, together 230,058 kw., so that on Sept. 1, 1900, the total output of the generators and accumulators installed in German lighting and power stations amounted to 322,550 kw. in round figures, or, approximately, the equivalent of 440,000 h.p., which represents an increase of about 38 per cent. as compared with the figures for the previous year. A valuable feature of the statistics consists in that for all those lines supplied with current from independent generating stations, the number of kilowatts provided per mile of single track or per motorcar is computed. For 70 lines enumerated as belonging to this class the average

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number of kilowatts provided per mile of track is shown to be 31·8, as compared with 32·8 in 1899 and 33·0 in 1898, while the average number of kilowatts per motorcar is given at 15·1, as against 14·3 and 14·2 in the years 1899 and 1898 respectively. Extreme cases have not been taken into account in making these computations. As regards systems, the overhead trolley still remains supreme. Up to date but three short stretches of line, totalling a length of not more than 2½ miles, are worked in Germany on the conduit system. Accumulator traction pure and simple is also in operation in only three cases, though it is noteworthy that this system has been adopted on two Bavarian full-gauge lines having lengths of over 31 and 37 miles respectively. In conclusion, it may be observed that the third-rail system has been adopted hitherto, so far as Germany is concerned, only in the case of the Wannsee Railway, which has already been fully described in these columns.

Glasgow International Engineering Congress. We are now in possession of the preliminary arrangements of the international engineering congress to be held in Glasgow on Sept. 3, 4, 5, and 6 next. The president is Mr. James Mansergh, president of the Institution of Civil Engineers, while on the vice-presidential list appears the names of the several presidents of the engineering institutions taking part in the congress. A general committee has been formed, with Mr. Mansergh at its head, and Sir Douglas Fox is named as the chairman of the London committee. Mr. Robert Caird is chairman both of the executive committee and the Glasgow local executive committee, while among the conveners of the reception committee and sub-committees we notice the names of Prof. Archibald Barr, Mr. C. C. Lindsay, Prof. J. H. Biles, and others. The meetings for the reading of papers will be held within the university buildings, which are in immediate proximity to the exhibition. As a rule, the sections will meet on the forenoons of Tuesday, Wednesday, and Thursday, Sept. 3, 4, and 5, at 10 a.m. Members of the congress will be entitled to attend the meetings of any or all of the sections. Visits to works in Glasgow and neighbourhood will be arranged by sub-committees representing the several sections, but the works will be open to all members of the congress. The subscription for membership of the congress, including free entry to the exhibition during the congress week, will be half a guinea. The congress, which is divided up into nine sections, will be of a thoroughly representative nature. Each section will be under the direct management of the institution representing that particular branch of engineering, with one or two exceptions. The following list of the sections and the office-bearers nominated, or the institutions which have accepted the invitation to take charge, will indicate the wide scope and general importance of the congress: Section 1.—Railways: chairman, Sir Benjamin Baker; hon. secretary, Mr. R. Elliott Cooper. Section 2.—Waterways and Maritime Works: chairman, Sir John Wolfe Barry; hon. secretary, Mr. L. F. Vernon-Harcourt. Section 3.—Mechanical: chairman, Mr. William H. Maw, president of the Institution of Mechanical Engineers; hon. secretary, Mr. Edgar Worthington. Section 4.—Naval Architecture and Marine Engineering: chairman, the Right Hon. the Earl of Glasgow, president of the Institution of Naval Architects; hon. secretary, Mr. George Holmes. Section 5.—Iron and Steel: chairman, Mr. William Whitwell, president of the Iron and Steel Institute; hon. secretary, Mr. Bennett H. Brough. Section 6.—Mining: chairman, Mr. James S. Dixon, president of the Mining Institute of Scotland; hon. secretary, Mr. James Barrowman. Section 7.—Municipal: chairman, Mr. Charles H. Lowe, president of the Incorporated Association of Municipal and County Engineers; hon. secretary, Mr. Thomas Cole. Section 8.—Gas (Institution of Gas Engineers): chairman, Mr. George Livesey; hon. secretary, Mr. J. W. Helps. Section 9.—Electrical: chairman, Prof. John Perry, president of the Institution of Electrical Engineers; hon. secretary, Mr. W. G. M'Millan. The general secretary of the congress is Mr. J. D. Cormack, The University, Glasgow.

Mond Gas.—Last week there was an important meeting in Birmingham, at which some explanations were given of the Mond gas and of the way in which it was proposed to use this gas for power and heating purposes throughout the manufacturing district. The meeting was presided over by Sir Alfred Hinckman, the chairman of the South Staffordshire iron trade council. The coal trade and the important collieries of the district were also represented, whilst numerous local authorities were also asked to send gentlemen to look into the question. It was explained to the meeting by Sir Alfred Hinckman that the Mond gas plant enabled use to be made of slack coal, which up to the present had been of little value in the district. The great advantage of the process was that the sulphate of ammonia was recovered, and this alone went a long way towards paying for the cost of the installation. The estimate given by this gentleman was to the effect that 8s. worth of sulphate of ammonia should be recovered from a ton of slack coal, and that after the expenses of the extraction had been paid there was still a margin of no less than 4s. 6d. per ton, which was ample to pay for the cost of the material from which the gas was produced. He also pointed out the convenience of the Mond gas for driving engines, in that it was quite free from sulphur, which was apt to deteriorate metal parts of machinery. He expressed the belief that the introduction of an up-to-date system of power gas distribution would be of great service to the districts over which the company propose to lay down their pipes. He hoped that the corporations who up to the present had in certain cases taken up an antagonistic position with respect to the matter would change their minds and support the scheme. Other gentlemen followed, speaking in favour of the undertaking, whilst Mr. Alfred Mond explained that the objections to the scheme were based as a rule under two heads—first, that the maximum price asked was too high, and next that the undertaking would not pay. In connection with the first point, he stated that the maximum price in the Bill was 4d. per 1,000 cubic feet for small consumers and 3d. for large, but he did not think the public would be asked to pay anything like this price. In any case the Act of Parliament would not force any consumer to take supply. As regards the other question of whether the undertaking would be a financial success, he explained that the scheme had all the financial support it required from six or seven commercial men in the Midlands, and hence the public would not be required to finance the undertaking. Some other figures were given as to the success of the Mond gas plant by Mr. H. Humphreys, the engineer connected with the same, in which he stated that 14 times as much gas was made from a ton of slack as was usually made from a ton of coal when producing lighting gas. This led one gentleman present to give his estimate that if 140,000 cubic feet of gas could be produced per ton of slack and sold at 3d. per 1,000ft., this, together with the sulphate of ammonia, would give a return of 42s. for every ton of slack used. Mr. Humphreys explained that in this estimate there was no allowance made either for labour or for the capital charges resulting from the first cost and upkeep of the plant.

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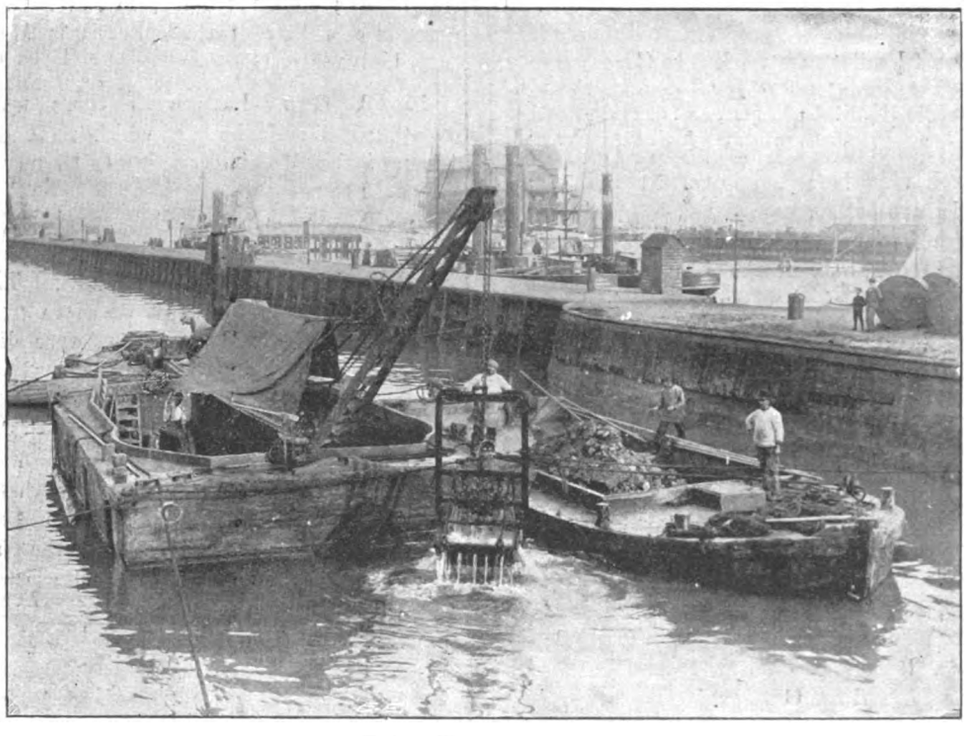
LOWESTOFT ELECTRICITY WORKS.

(Concluded from Supplement.)

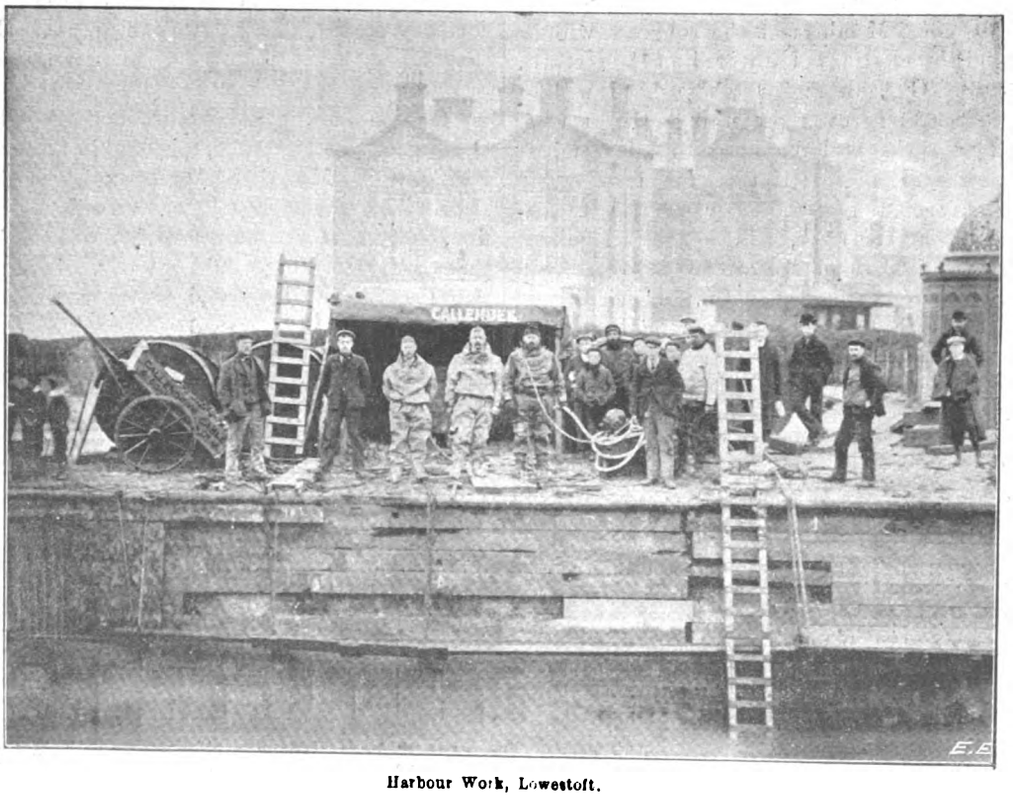
Arc lamps, of which there are 69, are fixed in the principal streets—viz., London-road South, London-road North, and the Esplanade—and are run four in series on the outers of the distributors, to which they are connected by $^{7}/_{18}$ single-conductor armoured cable.

The incandescent lamps on arc posts are connected to the mains by two single-conductor vulcanised bitumen cables laid solid in wooden troughs. All cables are laid 2ft. 6in. in roadway, and not less than 1ft. under pavements. The armoured cables under roadways are further protected by tarred boards. Disconnecting link network boxes are placed at convenient positions on the mains, so that any section of main can be shut off if necessary.

Lowestoft is divided in two parts by the harbour, and the traffic crosses by means of a swingbridge. To supply current to Southside the cables had to be laid under the harbour. Divers were employed to get out the necessary trench, and specially-made cables were used, consisting of single conductor with vulcanised bitumen insulation protected by two layers of wire armouring. Three spare 3in. stoneware pipes are laid in the same trench as the cables from the station, and run to convenient points of the town for future feeder extensions. Brick draw-boxes with cast-iron frames and covers are placed every 66 yards on these pipes for drawing in the cables. Two 3in. spare stoneware pipes are laid the whole length of the main thoroughfare from Pakefield-street to Belle Vue-park, in same trench as cables, for future telephone cables. The accompanying illustrations show the nature of this work at Lowestoft.



Harbour Work, Lowestoft.



Harbour Work, Lowestoft.

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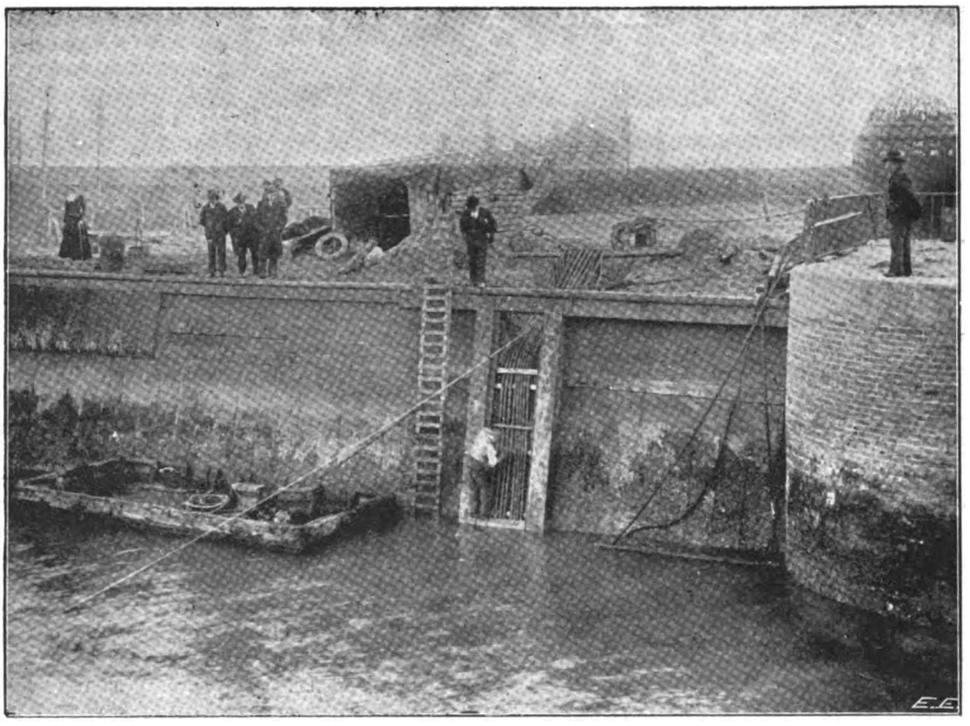
Street-Lighting.

The public street-lighting is carried out by means of five-ampere enclosed lamps of Crompton and Co.'s Chelmsford pattern, arranged for burning four in series across the outers of the distribution mains, the difference of potential being 460 volts. An automatic cut-out is provided in each lamp connected to a substitutional resistance in the base of the pillar, the cut-out being arranged to operate if the carbons stick or the arc falls from any cause, the remaining lamps in the circuit not being affected in any way. In the base of each pillar is provided a triple-pole isolating switch, by means of which a lamp may be entirely isolated from the circuit, the substitutional resistance being inserted in its place, thus making it possible to recarbon or remove one of the lamps whilst the others are burning. A quick-break switch and fuse is provided at either end of each circuit, by means of which the lamps are switched on and off. Each pillar is also



Harbour Work, Lowestoft.

Standard, Lowestoft.

Standard, Lowestoft.

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provided with two ornamental brackets, and fitted with a 6in. oval prism globe with weatherproof holder, the globe containing a 32-c.p. incandescent lamp. The arcs are switched off at midnight and the incandescent lamps switched on to replace them. The leads to the incandescent lamps are also taken from the distribution mains, a quick-break switch and fuse being provided in the base of each pillar. The whole of the fittings in the base of the pillar are of very substantial design, all switches being arranged that they may be operated by means of a key passing through the door. The original contract was for 32 lamps, which are now running regularly. An additional 37 lamps are now in course of erection, and it is anticipated will be running early in March.

The cast-iron pillars have been supplied and erected by Messrs. J. W. Brooke and Co., of Lowestoft, the contractors for this part of the work. The central carriers were specially designed for Crompton and Co.'s enclosed lamps, and supplied by that company as sub-contractors. There are 22 of these central carriers on the sea-front, the bracket columns, of which there are 47, being used in the streets.

As previously stated, the installation was duly started on Tuesday, Feb. 12 last. The Council-chamber was crowded with members of the Corporation and citizens interested in the work. An interesting feature of this ceremony was the large exhibition of electrical apparatus by the General Electric Company, including a fine display of the Robertson incandescent lamp and a practical demonstration of glass-blowing.

Most of the photographs from which our illustrations are reproduced were taken by Messrs. Boughton and Sons, of Lowestoft.

THE FORTHCOMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

[BY OUR BERLIN CORRESPONDENT.]

The preliminary announcement of the forthcoming visit of the Institution to Berlin will doubtless recall to the minds of those members of the society who were fortunate enough to take part in the Swiss visit the dinner at Rheinfelden, at which Herr Rathenau, of the Allgemeine Elektricitäts-Gesellschaft, in proposing the health of the Institution, invited, in the name of his firm and of Messrs. Siemens and Halske, the members to come out to Berlin. Many will remember, perhaps with a blush, how the linguistical deficiencies of the English were then made apparent by the fact of their rising—after the speech, and in their happy ignorance of its contents—to drink to their own health. The undeniable success and popularity of the Swiss visit will, no doubt, induce many of those who participated in it to make a big effort to take part in the journey to Germany, but we are afraid that the date settled upon—viz, the end of June, which it has, unfortunately, been found impossible to alter—will preclude many of those from joining the party who would otherwise have so wished, this, of course, being due to the fact that the colleges will be still open at that date. It is to be hoped, however, that a large party will be got together in order to ensure to the visit that success which its great importance deserves; for the German capital is quite unique in its interest to the members of the electrical profession, being the centre of operations of three of the largest electrical manufacturing concerns in the world, and possessing also some of the best examples of electrical central stations which can be seen anywhere.

The programme which has been drawn up by the German Reception Committee, of which Mr. Gisbert Kapp is secretary, includes not only visits in Berlin, but, should members so desire, extensions to Dresden, where the meetings and visits of the Verband Deutscher Elektrotechniker are to take place, and also to Nuremberg and Frankfort, where are situated the manufactories of Messrs. Schuckert and Co. and Messrs. Lahmeyer and Co. We venture to think that all members who are able to face the trying ordeal of this round of visiting will return home with a feeling of pained astonishment that Germany is so far ahead of England in all that pertains to their profession, and fully awakened to the crying necessity that something must be done to resuscitate the industry, which must otherwise eventually pass into the hands of our foreign competitors. The extent to which the three-phase system has been developed is, we fear, overlooked in England, and in the meanwhile our neighbours are obtaining all the big orders in our Colonies, where this system is often the only practicable one in consideration of the distances to which in these big countries energy has often to be transmitted. We are afraid that the opponents of the polyphase systems, while often correct in stating that in England the continuous current is more suitable, overlook the fact that it is to an *export* trade that they should look for future prosperity.

Returning to the subject of the Berlin visit, a map will be given in a future number to give readers some idea of the location of the different manufactories, etc., which it is hoped to inspect. The machine and apparatus factories belonging to the Allgemeine Elektricitäts-Gesellschaft lie to the north of the city, about two miles from the Central Railway station in Friedereichstrasse. The machine factory is situated in the Brunnenstrasse, and covers an area of 125,000 square yards. Nearly the whole of the tools are driven by separate three-phase motors, and extensive use is made of portable electrically-driven tools which are taken to the work. The apparatus factory is in the Ackerstrasse, covering a ground area of 15,000 square yards, and being in four storeys the equivalent area is 75,000 square yards. The two works are connected by an underground electric railway nearly a quarter of a mile long. The manufacture of cables was transferred in 1897 to a splendidly equipped new factory at Oberspree, a village quite outside the city, and to the east. The works are pleasantly situated on the north bank of the Spree, and are noteworthy by the entire absence of steam plant, being driven entirely by three-phase motors, the energy being obtained from the neighbouring central station of the Berliner Electricitätswerk. Members will be brought out to the cable works by water, an electrically-driven launch being kindly provided by the Allgemeine Electricitäts-Gesellschaft. They will be entertained to luncheon in the cable works, and will have an opportunity of witnessing a display of Prof. Slaby's latest method of speech telegraphy and of Röntgen rays, the apparatus for which is constructed in a building attached to the works. The factories of Messrs. Siemens and Halske are in the town of Charlottenburg, on the south bank of the Spree. They are most pleasantly reached by a drive through the beautiful Thiergarten. The works cover a very large area, and everything appertaining to the electrical industry—including cables—is manufactured here.

To the north of the Spree, and not far from Messrs. Siemens and Halske's, is the factory of the Union Elektricitäts-Gesellschaft, which adjoins the celebrated tool works of Messrs. Ludwig Loewe and Co. This firm, which is the German branch of the General Electric Company of New York, is devoted principally to the manufacture of traction apparatus and appliances. It is a significant tribute to the value of German labour to find so many American firms with big factories established in Germany, and especially in Berlin. The combination of American brains and push and German labour is a thing to be feared in the future. The Berlin Elektricitätswerk own six central electric supply stations, built and equipped by the Allgemeine Elektricitäts-Gesellschaft, whose combined output amounts to nearly 150,000 h.p. The largest and most modern is that situated at Oberspree, close to the cable works of the Allgemeine Elektricitäts-Gesellschaft. The capacity of this station when completed will amount to 54,000 h.p. Three-phase current is generated here at a tension of 6,000 volts and taken by underground cables to the various sub-stations in the city, where it is transformed into low-tension continuous current for light and power. In this station may be seen the large 3,000-kw. generators, one of which was exhibited at the Paris Exhibition.

At Moabit is the next largest central station, the output of which is 36,000 h.p. generated as high-tension three-phase current. The other stations (Schiffbaurdam, Luisenstrasse, Spandaurstrasse, Rathausstrasse, Maurstrasse, and Markgrafenstrasse) have a combined capacity of 40,000 h.p., generating both continuous and three-phase currents.

The above figures will convey to our readers some idea of the great demand which has arisen in Berlin for electric

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energy for lighting and other purposes. Up to the end of 1899 there were connected up to the street mains 400,000 incandescent lamps, 16,000 arc lamps, and 5,000 motors. The central station at Charlottenburg was erected in 1889 by the firm of the Elektricitäts Actien-Gesellschaft vormals W. Lahmeyer und Co., the order being obtained by this firm in open competition with Messrs. Siemens and Halske and the Allgemeine Elektricitäts-Gesellschaft, much, it is slyly whispered, to the disgust of these latter. It will be eventually taken over by the Muncipality, but is at present being run by the company. The station supplies light and power to houses and factories all over Charlottenburg, for which three-phase high-tension current is generated and transformed down at the sub-stations to 125 volts, and continuous currents at 550 volts, for the Charlottenburg portion of the Berlin and Charlottenburg electric tramways.

The above information will enable readers to form some notion of what there is to see if they are able to participate in the visit. We hope to be able to give a more detailed account of some of the works and stations in future issues. The German Reception Committee are doing their best to make the visit attractive. A ladies' committee has been formed to arrange for the comfort of those members of the gentle sex who will accompany the party. Although Berlin cannot offer the scenic splendour which made the Swiss visit so attractive, yet there is much of interest to be seen everywhere in this most modern of capitals. Noble buildings and broad tree-lined streets abound, and not least, as will be felt by those who have had some experience in the tiring work of visiting factories, ample provision for the refreshment of the "inner man" is to be found everywhere.

Although not included in the programme, members should try and arrange to see the splendidly equipped Technical High School in Charlottenburg. This huge building, where some thousands of students are educated, is in one of the best quarters of the town, and affords a very good example of the way in which Germany is equipping her children for the coming industrial struggle by the provision of numerous similar institutions, where a technical education of the highest order is given at an absurdly low charge. To those who would combine pleasure with business we recommend a trip to the Grunewald and Potsdam.

In conclusion, let us hope that members will show their appreciation of the great courtesy of our German neighbours in throwing open works to inspection by making every effort to be present, and that the party may be graced by the presence of a goodly number of ladies so as not to disappoint the expectant committee which has been formed for their entertainment.

THE ELECTRIC LIGHTING OF THE VICTORIA EMBANKMENT.

The opening of the London County Council station which is to supply the energy for arc lighting on the Victoria-embankment and Westminster Bridge took place on Saturday last. The inauguration of this arc lighting scheme recalls to memory that the first street-lighting to be carried out in London by means of electricity was also in connection with the Victoria-embankment. It was in 1878 that some 20 lamps were placed on the river side of this Embankment. In this instance the power was supplied from a small wooden shed on the west side of the Charing Cross railway bridge, in which were placed two of the early Gramme dynamos, which were driven by belts from a Ransomes and Sims engine. The actual lighting was done by means of Jablochkoff candles, and the experiment was so successful that an agreement was made with the company to continue the lighting for several years. This agreement expired in June, 1884, and was not renewed owing to the irregularity of the supply and the financial difficulties of the company. It was not until 1893 that the London County Council obtained powers in a general Act to put down plant for the lighting of the Embankment and Westminster Bridge. From the pamphlet which was given round at the opening ceremony last week, we gather that the Council considered it inexpedient to take the supply from any of the electric lighting companies in London, because different parts of the Embankment are in the area of different companies, any one of which could not, in the opinion of the Council, supply the whole of the Embankment. We do not think this reason a valid one, as the Council had the right to lay pipes along the Embankment, and it would not have mattered at which point along the route the supply was given.

FIG. 1.—Front View of the London County Council Electricity Station for the Embankment Lighting.

It was eventually decided by the Council to erect the present generating station on a vacant piece of land on the Embankment to the east of the Charing Cross railway bridge, and adjoining the station of the Metropolitan District Railway. In order to avoid the necessity of constructing a chimney shaft, which would have been unsightly in the position in question, it was decided to use gas-engines to supply the power for driving the dynamos. The outside view of the station is now completed, as shown in Fig. 1, while Fig. 2 gives the ground plan of the engine-room. Owing to the limited space, the dynamos have had to be placed in an excavation under the footway, while the ropes which drive the same pass through arches in the wall supporting the front of the building. In consequence of this, the engine-room floor is at a very con-

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siderably lower level than the street. All the engineering work in connection with the station was done to the specification of Mr. T. P. Gunyon, the electrical engineer to the Council.

The gas-engines, which are built on the Otto cycle, were supplied by the well-known firm of J. E. H. Andrew and Co., Limited, of Reddish. The diameter of the cylinders by means of a flange to the cylinder. The exhaust-valve box is cast as a portion of the cylinder end so as to do away with the jointing between the exhaust-valve box and the cylinder end. The pistons are made of cast iron, and fitted with four cast-iron spring rings held in position by loose intermediate rings. The crankshaft is a mild-steel forging cut out of the solid, machined and polished and

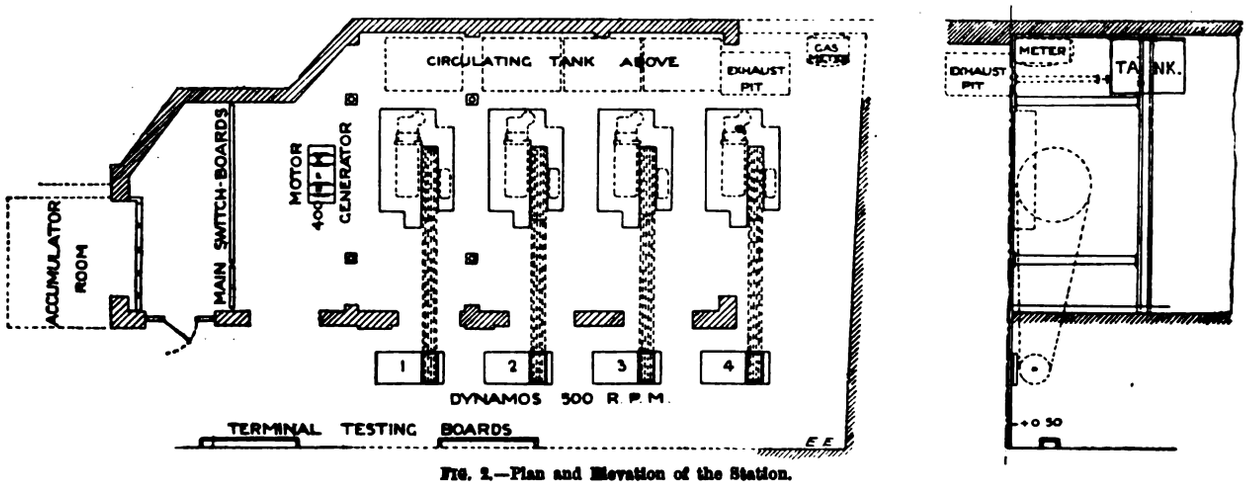

Fig. 2.—Plan and Elevation of the Station.

is 15in., stroke 22in., and each engine is able to develop a maximum of 68 b.h.p. when running at 210 revolutions per minute. The consumption of gas is guaranteed to be not greater than 17 cubic feet of coal gas per brake horse-power per hour. These engines (Fig. 3) are constructed to the standard design of the makers. Each engine is fitted with one massive flywheel weighing six tons, and having six 1¼in. grooves for driving the dynamos by means of ropes. balanced by means of counterweights secured to the crank webs by mild-steel straps, which pass round three sides of the webs of the cranks and terminate in screwed ends in recesses of the counterweight. Nuts on these screwed ends of the strap are screwed up tight and then locked by means of pins put through them. The connecting rods are of mild steel, both ends of the rods being of the marine type and fitted with phosphor bronze adjustable brasses with ample

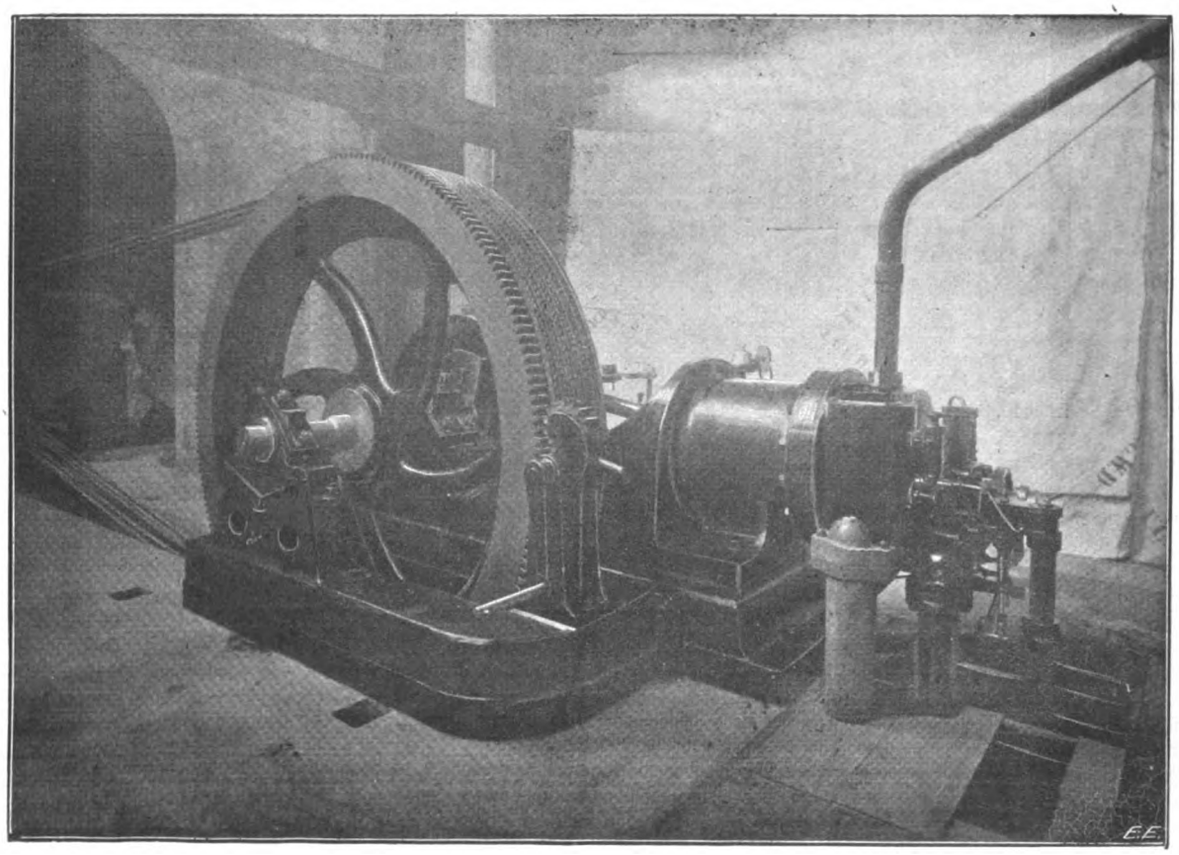

Fig. 3.—View of the Stockport Gas-Engine, showing the Barring Gear.

The flywheel is supported on the outer end of the shaft by an outer bearing which rests on a fender bracket, which fender bracket is bolted to the base-plate of the engine. The cylinders and frames are cast in one piece, so as to avoid the usual overhang of the cylinders that is so noticeable in many of the designs of gas-engines. The cylinders are also provided with a loose liner of specially hard metal accurately bored, and made to gauge. The cylinder ends or combustion chambers are separate pieces, and are bolted bearing surfaces. Each engine is fitted with a high-speed centrifugal governor driven by machine-cut noiseless gears. The engines are governed on the hit-and-miss principle. The engines are fitted with an ignition bracket, containing two timing valves and two tubes, so that in the case of one tube breaking the other tube can be instantly put into action. Automatic and continuous lubricators are provided for the cylinder, crankshaft bearings, crank-pin bearing, and piston-pin bearing. Each

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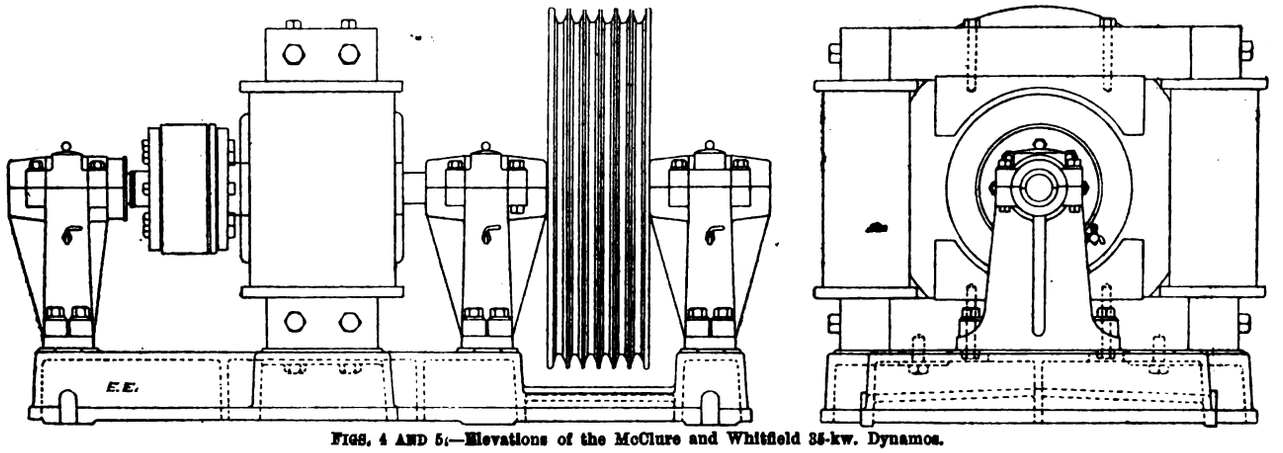
engine is fitted with efficient splash guards and oil drains to prevent any oil being thrown from the engine, and all the oil escaping from the bearings is collected. The engines are started by means of the makers' patent self-starter, which can be seen in the illustration (Fig. 3). A simple device of pinion wheels, which gear into teeth cast in the inside rim of the flywheel, enables the attendant to quickly and easily put the engine into proper position for starting, and this barring device is so designed that as soon as the flywheel is put in motion by the engine itself the pinions are thrown out of gear. The arrangement is extremely simple, and entirely prevents any chance of an accident to the attendant, and was made according to the designs of Mr. Atkinson, the head mechanical engineer to the London County Council.

were made. It will be seen from these that the field-magnet system is of the Manchester type. The pulley for the ropes has a very considerable diameter, which will considerably lengthen the life of the ropes used. A third bearing outside the pulley takes half of the strain from the driving ropes. All the bearings have automatic lubrication. Each of these dynamos is geared to run at 500 revolutions per minute, and at that speed is capable of giving 70 amperes at 500 volts. In addition to the machines in question, Messrs. McClure and Whitfield have also supplied and erected the motor-generator which is shown in Fig. 6. This machine runs at 400 revolutions, and is of 20-kw. capacity. It is driven by the 500-volt current of one of the dynamos, and is used for charging a battery of 56 cells



FIGS. 4 AND 5.—Elevations of the McClure and Whitfield 35-kw. Dynamos.

When the engine is in the right position for starting—that is, with the crank at the top centre at about an angle of 90deg. with the connecting rod—gas is then pumped into the combustion chamber to form a mixture with the air contained therein. As the gas is being pumped in, a portion of the air is driven out through a small hole which communicates with the ignition tube. After a certain number of strokes of the pump an explosive mixture is formed, and this, escaping through the small hole, is ignited by the ignition tube. The explosion which then takes place starts the engine. The time required to start an engine is about five minutes, which includes the time necessary for heating the ignition tubes.

which is to be placed in the accumulator-room behind the switchboard. The machine will also be used to light the station from its low-voltage side, while the accumulators will supply the necessary light for the incandescent lamps when the motor-generator is not working. Mr. Gunyon has also arranged for three arc lamps in the station, which will be in series with three of the lighting circuits, and will thus serve as pilot lights. The above dynamos have been carefully tested over an extended run at full load, from which tests it was found that the temperature rise on the armatures and fields was so low as to conform with the stringent conditions of the contract. Thus, a rise of under 50deg. F. as a maximum was insisted

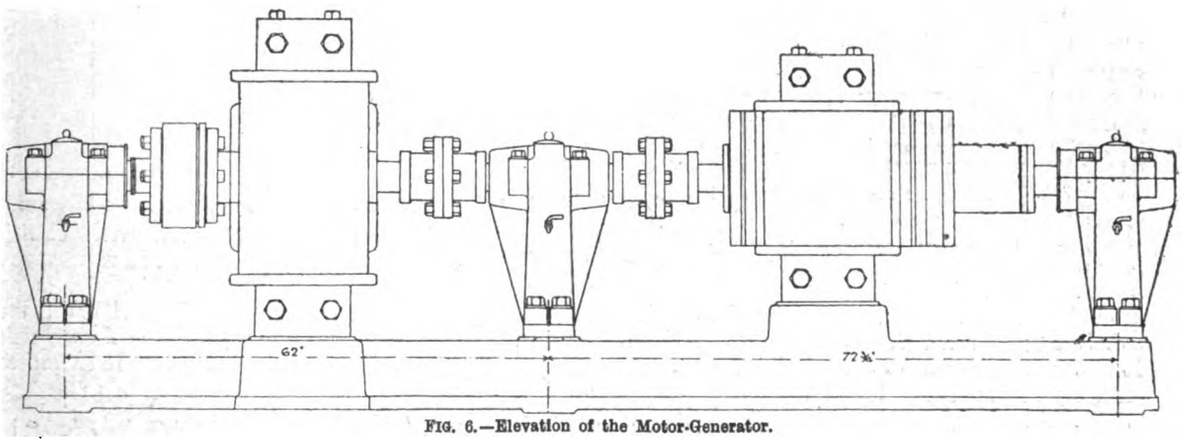


FIG. 6.—Elevation of the Motor-Generator.

Having regard to the position in which the engine-house is placed, it was absolutely necessary that the exhausts from these engines should be silent. A special arrangement of exhaust pits with silencing boxes has been devised, which ensures a quiet exhaust. Whilst the engines were being tested at the makers' works the variations of speed of the engines were taken by a Moscropp recorder, and it was found that the cyclical variation engine running idle was 1·15 per cent. above and below, engine running under full load 1·37 per cent. above and below, and that the governor regulated the engine to within 2 per cent. from no load to full load.

The four dynamos, each of which is driven from one of the above-mentioned engines, were manufactured by Messrs. McClure and Whitfield, of Stockport, who have kindly furnished us with the drawings from which Figs. 4 and 5

on and obtained. The efficiency of the dynamos at full load was 93 per cent.

From the dynamos the current is led to a main switchboard at the Westminster end of the station, whence, by means of a series of machine switches and circuit switches, it is distributed from the various machines amongst the various circuits, 15 in all, seven of which supply current to the 67 parapet lamps, and eight supply the 80 lamps on the Embankment kerbs and on Westminster Bridge and the approaches thereto. This switchboard, which was in Messrs. McClure and Whitfield's contract, was actually manufactured by Messrs. Hands, Limited, of Garlick-hill, E.C., to the detailed designs supplied by Mr. Gunyon. This switchboard is made to control four dynamos, at an output of 70 amperes 500 volts each; it also contains the necessary switch gear for a low-tension

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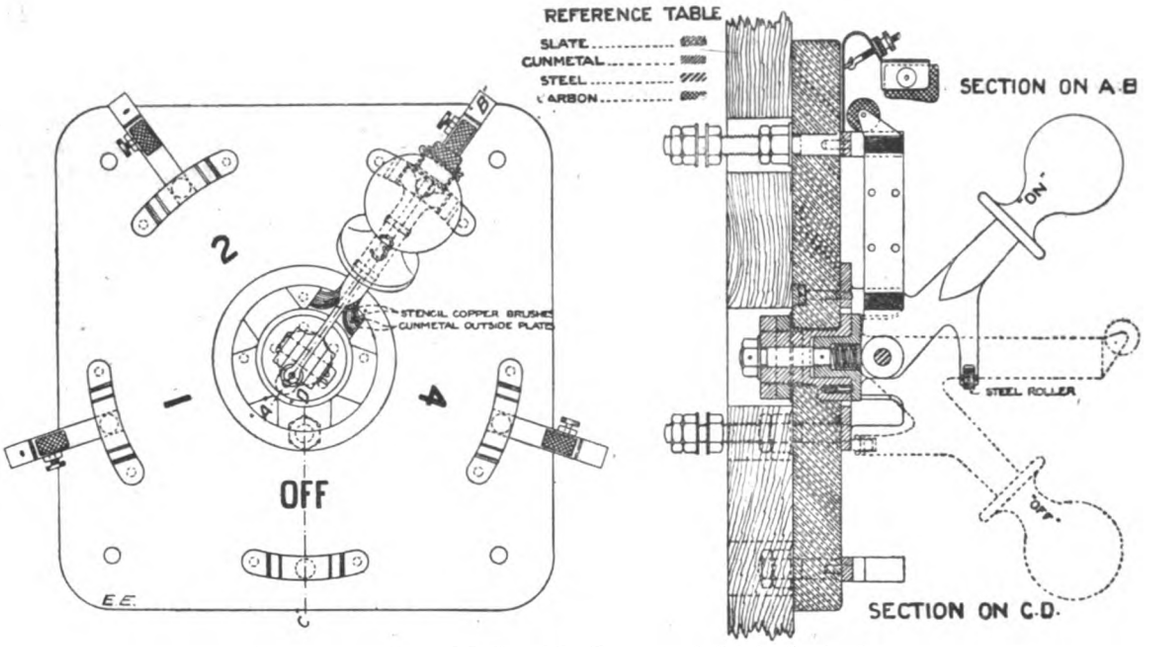
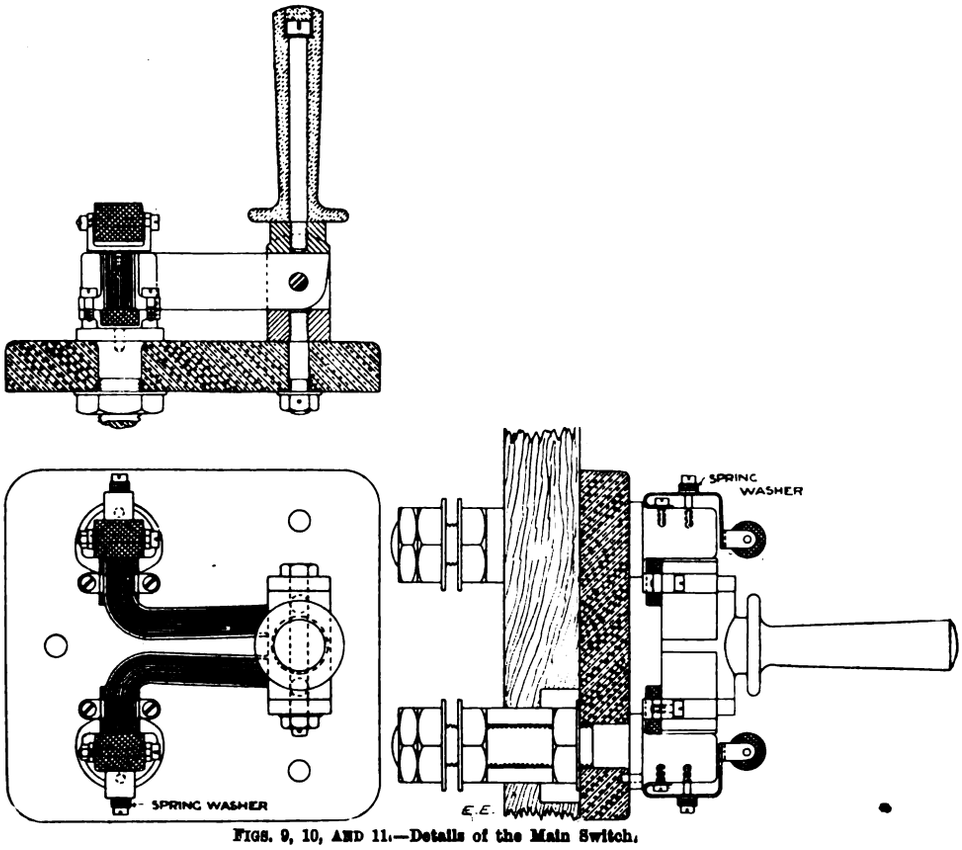
motor-generator for charging accumulators and for station lighting. The distribution panels are fitted with special four-way switches enabling any of the arc circuits to be fed from any one of the four machines. The details of these four-way change-over switches can be seen from Figs. 7 and 8, from which it will be gathered that the switch-lever is made to swivel round its centre. At each position the copper brush engages first at the centre contact, which gives the necessary alignment before completing the circuit at the outer contacts. A carbon break is provided at each outer jaw, so that the metal surfaces of the same are not damaged when the circuit is opened.



FIGS. 7 AND 8.—Plan and Section of the Change-over Switch for the Arc Lamps.

a terminal testing-board, fitted with disconnecting latches, thereby enabling any circuit to be isolated from all switch-board and machinery in the building. The cables used to connect up the lamps were supplied by the St. Helens Cable Company. They have paper insulation and are lead-covered, and armoured with steel. They are placed in a subway under the footpath of the Embankment. The connections to the lamps are so arranged that alternate lamps come on a different circuit, so that the lighting can be reduced at midnight.

The Council considered carefully the relative advantages of "enclosed" and "open" type arc lamps, and ultimately decided to adopt the latter. The order for these was placed with the Gilbert Arc Company, Limited, of Chingford, who have supplied a special long-burning "open" type of lamp. Thus the larger lamps on the kerb standards and on the bridge will burn, without retrimming, from 60 to 80 hours, and the smaller parapet lamps about 40



FIGS. 9, 10, AND 11.—Details of the Main Switch.

The main switch (Figs. 9, 10, and 11) shows how the same general construction has been adapted to heavier currents. All the switches and fuse blocks are separately mounted on slate slabs and surmounted on 1½in. teak panels. Apart from the main board switches, the external circuits are all intercepted at the point of entry to the building by

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hours. In this way they gain to a considerable extent the advantages of long hours of burning of the "enclosed" arc in lamps of the "open" type. The parapet lamps are supported on the old standards which have for so many years past been used for the gas lanterns. The necessary modifications have been made to the lanterns, the upper parts having been cut off and the lower parts reglazed, and new upper parts to support the lamps having been provided and fixed in the old cradles. The handsome design of the old lamp standards (Fig. 12) is well known, and the Council considered that it would be quite unnecessary to obtain new standards for the present lighting, although some difficulty was encountered in drawing in the leads from the subway into these standards, owing to the arrangements which had been made in them for gas fittings. Some parts of these fittings could not be removed without taking down the columns, a very serious operation, which, however, by the exercise of considerable care and trouble in drawing in the leads, it was found possible to avoid.

The lamps on the parapets are designed to take six amperes, while those to be supported on the posts on the kerb lines will take 12 amperes. The arc lamp pillars supporting these larger lamps (Fig. 13) have been specially designed and manufactured for the position they are to occupy by Messrs. Walter Macfarlane and Co., Saracen Foundry, Glasgow. One of the principal features is the

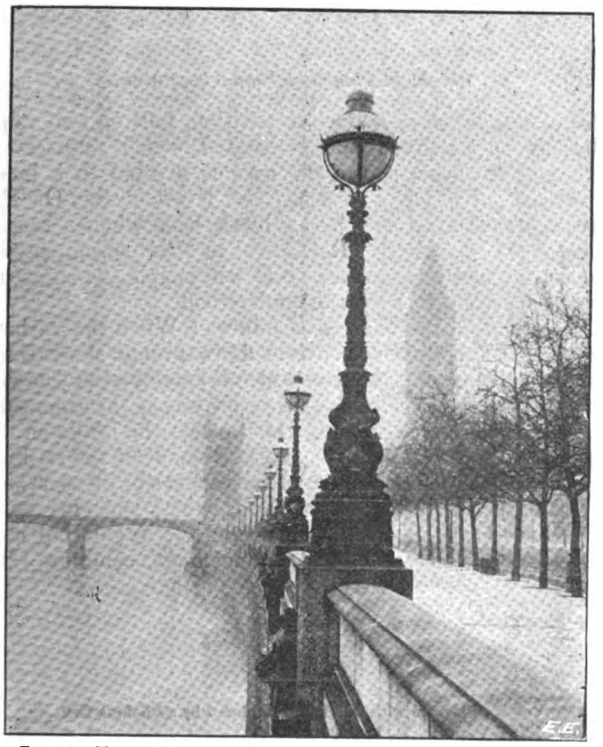

FIG. 12.—View of the Embankment Parapet and Lamp Standards with Arc Lamps in Globes.

massive, well-proportioned, and highly ornate pedestal base, bearing the London County Council coat-of-arms on the front and conventional arrangements of the Tudor rose on the side and back panels. There are no sharp corners, the object being to interfere as little as possible with the foot traffic. The transition from the oblong pedestal with its four corner pillars to the single round shaft above is successfully accomplished by the introduction of dolphins, to harmonise with the pillars already upon the Embankment wall. The bracket carrying the arc lamp springs from a Royal crown that forms the capital of the shaft and is entirely composed of wrought iron, combining in its form lines of elegance and strength. The line of the column or shaft is carried above the bracket, and terminates in a wrought-iron spiral, forming an appropriate finish. The projection of the arc lamp is 4ft. 6in. from the centre of the column, and the height is 24ft. from the ground line to the centre of the light. The Gilbert arc lamps on these pillars are arranged to lower for trimming. The automatic cut-outs, substitutional resistances, and switches, etc., used are all of the company's standard design. The circuits are arranged in series of 10, and are run off a constant potential of 500 volts, and we believe it is the first time that such small ampere arc lamps have been successfully used for public lighting in this manner. The lighting of the Embankment is not yet completed, but that the general effect will be good can be gathered by the success of Saturday's trial run.

A NEW ALTERNATING-CURRENT ARC LAMP.

We were recently invited to witness, at the Croydon Corporation electricity works, the working of a temporary installation of arc lamps of a type now being manufactured (under the patents of Mr. Frank Lewis) and introduced by

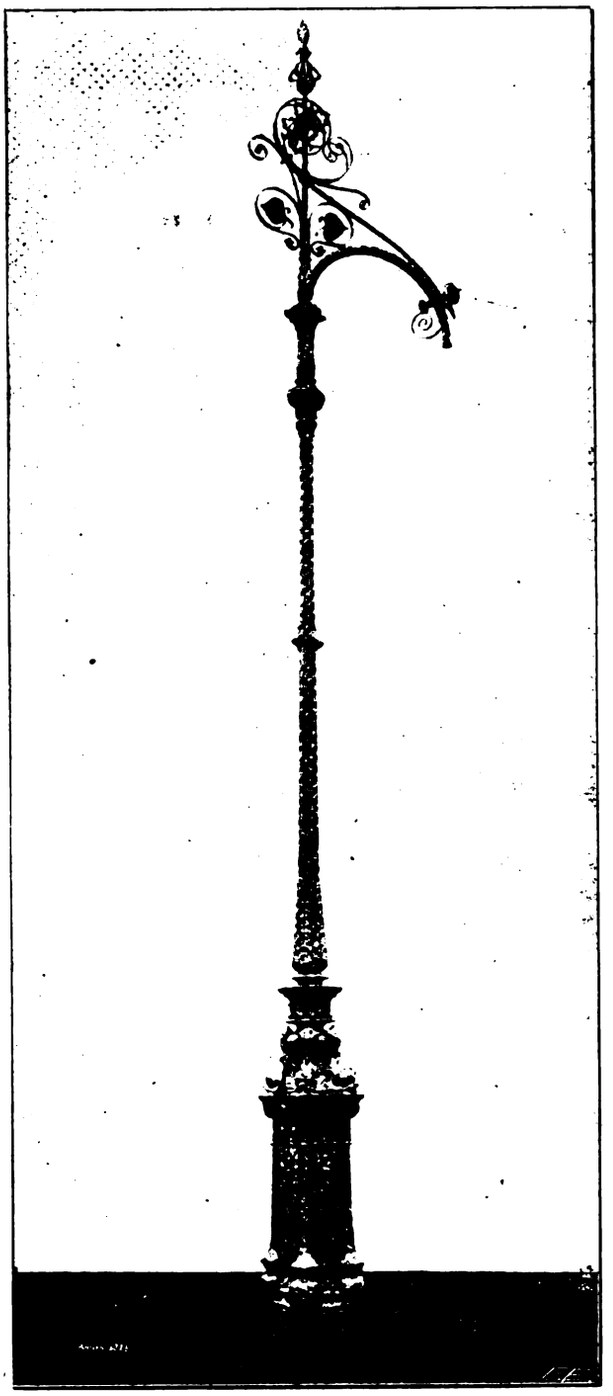

FIG 13.—The Arc Lamp Pillars to be used on the Embankment, designed by W. Macfarlane and Co.

the Reason Manufacturing Company, Limited, Brighton The lamp, it may be mentioned, has been designed to meet the requirements of a satisfactory series system of alternating arc lighting, and it now remains to investigate into how far these requirements are fulfilled. One of the advantages of series alternating enclosed lamps over parallel lamps, is that the large number of lamps in series have a steadying effect, and prevent large abnormal current rushes,

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which with parallel lamps often occur. The effect of this is that in the case of the series lamps the ends of the carbon become of a hard gritty nature, which gives the light a much better colour than when the carbon tips are softer, while at the same time a greater candle-power is obtained for a given consumption of energy. It is well known that series systems of alternating arc lighting are in great vogue in the States, but these systems have generally consisted of lamps working with shunt coils, each circuit being run from a constant current transformer, thereby necessitating the use of a cut-out for each lamp, which may be objected to as constituting a weak point. Another method which has been employed both in England, America, and on the Continent of Europe is to arrange a choking coil in parallel with the lamp, which, in the event of the latter failing,

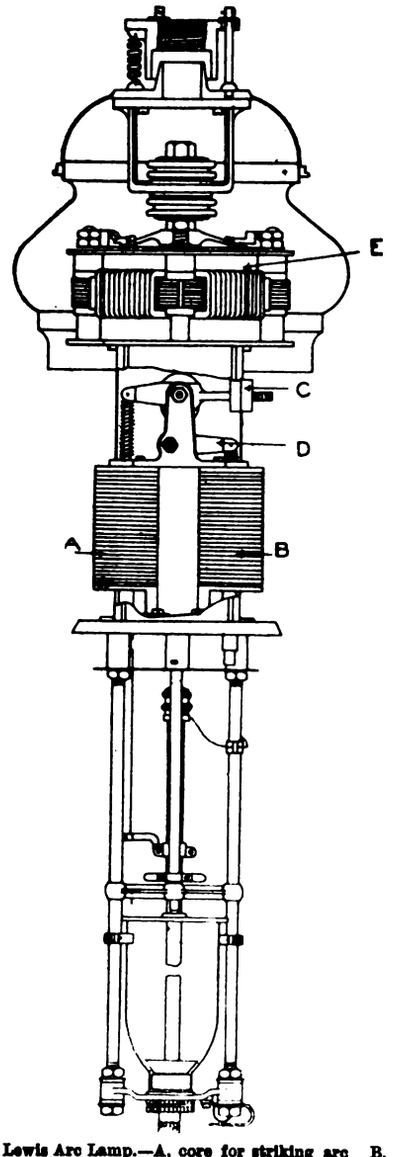
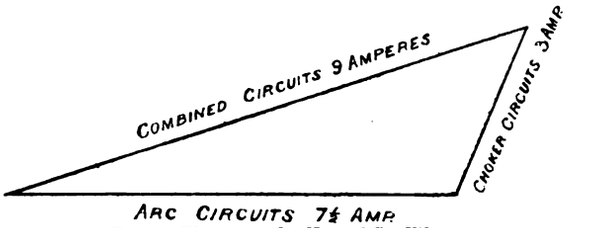


Diagram of Lewis Arc Lamp.—A, core for striking arc B. core for acting as a dashpot by braking striking lever C, balance weight; D, oblique approach; E, choker in parallel with arc.

substitutes a self-induction equivalent to it. The pioneering work in this direction must, we think, be accredited to the Helios Company, of Cologne, whose system was briefly described in our issue of July 3, 1896.

It is in this direction that Mr. F. Lewis has been working, and he so proportions the choking coils which are in parallel with each lamp that under normal conditions they take three amperes, while the arc lamp takes 7½ amperes. When a lamp fails for any reason, the whole current of the circuit, nine amperes, goes through the choking coil. This causes the E.M.F. of self-induction to rise to such a value that when combined with the E.M.F. of the rest of the circuit, a constant resultant is obtained which is equal to the applied voltage.

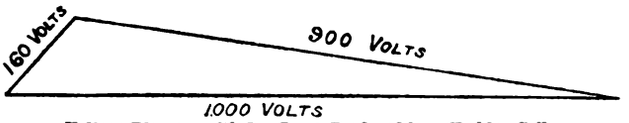
But the arc circuit for any such system to obtain good regulation must be extremely non-inductive, which, in other words, means that the controlling power for the carbons can only be weak. Should the lamp circuit be too inductive, in the event of failure of one of the arcs the circuit becomes affected unless a very large current is allowed normally to pass through the choker. The existence of a dash-pot involves to a considerable extent the necessity of large controlling power in arc lamps. When new and clean the dash-pot is a piece of mechanism which is not likely to cause trouble, but after prolonged use it is liable to introduce friction. In order to overcome this, arc lamp designers have hitherto provided as powerful controllers as possible consistent with keeping the price of the lamp within reasonable limits; but in the case of lamps provided with chokers in parallel to enable them to be run in series, such powerful controllers must be avoided, as previously observed, on account of their increasing the self-induction of the arc circuit. For this substantial reason Mr. Lewis has therefore contrived in his lamp to dispense entirely with the familiar dash-pot. In its stead he employs a solenoid, to the core of which is attached a strip which links on to a clutch acting directly on the upper carbon.



Current Diagram under Normal Conditions.

This clutch, when in its lowest position, falls on two stops, whereby an eccentric cam is rotated, which releases the carbon. The other end of the core is pivoted to a lever, to the axle of which a circular disc is attached. On this disc a brake lever and brake block bear when a second solenoid is energised. Reference to the accompanying illustration and explanatory notes will enable the construction of the lamp to be better understood.

The action of the lamp is as follows: When the carbons are together, an abnormal current flows through the striking coil and also through the coil which is employed as a brake, whereby the clutch is pulled upwards, but at the same time the second core is pulled up, which places the brake on the brake disc, and so prevents rapid movement of the striking core, hence also the possibility of the carbons being separated too rapidly. On the other hand, when the current is normal the brake is not in operation, the regulating core being free to move. This arrangement combines the



Voltage Diagram with One Lamp Replaced by a Choking Coil.

advantage that if the lamp is subjected to great vibration, as in the case of lamps suspended from trolley masts, and the carbons consequently tend to hunt, the braking apparatus comes into operation rapidly, while with a dash-pot the small movements are not effectively steadied. Apart from the controlling mechanism, several ingenious mechanical features have been embodied in the design of the lamp. Great care has, for instance, been taken to obtain perfect enclosure for the carbons. The use of asbestos for obtaining airtightness is dispensed with—since it has been found that carbon monoxide is able to pass freely through asbestos—and after the lamp has been running for a short time the gas inside is natural carbon monoxide and, of course, nitrogen. A universal joint is provided both above and below the enclosing globe and lower carbon-carrier, whereby it is possible to centre the lower carbon with the upper one by simply manipulating the globe. The spring suspension of the lamp is also neat, as will be seen from the accompanying illustration.

Now, as regards the commercial qualities of the lamp, it may be mentioned that it will burn for 70 hours without attention. A maximum number of 27 lamps may be run in series on a 2,000-volt circuit, or a minimum of five lamps on a 400-volt circuit. By virtue of the choker coil inserted in parallel with each arc, as above described,

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which when a lamp fails supplies an equivalent self-induction, it is claimed that 30 per cent. of the total number of lamps on circuit may fail without seriously affecting the rest of the circuit. A liquid resistance is employed in switching a number of lamps in circuit so as to avoid blinking the light, but, as previously observed, no special transformer is required. The power factor of the circuit is ·75, and the normal E.M.F. on the arc 80 volts. One of the appended diagrams shows graphically the current in the arc circuit, the combined circuit, and the disc circuit, while the other shows roughly the effect of one lamp in a series of 12 on 1,000 volts falling. The temporary installation which we were invited to inspect consisted of 12 of the lamps arranged in series on a 1,000-volt circuit, eight of them being under cover and the rest in the open. We were favourably impressed by the steadiness of the lamps, as also by the inappreciable extent to which the rest of the circuit was affected when two of the lamps were made to fail simultaneously. We understand that about 70 lamps of the type described are on order for installation in Croydon, some of them to be suspended from trolley masts yet to be erected.

In conclusion, we may add that Mr. Lewis, the inventor of the lamp, does not claim to have introduced any essential novelty in principle, but rather to have effected a combination calculated to overcome the difficulties hitherto experienced in connection with series alternating arc systems, and in this we trust further experience will prove him to be correct.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE LONDON COUNTY COUNCIL TRAMWAYS.

SIR,—On p. 653 in your contemporary, the *Electrician*, I have noticed the following paragraph:

"The only thing to be said for the London County Council conduit is that, as the yoke is only 26in. wide, the excavation will be *less than if the yoke spanned right across the track*. Seeing that track rails will have to be relaid, however, it is doubtful whether there will really be much saving," etc., which I feel justified in saying inadvertently cancels much of the praise of American conduits contained in the article, and which, at the same time, indicates the weak points in the admittedly sarcastic letter on the same subject in your last issue signed "M. B."

If "M. B." is an American, as I suppose he is, it would not be apparent to him that some of our London roads have been for many months in a condition of upheaval, which to an Englishman is by no means as acceptable as it would be in America, where, as he says himself, bad systems are continuously blowing up, and where, I may say, the roads are anything but satisfactory. There are more conditions to be considered in Great Britain than those of ingenious design and elaborate machinery, and this is why I quote the paragraph from the *Electrician*.

It gives the kernel of the more conservative English method, which prefers a system that does not necessitate the tearing up of the roadway to a great extent, and which is more simple and easy to repair. The relaying of track rails to a certain extent will always be necessary, and again I think that the English conduit exhibited at Camberwell will offer advantages over the much-praised American system in this respect.

The wood paving which "M. B." says predominates, and which the promoters of foreign conduits so object to, will not, as has been distinctly said, be used. It seems odd that the Americans should not feel complimented at our adopting mineral paving, which is the "predominating" feature of the roadways in the United States.

A good motto which "M. B." would do well to consider is *Via trita, via tuta*.

In England we look before we leap, and a conservative progress is better than the "sense of progress" which the American Demos get from the systems which "blow up" the day after they are laid.—Yours, etc.,

PRO BONO PUBLICO.

INSULATION TESTS.

SIR,—There appears to be some misunderstanding on the part of Mr. Pierson, for he has not evidently read my reply to question No. 342 in the right light. The first portion of the question asked for a description of some method whereby rough tests could be taken weekly to ascertain the insulation resistance of a three-wire network during working. I notice in Mr. Pierson's remarks that he has taken F in the formula

$$F = \frac{d^1 - d^2}{2\,d^2 - d^1} \cdot r^1$$

to be the resistance of the fault; but this is not the case, for $F = f_1 + f_2 + f_3$—*i.e.*, equal to the insulation resistances of the positive, neutral, and negative mains.

The above formula may be proved direct from Kirchoff's laws, but as this is a somewhat lengthy process, the following condensed proof is given according to Raphael:

If F = the insulation resistance of the network,

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}.$$

Putting $G + r = g$, and $r^1 = s$, V = the difference of potential between any two sides of the system (1 and 2, or 2 and 3), we have:

$$\text{First reading} = d^1 = \frac{V}{g} \cdot \frac{\frac{1}{f_3} - \frac{1}{f_1}}{\frac{1}{F} + \frac{1}{g}} \quad \ldots\ldots\ldots (1)$$

$$\text{Second reading:} \quad d^2 = \frac{V}{g} \cdot \frac{\frac{1}{f_3} - \frac{1}{f_1}}{\frac{1}{F} + \frac{1}{g} + \frac{1}{s}} \quad \ldots\ldots\ldots (2)$$

$$\text{Whence} \quad \frac{d^1}{d^2} = \frac{\frac{1}{F} + \frac{1}{g} + \frac{1}{s}}{\frac{1}{F} + \frac{1}{g}} \quad \ldots\ldots\ldots (3)$$

From (3) we have

$$\frac{1}{F}(d^1 - d^2) = \frac{d^2}{s} - \frac{d^1 - d^2}{g},$$

$$\text{whence} \quad \frac{1}{F} = \frac{d^2}{(d^1 - d^2)\,s} - \frac{1}{g} = \frac{2\,d^2 - d^1}{d^1 - d^2} \cdot \frac{1}{g},$$

$$\text{and from this} \quad F = \frac{d^1 - d^2}{2\,d^2 - d^1}\, s,$$

being similar to the formula given.—Yours, etc., A. H.

Feb. 26, 1901.

DIRECT OBSERVATION, GUIDED BY SCIENCE AND TESTED BY EXPERIENCE.

SIR,—I have come to the conclusion, after a most severe test, that the time has come when my researches will be of use to the community at large, as I will explain. For the past 23 years, ever since a child, I have believed that by careful observation a man can understand the working of everything around him without the aid of books, to the extent most people think is necessary. For an example, as a boy I had the opportunity to study the working of a distillery, and by careful scrutiny I found myself able to follow the whole process from where the grain is fermented to where the spirit comes out finished. At an early age I left my native village and took up electrical engineering as a profession. After a few years of careful observation and hard work I find I understand both theory and practice of all branches of electrical engineering, and I can understand the means by which electricity is applied to attain any ends, by studying the results, and applying the results of my previous observations to them.

After several years, I started independently as an electrical and mechanical engineer in all the various branches. But I was not satisfied, and after a time I made up my mind to travel all over the civilised world and study the various systems of electrical and mechanical engineering in vogue. I worked in most of the principal shops in Europe and America, and my spare time I devoted to experiments

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in various branches of science. Still unsatisfied, for a long time I studied the way in which habits govern people. By also studying closely my own habits, I find that the opinion I have formed as to the various organs of the body and their functions compares favourably with that of doctors. I have also studied, by direct observation, physiography and natural phenomena. I claim that what the world calls a genius is nothing more than a man with an abnormal memory, and that by putting certain facts which he has remembered together he produces his invention, and is acclaimed great by the world, for the simple reason he remembered and they forgot the facts on which the invention is based. In conclusion, in my opinion, by close observation and actual practice, a man will get better results than if he worked on scientific lines only, and, further, the value of so-called science is in most things greatly over-rated. If anyone should dispute this, I will be pleased to prove the truth of what I say. I am an unknown man, for I have not striven after wealth and fame, preferring to pursue my studies and experiments as a working-man, and learn my lessons in the hard school of experience.—Yours, etc., MAX HANKIN.

151, Minories.

DOUBLE-POLE SWITCH.

SIR,—What is a double-pole switch, and is it necessary that a double-pole switch should break circuit on *both* positive and negative poles when the D.C. machines are connected in series? As a friend of mine and myself differ in opinion upon the above subject, we should be pleased if you could enlighten us through your correspondence column, and very much oblige, yours, etc., G. M.

[The requirements of a double-pole switch are practically indicated by the name, as it is a switch which is so constructed as to break both the poles of an electric circuit.—ED. *E. E.*]

FEEDER REGULATION.

SIR,—I should be much obliged if any of your readers would kindly inform me as to the most modern method of regulating the voltage on feeder mains in the case where several feeders require to work from the switchboard at different pressures, and only one dynamo is used.—Thanking you in anticipation, yours, etc., J. K.

283, Wightman-road, Hornsey, N.

REVIEWS.

Polyphase Electric Currents and Alternate-Current Motors. By SILVANUS P. THOMPSON. Second edition. London: E. and F. N. Spon; New York: Spon and Chamberlain.

The original little book has now grown into a stout volume of some 480 pages and eight plates illustrative of polyphase machinery, mostly of Continental make. It is, perhaps, inevitable that every book on dynamo-electric machinery written nowadays should start with the elements of the science, but the author has wisely curtailed this elementary introduction as far as he could. There are no long-winded explanations how an E.M.F. is produced by a wire cutting lines of force, but the reader is at once introduced into the more practical part by being shown the E.M.F. curves as obtained from actual machines. Clock diagrams occur also very early in the book, so that the reader is saved much complicated mathematics. A neat way of finding the effective E.M.F. by planimeter from the polar E.M.F. curve is given on p. 16. This method is too little known by practical engineers, and the author has done well to give it. We notice that he does not use the term "effective," but "virtual" E.M.F. This is to be regretted, for the former term was adopted 12 years ago at the Paris Congress, and is used throughout the Continent and by the majority of English engineers. Whether "virtual" is preferable to "effective" we need not consider. The fact that the latter term is in almost universal use ought to weigh more than any real or imaginary advantage which the rival term may have from the point of view of the philologist.

The combination of magnetic fields is treated in the third chapter. Most readers will rather wonder that the combination of two fields at right angles is dignified by the term "Marcel Deprez theorem." On p. 73 the author treats the combination of three fields analytically, and arrives at the conclusion that the resultant field is 1·5 times as strong as each component and revolves with constand speed. This is theoretically true, but not true when the fields are produced in a real motor. The author ought to have pointed out that in the real motor the revolving field is slightly pulsating, and such a correction of the purely theoretical result of his investigations would have been the more desirable as he has previously, in Fig. 60, given a method of winding three-phase fields designed by Dobrowolsky for the very purpose of reducing these pulsations.

In the fourth chapter are introduced the polyphase generators. A very good feature is the clear representation of different forms of winding in Figs. 82 to 118. By using different colours to distinguish the phases, the reader is enabled to follow the winding with much more certainty and less fatigue to the eye than would be the case if the windings were distinguished by dotted lines or dots and dashes, as is usual. In the following chapter are given examples of polyphase generators, including a monocyclic machine made by the General Electric Company of Schenectady. The author calls the supplementary winding the "teazer," and states that the teazer gives almost entirely a wattless current. In the particular machine described the teazer has only one-quarter as many turns as the main winding; the pressure between each main lead and the third teazer lead is, therefore, only $\sqrt{(\frac{1}{4})^2+(\frac{1}{2})^2}=0{\cdot}57$ of the pressure between the main leads. Such a machine is, of course, mainly intended for supplying lighting circuits or single-phase motors, and the teaser is only of use in starting. Under these conditions, we agree with the author that the teaser carries normally a wattless current. He ought, however, to have told the reader that this is not the only way of building a monocyclic machine. In some cases it is necessary to provide current for three-phase motors; then the teaser must be made stronger so that the pressure between the three line wires is the same all round, just as in a regular three-phase plant, and then the teaser carries by no means only a wattless current.

In Chapter VI. we are introduced to polyphase motors, starting with the synchronous and then passing on to the asychronous type. The vexed question which part should be called the field and which the armature is solved by the author in a very simple manner. He employs neither one nor the other of these terms, but calls the parts "stator" and "rotor." He first deals with the structural aspect of the matter, shape of stampings, disposition of holes, windings, etc., and then proceeds to give an explanation of the manner in which the field progresses. This is shown very clearly in a succession of diagrams on p. 161, whilst the effect of magnetic leakage is very clearly illustrated on the next pages. Then follows the construction of the rotor, including its winding and starting resistance. The theory of the polyphase motor is treated in the next three chapters; in the seventh and eighth graphically, and in the ninth analytically. These expositions of the theory of the asynchronous motors are the best that have as yet appeared in the English language. They are clear and as simple as the somewhat complex nature of the subject permits, whilst for the practical engineer, who wishes, above all things, not to lose sight of the connection between the natural phenomenon and its mathematical representation, the example worked out on pp. 200 to 209 will be a great help. The graphic representation of leakage fields in Figs. 222 to 224 will also greatly aid the student. The backbone of the graphic treatment of the whole question is, of course, Heyland's diagram, given in Fig. 226 and in a more complete form in Fig. 227. Based on this, the author gives a complete investigation of a motor by Kolben, working drawings of which are given in Plate V. If the reader has mastered this example, he may skip Chapter IX., containing the analytical theory of polyphase motors. It is difficult to see what useful purpose is served by this theory, which by the author's own admission (top of

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p. 248) is incomplete. He says there: "To make the theory complete, we must take account of the leakage self-induction, the changes in the magnetising current, and the core losses. The expressions involving all these terms become so complex that they are of no practical utility." In plain English, this simply means that the practical engineer will do well to eschew the analytical treatment and stick to clock diagrams.

In Chapter X. are given examples of polyphase motors. Then follows a chapter on hints for designs, another on the working of motors, including characteristic curves and behaviour at starting. In Chapter XIII. we come to single-phase motors, the theory of which is developed by substituting for the oscillating field the equivalent of two constant fields rotating in opposite direction. This chapter, as well as the next, on polyphase transformers, might with advantage be amplified. We doubt very much whether the author's suggestion for a "phase-transformer" will give the desired result. We do not mean to say that supplied on the primary side with a three-phase current it will not give on the secondary side a single-phase current, but we very much doubt whether the load on the primary will be equally distributed between the three phases. We know of no static phase transformer which fulfils this condition, but if the phases are unequally loaded, then the transformer is only a useless complication, for a single-phase current can always be obtained from a three-phase apparatus by the simple expedient of using only two of the three terminals.

In the same chapter the author discusses rotary converters, and shows how the converting ratio is influenced by the width of the poles. This is further exemplified by reference to a converter made by the Oerlikon Company, of which detail drawings are given. In this machine the converting ratio (continuous to three-phase current) has been increased from 0·577 to 0·666 by narrowing the pole arc. In the following chapters we find notes on the measurement of polyphase power, on the use of polyphase motors in factories, on distribution of polyphase currents (including short accounts of some Continental power stations), and a fairly exhaustive dissertation of the merits of polyphase railways. For the particular method of connecting two motors in series for railway work, which on the Continent is termed coupling up in "cascade," the author uses the much better term "tandem control." For long lines and heavy trains the author thinks polyphase currents much preferable to continuous—provided the stops are not frequent, we are quite ready to agree with him. But on the vexed question whether the transformers should be placed along the line, or be carried on the train, he is silent. Yet this is one of the most important questions to be decided before a line can be built. Both systems find advocates. Messrs. Ganz believe in transformers along the line; Messrs. Siemens and others prefer to carry the transformer on the train. As lines on both plans are being built at the present time, it is all the more remarkable that the author has nothing to say on so important a question. We cannot help feeling that in his advocacy of polyphase working he has been a little unjust to the continuous current. Thus he has omitted to take into account the great advantage of the continuous current for urban traffic, where each run only requires current for accelerating the train, the rest of the journey being done by coasting. Under these circumstances three-phase working, even if tandem control be used, is most wasteful, whilst the continuous current, supplemented by buffer batteries, is the ideal system.

Chapter XIX. has the title "Properties of the Rotating Magnetic Field," and is partly a historical account of the subject, as is also the following chapter on the early development of the polyphase motor. The symbolic method of treating vector quantities, and a list of British patents bearing on polyphase apparatus, conclude the book. Appended are eight plates giving working drawings of polyphase apparatus. The index, as is usual in the author's books, is very complete, and the get-up of the work is worthy of its publishers. We congratulate Prof. Thompson on having produced a very readable book, which will prove useful not only to the student but also to the practical engineer. G. K.

METROPOLITAN DISTRICT RAILWAY.

We understand from a note in the *Scotsman* of yesterday that Sir John Wolfe Barry, K.C.B., has retired from the Metropolitan District Railway. It is said that his resignation is due to a difference of opinion regarding the particular system of electric traction to be adopted on the Inner Circle. The report adds that Sir John Wolfe-Barry has been in favour of the acceptance of the Ganz Company's scheme, and that the Board are not of the same opinion in view of the high voltage which would be employed on the line wires.

FORTHCOMING EVENTS.

FRIDAY, MARCH 1.

Royal Institution.—At 9 p.m., discourse by Mr. Henry H. Cunynghame on "Enamels."

Board of Trade.—At 11 a.m., at the Westminster Town Hall, enquiry into the question of increasing the declared pressure of supply.

SATURDAY, MARCH 2.

Royal Institution.—The Right Hon. Lord Rayleigh on "Sound and Vibrations" (Lecture II.).

Institution of Electrical Engineers.—Students' visit to the generating station of the London United Tramways Company, Chiswick.

General Electric Company.—Annual dinner.

North-East Coast Institution of Engineers and Shipbuilders. At 6 p.m., general meeting at West Hartlepool. Mr. F. W. Jennings will reply to the discussion on his paper on "The Ventilation and Heating of Ships." Discussion on Mr. G. M. Brown's paper on "Some Attempts to Increase the Efficiency of Marine Boilers." Paper on "Some Remarks on the Commercial Organisation of Shipyards," by Mr. Walter Scott.

MONDAY, MARCH 4.

Society of Engineers.—At 7.30 p.m., ordinary meeting, at the Royal United Service Institution, Whitehall. Paper, "Notes on Certain Details of Drainage Construction," by Mr. Gerard J. G. Jensen.

Society of Arts.—At 8 p.m. "The Bearings of Geometry on the Chemistry of Fermentation," by Mr. W. J. Pope (Lecture IV.).

Royal Institution.—At 5 p.m., general monthly meeting.

TUESDAY, MARCH 5.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper on "Arc Lamps," by Mr. P. Laubach.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed, "The Rotary Process of Cement Manufacture," by Messrs. W. H. Stanger and Bertram Blount.

WEDNESDAY, MARCH 6.

Society of Arts.—At 8 p.m., ordinary meeting. "Modern Artillery," by Lieut. Arthur T. Dawson (late R.N.).

THURSDAY, MARCH 7.

Institution of Electrical Engineers.—At 8 p.m., extra meeting. If the discussion on Mr. Magden's paper be concluded, the following will be read: "Insulation on Cables," by Mr. Mervyn O'Gorman.—At 3 p.m. (Students' Section). Visit to the works of the Thames Ironworks and Shipbuilding Company, Blackwall.—At 8 p.m. (Dublin Section). Visit to the Dublin United Tramway Company's power station at Ringsend.

Institution of Junior Engineers.—At 8 p.m., "Works Management," by Mr. A. H. Barker. (Lecture III.).

Rontgen Society.—At 8 p.m., ordinary meeting. Exhibition evening.

Civil and Mechanical Engineers' Society.—Ordinary meeting. Paper on "Authoritative Rules for Unit Stresses in Railway Girders," by Mr. J. Bell.

FRIDAY, MARCH 8.

Royal Institution.—At 9 p.m., discourse on "Vitrified Quartz," by Mr. W. A. Shenstone.

SATURDAY, MARCH 9.

Royal Institution.—At 3 p.m., "Sound and Vibrations," by the Right Hon. Lord Rayleigh (Lecture III.).

Institution of Junior Engineers.—At 3 p.m., visit to the Southall station of the Brentford Gas Company to inspect the carburetted gas plant, etc.

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "The Progress of Electricity Supply," by Mr. J. G. Scott.

Birmingham Section, Electrical Engineers.—We can only say in this issue that the president (Dr. Oliver Lodge) of this section of the Institution delivered his inaugural address on Wednesday last.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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CITY OF LONDON ELECTRIC v. MAYOR, ETC., CITY OF LONDON.

Judgment in this case was given too late to refer to in our last issue. Its effects, however, seem to be somewhat far-reaching, and it will have to be considered in all future transactions with corporate bodies. The case is too well known to require lengthy reference. Briefly, then, three agreements were in dispute, and the judgment of Mr. Justice Farwell in regard to these agreements was appealed against. The legal proceedings will not give the true inwardness of the case; to know this it is necessary to know the whole history of electric lighting as regards the City. The topic is not a pleasant one, and redounds nothing to the credit of the Corporation. However, after years of negotiations of one kind and another these agreements were made—two with the Brush Company and one with Laing, Wharton, and Down. These three agreements subsequently came into the hands of the "City of London Electric," the work was carried out, and the City has been lighted under them since 1891. In 1898 the City Fathers repudiated the agreements, hence the litigation. The result of the appeal is that two agreements are held to be invalid—those with the Brush Company—and the third held to be valid. Practically, this ruling was owing to some members of the Corporation having been interested as shareholders in the Brush Company. The exact words concerning this important question show that London differs from every other municipality, and therefore what holds good in the latter does not in the former.

The words of the judgment are: "The conclusion I arrive at is that a shareholder, commissioner, alderman, or common councilman is interested within Section 42, and that the existence of his interest is sufficient to render a contract with his company null and void. The fact that express provision has been made by Parliament that a member of an ordinary municipal council shall not be precluded, by being interested only as a shareholder of an incorporated company, from taking part in making a contract between his company and the corporation of which he is a member, only emphasises the distinction in this respect between ordinary municipal corporations and the City Corporation, as to which no similar parliamentary provision exists, or apparently ever has existed."

Unfortunately, every Englishman in theory is supposed to be thoroughly conversant with every word of the law, but in practice, of course, such knowledge is impossible. Upon the face of it, this exception of the first city of the Empire is peculiar—the members of its governing body suffer under disabilities such as exist with no other authority in the kingdom. We had supposed that its members were as high above suspicion as the members of any authority, but the law seems to point differently. However, we need not now enter into these abstract questions; the fact remains that because two or three of its members had invested some five hundred pounds in a limited company, agreements under which between one and two hundred thousand pounds were expended and work carried on during a period of some seven years

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with the impression that such agreements were good in law, the company is now told that its agreements have been illegal from the start. There is no suggestion of bad faith on the part of the company, yet it is put into a position very detrimental, or which may be very detrimental to its shareholders. It seems to us that the only honest course for the Corporation to have pursued was at the time the legality of the agreements was doubted to have examined into the *bonâ fides* of the whole matter, and if that could not be impugned to have made at once agreements that were valid. The attempt to break through an agreement honestly made after due consideration, is not in accordance with the honoured traditions of the City. Throughout the whole of its connection with electric lighting matters it may be said to have had no settled policy, but to have pursued a policy of shuffle, which is as unbusinesslike as it is detrimental. Any member of the Corporation, as the law stands, can render a proposed agreement with a limited company nugatory by purchasing a share in that company. Truly, if this is the view to be adopted, the law needs modification, and the Corporation of London to be put in a position at any rate not worse than that of any other municipality.

THE LIVERPOOL ACCIDENT.

On Wednesday, the 20th ult., the Liverpool coroner resumed the adjourned enquiry into the circumstanees attending the death of Thomas Hankey, carter, and David Singleton, butcher, who lost their lives through a fall of telephone wires on to trolley wires in Pembroke-place on the 4th ult., under circumstances already reported in these columns.

Mr. PIERCE, who appeared for the Liverpool Corporation, briefly explained the position of the Corporation in the matter. It had been decided, only after the most careful enquiry and consideration, that the form of traction best suited to the requirements of Liverpool was the overhead trolley system, and this was eventually adopted. Subsequent to making this decision the Corporation called in Dr. John Hopkinson for advice, and an experimental line was laid down to Dingle, which proved a success, and resulted in the reconstruction of all the tramways in the city and the electrical equipment on the same system. There was what was termed a guard wire and a guard strip over the trolley wire, and the Tramways Committee decided to adopt the guard strip. The Board of Trade certified that particular part of the tramways where the accident took place on Jan. 21, and the accident occurred on Feb. 4. On the night of the latter date there was a very exceptional snowstorm.

Several witnesses were next called to give evidence bearing on the exact circumstances of the accident and the attempts which were made to rescue the victims from the coils of the telephone wire with which they had become entangled. The medical evidence showed that death was due in both instances to exhaustion following upon an electric shock.

Mr. THOMAS DAVIES, civil engineer, Liverpool, who had made certain investigations into the case at the request of the coroner, explained that the telephone wires up to near the site of the disaster were underground. At Coustance-street, however, they entered the distributing box, from which point they were carried from a standard along London-road over the trolley wires to another standard in Oak-street, the span being about 350ft. It was the wires between this span which were alleged to have fallen. He had tested a piece of the wire taken from Singleton's body, and found the breaking strain was 161·5lb., whereas the ordinary breaking strain was 200lb. The maximum strain to which the wire would be subjected by stretching it into position was about 50lb., so that an extra strain of 109lb. was obviously introduced in some form before the wire broke. The most likely form was the weight of ice clinging to the wire and the force exerted by the wind at the time of the occurrence. The wire was of the customary weight used. He had made another test with a piece of the telephone wire taken down for him two days after the accident, and the breaking strain of that was 187·5lb. Two days after the accident he found that the trolley wires in London-road were without guards, but there were clips on the up line as though there had been guards when the accident occurred. In Pembroke-place there was a gap of about 2in. between the guards, which might have been caused by tugging at the wires, or the fall of the telephone wires might have disturbed the strip. He thought it advisable that the guard strips should be extended to the bow of the insulator. As to the means of cutting off the electric current, it seemed to him that the Corporation depended in a great measure upon the telephone service, and when it became disorganised they were prevented from communicating with certain individuals. It was also apparent that the guards and drivers of the electric cars, and also the policemen, were not familiar with the mode of cutting off the current. They should be instructed and provided with rubber gloves and nippers to cut wires. He could not suggest any stronger wire than that used by the Telephone Company, which was made of phosphor-bronze and had a breaking strain of 45 tons to the square inch. There was a divergence of opinion as to the respective utility of the strip guard and the wire guard. Both were unsatisfactory, but of the two he would prefer the wood guard, the chief objection to which lay in the fact that it was almost impossible to secure it to the trolley wire. With regard to the other guard there were more serious objections, the general view being that the more metallic things they had overhead the greater the danger. Assuming the Corporation had decided to maintain the trolley system, the proper course was to have the telephone wires laid underground, and do away with all overhead wires other than the trolley wires. Until the Telephone Company could do this they should encase their wires in cables.

WM. LAMB, a lineman employed on the Liverpool electric tramways, described the condition of affairs in Pembroke-place at the time of the occurrence. The guard strip on the trolley wire was in good order, but the telephone wires were coiled round it, and he had some difficulty in getting them away. Owing to the force he had to use the guard strip might have got displaced.

Mr. MATTINSON, K.C., representing the National Telephone Company, said Mr. Pierce had pointed out that the trolley wires were placed in the street under statutory authority. The telephone wires which crossed the trolley wires were also there by statutory authority. The only difference between the two cases was that the tramway system in Pembroke-place was only completed two or three weeks before the accident, whereas the telephone wires were in position there two or three years before. The wires in London-road were put up 18 months' previous to the accident, so were not only of first-rate quality, but had not been in position longer than was consistent with a large margin of public safety. The Telephone Company were, however, anxious to get rid of their overhead wires as soon as possible. At the present time all the main wires in Liverpool were underground. At the spot where the accident occurred cables had been substituted for wires as a temporary measure.

DANIEL SINCLAIR, engineer-in-chief to the National Telephone Company, said the wire the company used was tested to bear a breaking strain of 200lb. The life of a telephone wire of this class at the place of the accident should be about 10 years. When such atmospheric conditions prevailed as on the occasion in question, it mattered very little what kind of wire was erected, as down it would come. The reason why, with the knowledge of all this, no special precaution had been taken to minimise the effect of the falling was that at the time these works were designed there were no trolley wires there. The main point of protection was to have a wire elastic, strong, and light, so that if it did come down to the street it would do no harm to anyone. Everyone was thoroughly convinced that the right thing was that where there were trolley wires, the telephone wires should either be in cables overhead or underground. They had already handled 1,600 or 1,700 wires in cables overhead or in cables underground, and their promise to the Corporation was to go on until they had finished them.

At this point the enquiry was adjourned until the following morning, when the evidence was continued.

ARTHUR BENFIELD, foreman in the employ of the National Telephone Company, spoke as to the state of the poles and insulators in the vicinity of the accident the day after the occurrence. On examination he had found the poles and insulators in good condition. There were no insulators down in Pembroke-street. Other witnesses corroborated this evidence, which had an important bearing, in that suggestions to the contrary had been made.

This completed the Telephone Company's evidence.

In giving evidence on behalf of the Corporation, Mr. C. R. BELLAMY, general manager to the Liverpool Corporation tramways, said that by means of electric traction they had carried about 100 million passengers since the first route of the electric tramways was opened in November, 1898, and with the exception of the present case no fatal accident had occurred from electric shock. After the accident he made an inspection of

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the site, and found the wooden guard strips in their place. As to the provision made for turning off the current, the system was divided into half-mile sections, and 36 assistants, who had keys of the section boxes, could on short notice cut the current off from each half-mile section. He had found the insulators on the telephone poles all right after the accident.

Mr. A. BROMLEY HOLMES, electrical engineer to the Liverpool Corportion, stated that for the purpose of catching fallen telephone wires there was not much to choose between the wood strip guard and the wire guard, but as regarded the safety of the system as a whole the wood guard was the more advantageous. The latter means of protection had been adopted in Liverpool on the advice of Dr. John Hopkinson. But neither form of protector was effectual for such a fall as the one in question. The only safe course was to carry the telephone wires underground, and the Corporation recognised that. He did not think that if any other form of protector had been employed the accident could have been avoided, but that was a matter of opinion. The wood strip dealt satisfactorily with ordinary falling wires, but not with tangled wires.

Major CARDEW, electrical adviser to the Board of Trade, said that in the case of the wooden strip no "earthing" was possible. Much difference existed amongst engineers as to which was the best form of guard. The guard strip as sanctioned for use in Liverpool was the outcome of a great number of Continental experiments. The real difficulty to fight against was the tendency of the telephone wires to twist into small coils; they became springy, and would insert themselves into almost anything. Where there were trolley wires the most effectual remedy was to put all cross-wires underground, unless they were put in cables overhead. The span of the trolley wires in Pembroke-place was long, but with the weight of wire used it was not unreasonable.

Mr. PHILIP DAWSON, chief engineer and managing director of Messrs. Robert W. Blackwell and Co., who supplied the overhead equipment for the Liverpool tramways, said so far as Liverpool was concerned he thought the guard strip was the best method that could be adopted for protecting the trolley wires. He was convinced that had there been guard wires instead of wooden guard strips the accident would have been more serious, inasmuch as the guard wires would have been burnt through, and would have fallen together with the telephone wires.

Mr. SAMUEL B. COTTRELL, manager and chief engineer for the Liverpool Overhead Railway, gave evidence to the same effect.

This concluded the evidence.

The CORONER, in summing up, said that the question for the jury to decide was whether all reasonable and proper precautions were taken by the Corporation and the Telephone Company. Was there anything else they could possibly have done to avoid accidents short of putting the telephone wires underground, to accomplish which work every reasonable effort was now being made? Had anyone been guilty of negligence which had caused death? He would advise the jury to be careful with regard to any recommendations they might make as to the means of avoiding similar accidents in future. The subject was receiving the most serious consideration, and their suggestions might hamper the authorities in coming to a safe conclusion.

The jury agreed upon a verdict of accidental death from electric shock, at the same time expressing an opinion that if the span between the telephone standards had not been so long the accident would not have occurred.

CATALOGUES.

We have received from the General Electric Company, Limited, a four-sheet supplement to their large catalogue, which deals entirely with the steel interior conduit work. The conduits which are described in this list are enamelled both inside and out, the tubes being made of steel of sufficient strength to give ample protection against any risk of damage by nails, etc. The elbows and bends are made with inspection chambers from which the wires can be withdrawn if need be. The ordinary sleeves for connecting up the lengths of tubes are provided with a groove at either end in which red lead can be placed before the sleeve is put over the two ends of the tube. In this way watertight joints are obtained at a very slight cost. The same means of rendering the joints waterproof is adopted in all the elbows, joint-boxes, reducing sockets, etc. We notice that the enamel bends advocated by the firm have a considerable radius, and these, we think, should be used wherever possible when carrying out insulation with these steel conduits. While the large radius may involve a certain amount of extra work in erecting, it renders the drawing in and out of the cables a much more easy matter. The same firm have just issued the eighth edition of their telephone (or K) catalogue, in which there are many excellent things put in an excellent way. The keen competition imposed by Continental makers is evidently an incentive to improvement, as we find several interesting and practical novelties, whilst, despite the general increase in cost of material and labour, the firm tell us they have generally reduced the prices of the older apparatus, the high quality remaining as before. A great feature is made of the "Handcom" telephone, in which the automatic switch hooks or cradles are dispensed with, the whole of the necessary functions being performed by a switch in the handle of the hand combination. This type is also developed into a most comprehensive inter-communication system, the instrument lending itself to fixture in any position. The "General" intercommunication system has also been improved in that private circuits can be fitted if required. Among other novelties we notice the magneto intercommunication "Handcom," the direct-working bell-push telephones (for connecting to existing electric bell wires), and the "reply and call" system. The latter completely does away with the cumbersome plugboard for sub-station intercommunication, and substitutes a line selector instrument, whilst the telephone proper has a two-way switch for reply and call. This type is particularly neat in the "Handcom" pattern. The "Municipal" is a new type built according to Continental practice; these have already been supplied to Glasgow, Tunbridge Wells, and Guernsey. A further novelty is the traction system, comprising telephones, both fixed and portable, for communicating from feeder pillars with the central station. Among telephones for special purposes we find mining, engine-house, military, police, etc. The last is a particularly neat pocket instrument in connection with the firm's police and fire calls, which are now being supplied to Walthamstow and Tottenham. An excellent system of electrically-controlled clocks is shown, and the catalogue ends with a comprehensive set of wiring diagrams and a very complete telegraphic code.

PHYSICAL SOCIETY.

The annual general meeting of this society was held on Feb. 8, Mr. G. Griffith (vice-president) in the chair. The report of the council was read and adopted. Prof. Willard Gibbs and Dr. Rudolph Koenig were elected to the two vacant honorary fellowships of the society. The following officers and council were elected for the ensuing year:—President: Prof. S. P. Thompson. Vice-presidents (members who have filled the office of president): T. H. Blakesley, C. V. Boys, Prof. J. D. Everett, and J. Walker. Secretaries: H. M. Elder and W. Watson. Foreign secretary: Dr. R. T. Glazebrook. Treasurer: Prof. H. L. Callendar. Librarian: W. Watson. Other members of the council: Prof. Armstrong, W. R. Cooper, G. Griffith, E. H. Griffiths, Dr. R. A. Lehfeldt, S. Lupton, Prof. Perry, Dr. Porter, W. A. Price, and R. Threlfall.

Prof. S. P. Thompson then took the chair and delivered an address. In opening, the President gave in detail the various ways in which the aim of the Physical Society to promote the progress and study of physics has been accomplished during the 26 years of the society's existence. Referring to the election of two hon. Fellows, Prof. Thompson said they had added to their roll two men distinguished in very different walks of physics. Prof. Willard Gibbs was a United States mathematical physicist, whose work in thermo-dynamics, elastic solid theory of light, and other specialised subjects, was of the highest order, and was valued for its beauty and profundity. Dr. Rudolph Koenig, of Paris, was known as a maker of acoustical instruments of perfect standard—tuning-forks in particular. He had, however, found time to extend the borders of acoustics, and to him they owed the manometric flames, the wave siren, and other instruments of research. He had also published works on the facts about the combinations of pure tones. The president appealed to all searchers of physics in the country to make use of the society and give it their active support. It was mainly in the interest of teachers and students that the society undertook the publication of *Science Abstracts* By means of the *Abstracts* teachers had at hand the latest information on the subject, and could thus continually supplement their text-book knowledge. Every teacher from time to time devised new or improved modes of presenting his subject. At the Physical Society the Fellows always welcomed contributions of that kind, even though there might be little of actual novelty in the principles so illustrated. The routine work and administrative duties of teachers, although hampering their usefulness to science and diminishing their fruitfulness, prevented their attention, without intermission, to one subject, and produced a direction of thought over various domains of physics which was to be welcomed rather than deplored. It has been the custom for Fellows of the Physical Society to bring models to illustrate physical principles. That practice of using models was regarded by our Continental brethren as a peculiarly English matter, and one that showed a sort of mental constitution they did not quite understand. Models had become a part of their mental furniture. It never occurred to them that there was anything unusual in the habit. Faraday had used them in connection with the electrostatic field surrounding charged bodies. Lord Kelvin had made models to convey his ideas of elasticity, of the elastic solid theory of matter, and of the constitution of matter itself. Maxwell's models of

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heterogeneous dielectrics and the mutual induction between two circuits were well known. These models were useful for teaching purposes and for enabling one to grasp that which in its nature was abstract by contemplating the representation of it or its analogue in the concrete. The French physicist could not understand a complicated phenomenon until he had reduced it to a mathematical equation. The British physicist must construct a model which would produce mechanically the analogous operation. Both methods were right, but, judging by their fruitfulness, the method of Faraday had advantages over that of Poisson. Referring to the new teaching university of London, the president said that now was the time for Fellows to offer suggestions for the teaching of physics.

An ordinary meeting of the society was then held. A paper on "**A Mica Echelon Grating,**" by **Prof. R. W. Wood,** was read by Mr. Watson. This grating occupied a position midway between an ordinary grating and an echelon with thick plates. A number of sheets of mica were examined with the interferometer and one selected over a considerable portion of which the fringes were straight and unbroken. That portion was marked off and cut up into rectangles. The mica was about 0·05mm. thick, and the retardation of one of the rectangles was found to be 50 wavelengths for sodium light. Nine of these rectangles were used to form the grating, and they were put in position under a microscope, and cemented together at the edges with sealing wax. The grating space was 0·5mm. The battery was mounted on a square of cardboard over a rectangular opening of the same size, a clear space of 0·5mm. wide being left to serve as the first grating line of zero retardation. The number of lines was therefore 10. The resolution of the sodium lines was beyond the power of the instrument, but the yellow mercury lines were easily separated. The distance between the lines was one-third of the distance between the spectra. For the sake of comparison a grating of the same spacing and number of lines was ruled on a piece of smoked glass, and it was found that in the first order the grating was unable to separate the extreme red and blue ends of the spectrum. The Zeeman effect could be shown with an echelon made of four interferometer plates, the light being the green rays from a mercury tube.

The society then adjourned until Feb. 22.

At the ordinary meeting held on Feb. 22 Prof. S. P. Thompson, president, in the chair,

A paper on "**How Air Subjected to X Rays loses its Discharging Property and how it Discharges Electricity,**" by **Prof Emilio Villari** (hon. Fellow), was read by the Chairman. Air made active by X-rays in passing through a long tube coiled in many turns loses much more of its discharging power than it does in passing through the same tube if straight. During this process the tube charges itself to a certain potential. If active air is allowed to stream on masses of wire gauze or wound up ribbons, enclosed in tubes, the metals, independent of their nature, take a positive or negative charge, according to whether the active air rubs against them with force or lightly. Experiments have been performed to prove this. For instance, tubes of copper or lead, if short and straight, take negative charges, but if long and coiled they take positive charges. These phenomena cannot be attributed to chemical actions, but seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which they assume one of the charges, and the other charge ought to manifest itself in the air. This is not the case, the charge of the air being often of the same kind as that of the metals. It has previously been shown by the author that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces, and the other goes to reduce the active air to ordinary air, and, therefore, does not become manifest. The electroscope used in the experiments consisted of a fixed brass plate and a gold leaf, whose position was determined by means of a telescope with an eye-piece scale.

The **Chairman** said he had observed the fact that metals were charged sometimes positively and sometimes negatively by active air.

Mr. Watson asked if any experiments had been performed on the viscosity of gases rendered active by X-rays.

A paper on "**Cyanine Prisms,**" by **Prof. R. W. Wood,** was read by Mr. Watson. Prof. Wood has already described a method of making prisms of solid cyanine by pressing the fused dye between plates of glass. Until recently angles of about ½deg. were the largest that could be used with advantage on account of the small quantity of green light transmitted. A new supply of the dye has been found to transmit a large quantity of green light with an angle of over 1deg. By viewing the filament of an incandescent electric lamp through one of these prisms the anomalous spectrum is seen, the colours being arranged in the order: green, blue, violet, red, orange. Prof. Wood has crossed one of these prisms with a photographic copy of a diffraction grating having 2,000 lines to the inch. On viewing a naked arc lamp the diffraction spectra are deviated by the prism, the red ends being turned up and the blue-green ends turned down.

The **Chairman** said he had been trying to obtain some cyanine, but had not succeeded. Rosaniline has an anomalous dispersion, but could not be fused. The acetate of rosaniline might, however, be used.

The society then adjourned until March 8.

COMPANIES' MEETINGS AND REPORTS.

NATIONAL TELEPHONE.

The ordinary general meeting of the shareholders of this Company was held on Thursday week at the Cannon-street Hotel.

The **Chairman** (Mr. J. Staats Forbes) said the business of the year, taken as a whole, had created a record, and that notwithstanding some very adverse circumstances. The Government had now become their competitors in London; they had the power to grant licenses outside the Metropolis, whereas the company had a short life—1911 was the end of their license. What was going to arise in 1911? No one could tell. The Government under the license could every seventh year take over the concern by arbitration. If the Government persisted in competing with the Company at very low rates, he was afraid they would have a sorry tale to tell in 1904. After much deliberation and great individual anxiety on the part of the directors, they had come to the conclusion—subject to the sanction of the shareholders—to go on; to relax no reasonable effort to increase their subscribers, and to make the best of their property. Taking the year as a whole they had erected 23,490 additional exchange and private lines. Of those 16,776 had been for subscribers on the message rate system—namely, the payment of a low annual charge in respect of the cost of installation, and the addition of 1d. for each call made. He understood the Government intended to promote and extend that system. Well, he wished them joy if their result was to be anything like this Company's under it. On an outlay of half a million of money they had not made one farthing of interest. The Company could not afford to give services of that kind for nothing, but if they were forced by competition to do so they would have to take their chance. He moved the adoption of the report and accounts and the payment of dividends as recommended.

Sir Henry Fowler, M.P., seconded the resolution.

Mr. Lee Smith considered that the Government were treating this Company very unfairly.

The **Chairman** said they had made their bed with the Government, and they must to a certain extent suppress their indignation. No one was more astonished and nonplussed than the Board by the treatment the Company had received at the hands of the Government. The directors had tried to act with the Government in friendly competition, but all to no purpose. With the support of the shareholders they could beat the Post Office, because they were not tied round with red-tape. During the existence of the Company they had paid the Government 1¼ millions of money, and the authorities were now using it to fight them with.

The resolution was carried with one dissentient.

The **Chairman** then moved resolutions authorising the Board to convert 590,000 fully-paid (issued) and 10 000 (unissued) ordinary shares into preferred and deferred stock; to issue 200,000 of the unissued ordinary shares as preferred shares and the payment of a commission not exceeding 5 per cent. to persons for procuring subscriptions.

Sir Henry Fowler seconded, and the resolutions were agreed to.

Mr. Springman suggested that a petition, signed by every shareholder, should be presented to the House of Commons, and to the House of Lords and the Crown, if necessary, setting forth their grievances.

The **Chairman** stated that all suggestions made by the shareholders would receive the Board's consideration.

The proceedings then terminated.

CAMBRIDGE ELECTRIC SUPPLY.

The annual general meeting of this Company was held at the Company's offices, Cambridge, on Friday.

The chairman (Mr. D. Munsey) presided.

The report stated that during the year 1900 there had been added to the Company's mains the equivalent of 2,863 8-c.p. lamps, making the total 30,986. The number of units supplied has been 357,435, an increase of 59,043, or 19 per cent. In spite of the large increase in the price of coal the Company has been able to more than maintain its income without increasing the price of electricity. The Company, after paying all charges, placing £250 to the extinction of preliminary expenses, £448. 14s. 10d. to the extinction of suspense account, and £750 to depreciation account, has a balance of £4,278. 10s. 11d., which, added to £210. 15s. 2d. brought forward from last year, makes £4 489 6s. 1d. An interim dividend of £1,413. 16s. 2d., and interest on temporary overdraft and loan £193. 18s. 9d., have already been paid, leaving a net balance of £2,881. 11s. 2d., out of which the directors recommend the payment of a dividend of 4½ per cent., making with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,843. 2s. 5d., leaving a balance to carry forward, subject to fractional adjustment of income tax, of £38. 8s. 9d.

The **Chairman,** in proposing the adoption of the report, said that during the past year they had made progress quite to their satisfaction, and he might also say that their prospects for the present year were exceedingly good. The staff, from the top to the bottom, had worked well.

The **Hon. C. A. Parsons** seconded the motion.

The report was adopted, and the dividend as recommended by the directors declared. Mr. D. Munsey and Dr. Latham were re elected directors, and after some other business had been transacted the proceedings terminated.

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WESTMINSTER ELECTRIC SUPPLY.

Directors: Right Hon. Lord Suffield, K.C.B. (chairman); Captain Edmund I. Bax; Edmund Boulnois, Esq., M.P.; W. Hayes Fisher, Esq., M.P.; the Right Hon. Lord Kinnaird; J. Browne Martin, Esq.; R. W. Wallace, Esq., K.C. Engineer-in-chief: Prof. Alex. B. W. Kennedy, LL.D, F.R.S., M.I.C.E. Manager: L. H. Hordern, Esq. Secretary: Frank Iago, Esq.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1900:

The supply of current, which on Dec. 31, 1899, was provided for the equivalent of 421,445 lamps of 8 c.p., had increased by Dec. 31, 1900, to the equivalent of 469,589 lamps At the present time there are on circuit the equivalent of 479,056, and applications have been received for a further 7,056 lamps of 8 c.p. The length of roadway in which mains have been laid now exceeds 54 miles, making about 219 miles of ways, into which upwards of 188 miles of copper (strip and cable) have been drawn. Since last meeting the directors have entered into an agreement with the Vestry of St. George (Hanover-square) for lighting the whole parish by electricity. The experimental lamps erected near Victoria Station, which have been in use for some time past, have given great satisfaction. The mains for this purpose are being laid, the lamp-posts are being rapidly erected, and in a short time a considerable section of the area will be lighted by arc lamps. The continued high price of Welsh steam coal has entailed an extra cost of about 50 per cent. for fuel, and has, of course, materially affected the profits of the past year. Since the supply of current has been given at 200 volts, the revenue has also been reduced by the allowance of 8 per cent. to consumers supplied at that pressure. All the consumers (5,651), with the exception of nine, are now on the 200-volt circuit. During the year, in accordance with resolutions passed at the extraordinary general meetings, ordinary share capital to the amount of £148,100 has been duly issued at par to the shareholders A large proportion of this sum has been expended on the joint undertaking of the St. James's and Pall Mall Company and this Corporation in the purchase of lands and erection of works at North Bank, Marylebone. This capital must necessarily, until the opening of the works for supply purposes, remain unremunerative. An interim dividend at the rate of 10 per cent. per annum for the half-year ending June 30, 1900, has been distributed. After allowing for depreciation, sinking fund, etc., the net balance available for dividend is £30,536. 19s. 4d., out of which the Board recommend the payment of a dividend at the rate of 11 per cent. per annum, less income tax, for the past half-year, carrying forward a balance of £3,860. The directors regret that during the year, owing to his appointment as Governor of Madras, their colleague, Lord Ampthill, has had to resign his seat at the Board. In accordance with Article 127 of the articles of association, they have elected Lord Kinnaird to fill the vacancy. In accordance with the articles of association, two of the directors, Lord Suffield and R. W. Wallace, Esq., K.C., retire, but, being eligible, offer themselves for re election.

Revenue Account.

Dr.	Generation of Electricity.	£	s.	d.
Coal, carriage, unloading, etc.	£28,850 16 9			
Oil, waste, water, and stores	2,582 2 0			
Proportion of salaries of engineers and officers	2,527 3 7			
Wages, etc., at generating stations.	5,739 15 11			
Repairs and maintenance—buildings, plant, etc.	4,550 7 1			
		44,250	5	4
	Distribution of Electricity.			
Repairs and maintenance of mains...	1,342 17 9			
Repairs and maintenance of meters	2,266 0 8			
		3,608	18	5
	Public Lighting.			
Attention to arc lamps, etc.		173	4	11
	Rents, Rates, and Taxes.			
Rents	1,080 4 0			
Rates and taxes	6,510 15 2			
		7,590	19	2
	Management Expenses.			
Directors' fees	3,000 0 0			
Salaries of manager, etc.	7,219 5 11			
Stationery and printing	484 11 11			
General charges and office expenses	753 6 7			
Wages of meter readers, etc.	1,078 11 3			
Depreciation on office furniture	60 0 0			
		12,595	15	8
	Law and Parliamentary Charges.			
General law charges and parliamentary expenses...		784	17	9
	Depreciation, etc.			
Sinking fund	2,500 0 0			
Depreciation account	18,594 0 0			
		21,094	0	0
	Special Charges.			
Insurance	643 1 11			
Board of Trade audit	85 0 0			
Cost of supplying steam	1,499 0 0			
Experiments and cost *re* smoke abatement	88 15 1			
		2,315	17	0
Total expenditure		92,413	18	3
Balance to net revenue		58,681	14	4
		£151,095	12	7

Cr.	£	s.	d.
Sale of current by meter	144,580	4	8
Sale of current by contract	3	13	3
	144,583	17	11
Less bad and doubtful debts	701	11	9
	143 882	6	2
Public lighting	299	5	10
Rental of meters, etc., on consumers' premises	5,490	4	4
Transfer fees	78	15	0
Supply of steam	1,345	1	3
	£151,095	12	7

General Balance-Sheet.

Dr.	£	s.	d.
Capital account	797,600	0	0
Amounts received on founders' shares cancelled	500	0	0
Sundry creditors	11,904	6	10
Deposits by consumers	71	10	0
Debenture interest accrued, less income tax	4,156	5	0
Unclaimed dividends	3	2	7
Depreciation account	73,712	9	6
Sinking fund	15,063	12	1
Reserve fund	10,148	9	7
Net revenue account, £49,678. 15s.; less interim dividend to June 30, 1900, at the rate of 10 per annum, £19,975; and income tax, £833. 4s. 4d...	30,536	19	4
	£943,696	14	11

Cr.	£	s.	d.
Capital account	753,007	8	9
Stores in hand	9,499	15	6
Sundry debtors for current supplied	49,324	6	6
Other debtors	2,608	17	6
Cash at bankers	51,588	9	7
Cash in hand	130	13	8
Deposits with vestries, etc.	383	8	0
Central Electric Supply Company, Limited, outlay on freehold site, etc.	58,851	2	5
Advances under house wiring agreements	354	9	8
Investments at cost	17,948	3	4
	£943,696	14	11

Statement of Electricity Generated, Sold, etc.

Board of Trade units generated			8,618,640
Quantity utilised	Sold to consumers	7,281,109	7,361,374
	Used on works	80,265	
Quantity expended in distribution	In batteries	19,425	990,553
	In feeders	971,128	
Total quantity accounted for			8,351,927
Quantity unaccounted for			266,713
Number of lamps on circuit on Dec. 31, 1900			469,589

The ordinary general meeting of this Corporation was held at the offices, Eccleston-place, Belgravia, on Wednesday.

Lord Suffield (the chairman), in moving the adoption of the report, regretted to have to state that there was a reduced dividend on that occasion, for though they had added to their circuits over 48,000 lamps during the 12 months, like all other users of Welsh steam coal they had been very hard hit by the great rise in price. Their profits were also affected by the rebate made to consumers taking their supply at 200 volts and by a considerable increase in rates and taxes. The shareholders would, no doubt, have been pleased to learn that after negotiations extending over a period of two years the directors had come to an agreement for lighting the whole of St. George's parish. The directors very much regretted the loss of the services of Lord Ampthill, who had taken a deep interest as a director in the work of the Corporation, but they considered that they had been very fortunate in obtaining the services of Lord Kinnaird in his place. Lord Kinnaird was known to a great many of the shareholders as a thoroughly business man, and he was prepared to devote the greater part of his time to promoting the interests of the Company.

Mr. Boulnois, M.P., seconded the motion, and the report and accounts for the past year were adopted unanimously.

WINDSOR ELECTRICAL INSTALLATION.

Directors: M. Drury Lavin, Esq. (chairman); H. L. Prior, Esq. (deputy-chairman); Tonman Mosley, Esq.; Edward Riley, Esq.; A. W. Shipley, Esq, and managing director; A. A. Somerville, Esq.; Rev. R. H. Whitcombe. Engineer-in-charge: Mr. A. E. Farrow, A.M.I.E.E.

The fifth annual report of the directors states that the Company's business is steadily progressing, as will be seen from the abstract of the accounts given herewith. The number of lamps and motors installed on Dec. 31, 1899, was equivalent to 13,878 of 8 c.p. During the year 3,930 were added, bringing the total to 17,808 at the end of the year 1900, of which 1,083 represent the motor power. The additions to the mains and machinery during the year have not been large, the expenditure on capital account amounting to £6,764. 14s. 4d., bringing the total capital expenditure up to £53,670. 3s. 5d. The principal expenditure was on mains, which included a new cable to Windsor Castle, where a considerable number of additional lights have been connected, and also in St. George's Chapel. A new battery of accumulators has also been provided, and is now working.

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This, it is hoped, will be of sufficient capacity to supply the day load, and thereby effect a considerable saving. The net profit for the year is £4,372. 11s. 11d., and this would have been considerably increased but for the high price of coal. The favourable feature of the accounts is that over three-fourths of the profit has been earned from the supply of electric current. The total amount of profit available for distribution, including the balance of £690 12s. 3d. brought forward from the previous year, is £5,063 4s. 2d. Out of this the directors recommend the declaration of a dividend at the rate of 8 per cent. for the year, free of income tax. An interim dividend of 3 per cent. having already been paid, the remaining 5 per cent. will be distributed forthwith. After payment of the dividends, a balance of £1,400. 14s. 2d. will remain, out of which the directors recommend that the sum of £750 be added to the depreciation, renewal, and reserve fund, and out of the remainder the shareholders will be asked to vote the sum of £350 for directors' fees. The sum of £3,747. 9s. 6d. was received during the year, representing the premiums on the issue of the balance of the share capital less expenses, and the directors recommend that £1,500 of this sum be carried to the dividend equalisation account, and the remaining £2,247. 9s. 6d. to the depreciation, renewal, and reserve fund, bringing that account up to the very substantial total of £5 919. 10s., and the reserve for equalising dividends up to £2,000. The directors retiring in rotation are Messrs. Tonman Mosley, A. W. Shipley, and the Rev. R. H. Whitcombe. The two former, being eligible, offer themselves for re-election. Mr. H. R. de Salis, C.E., is recommended by the directors to fill the vacancy caused by Mr. Whitcombe's retirement.

Dr.	Revenue Account.	£	s.	d.
Generation of electricity		2,754	9	2
Distribution of electricity		425	2	0
Rents, rates, and taxes		259	6	6
Management expenses		519	9	0
Law and parliamentary charges		24	9	11
Special charges		113	17	0
Total expenditure		4,096	13	7
Balance carried to net revenue account		3,455	11	5
		£7,552	5	0
Cr.		£	s.	d.
Sale of current		7,176	0	11
Rental of meters, etc.		185	3	5
Rents receivable, less repairs and renewals		15	9	0
Transfer fees		5	10	0
Pupils' premium		35	16	8
Sale of steam, etc.		134	5	0
		£7,552	5	0

General Balance Sheet.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		50,000	0	0
Due from sundry tradesmen and others		4,947	5	5
Premiums on shares		3,747	9	6
Depreciation, renewal, and reserve fund account		2,922	0	6
Dividend equalisation account		500	0	0
Balance at credit of net revenue account		3,900	14	2
		£66,017	9	7
Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		53,670	3	5
Stores on hand		1,906	4	6
Free wiring and cells, etc., on loan		1,688	10	5
Unfinished contracts		509	10	3
Sundry debtors for current supplied		3,019	3	8
Other debtors		2,241	0	7
Cash at bankers and in hand		2,982	16	9
		£66,017	9	7

BRITISH INSULATED WIRE.

The report of the directors for the year ended Dec. 31, 1900, to be submitted to the shareholders at the fifth ordinary general meeting to be held at the Adelphi Hotel, Liverpool, on Feb. 25, 1901 at 12 noon, states that the gross profits for the year amounted to £134,226. 0s. 11d., to which has to be added the balance brought forward from the previous year, £6,432. 14s. 9d., making a total of £140,658 15s 8d. From this have to be deducted the total cost of administration, legal expenses, patent fees, etc., £27,908. 11s. 4d.; depreciation off the buildings, plant, and machinery, according to scale, £13,098. 10s. 6d.; written off patents, £5,000; debenture interest for the year, £2,500; interest on preference capital for the year, £17,987. 18s. 6d.—total, £66,495. 0s. 4d.—leaving a balance available for dividend, reserve, etc., of £74,163 15s. 4d. Out of this balance the interim dividend at the rate of 10 per cent. per annum already paid on the ordinary shares absorbs the sum of £12,481. 7s. 9d., and the directors have decided to transfer to reserve the sum of £22,400, leaving a balance of £39,282. 7s. 7d. The directors recommend that a dividend be now declared of £32 518. 12s. 3d., making with the interim dividend already paid a total dividend for the year of 15 per cent. on the ordinary shares, carrying forward to next account a balance of £6,763. 15s. 4d. The amount now transferred to reserve, £22,400, together with the amount received as premium on shares make a total reserve of £200,000. During the year 30,000 preference shares of £5 each have been issued at a premium of 10s. per share, and 30,000 ordinary shares of £5 each at a premium of £5 per share. The premiums thus received, £165,000, together with £12,600 formerly received, make £177,600. The new copper-rolling and drawing department is now in active operation, and has fully justified the capital expenditure on these works. It will, however, be necessary to further extend them in the near future. The Company has acquired the freehold property commencing at "The Hollies," Warrington-road, Prescot, extending in a westerly direction and giving an important frontage on Kemble-street. The debenture issue of £50,000 matured on Dec. 31, 1900, but as the directors contemplated in the near future making a larger issue on more favourable terms, arrangements have been made with most of the holders to temporarily extend their bonds to June 30, 1901. The results of the year's working have been very satisfactory, and the business of the Company has considerably increased. Large additions have been made to the buildings and plant, for the purpose of coping with the great increase of the Company's business, and the directors have still further extensions in contemplation. Mr. W. Marriner Brigg and Mr. S. Z de Ferranti, who are the retiring directors, being eligible, offer themselves for re-election. Messrs. Chalmers, Wade, and Co., the auditors, also retire, and offer themselves for re-election.

The ordinary general meeting of the shareholders of this Company was held at the Adelphi Hotel, Liverpool, on Monday, Mr. W. Marriner Brigg (the chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said the profits had been fully maintained—indeed, increased. The bonus of 5 per cent. of the previous year had not been repeated on this occasion. The Company required all the strength it could possibly get, for they had a great amount of work in hand and in prospect. Further, the directors deemed it very desirable to establish a strong reserve, which now amounted to the very handsome sum of £200,000, this having been created to the extent of £177,000 by the premiums of the new shares issued last year, and by the sum of £22,400 now proposed to be transferred. Referring to the investments, the Chairman said these had been the means of obtaining for the Company valuable contracts.

Mr. Snape, J.P., in seconding the motion, said the past year had brought to the Company a larger amount of business than they had known in any previous year, and also the largest amount of profit. The work of the Company was likely to increase because not only was the Government extending its trunk telephone service by means of underground cables, but municipalities were following suit, and in Liverpool, owing to the recent accidents, the National Telephone Company were actively engaged in transforming their overhead system into an underground system.

The motion was carried unanimously, and the dividend recommended having been declared, the retiring directors, Messrs. W. Marriner Brigg and S. Z. de Ferranti, were re-elected unanimously.

The proceedings then closed.

BRISTOL TRAMWAYS AND CARRIAGE.

The report of the directors for the year ending Dec. 31, 1900, states that the gross receipts for the year amount to £165,115. 15s. 7d., and the working and general expenses and renewals are £110,794. 12s 3d., leaving a net revenue of £54,321. 3s. 4d. The following amounts have already been distributed—viz.: interest on 4 per cent. mortgage debenture stock and temporary loans, £5,985. 1s. 1d.; dividend on 4 per cent. preference shares and interest on calls in advance, £7,990. 16s. 8d.; interim dividend at the rate of 7½ per cent. per annum (subject to income tax) for the half-year ending June 30, £17,968. 15s.; and it is proposed to appropriate the balance as follows: dividend for the half-year at the rate of 8½ per cent. per annum (subject to income tax), £20,187. 10s.; to carry to reserve and renewals funds—leased premises redemption, £500; contingencies, £1,689. 0s. 7d. The reserve funds will be increased from £90,444. 11s. 6d., at which they stood at the end of the previous year, to £97,228. 9s. 2d. The receipts from the tramways department show an increase of £4,270, and those of the carriage department an increase of £2,126. The total number of passengers carried during the year on the Company's cars and omnibuses was 26 971,606. The directors are pleased to be able to report the completion of the electrical conversion and extension of the tramways, as well as the building of the central power station and additional depôts, works which have together involved the expenditure of capital to the amount of £650,000, and called for the unremitting energies of the Board and their officials over a period of 2½ years. At the occasion of last year's report it was hoped that this result might be achieved in time to secure the advantage of the summer's working by electric traction, but, in consequence of delay on the part of contractors in the delivery of the plant, the general opening of the new system for public traffic was not possible until the end of December. Bearing this fact in view, it may be regarded as satisfactory that the net revenue of the year, besides admitting of a slightly improved dividend, is capable of meeting, even in a greater degree than the preceding one, the heavy charge for dividends on temporarily unproductive capital outlay. It is gratifying to the directors to feel assured that the shareholders have good reason to be satisfied with the future prospects of the Company. During the year the 25,000 preference shares were fully paid up, and the issue of mortgage debenture stock was increased to £213,100. Since the close of the year the latter has been further augmented by an allotment to applicants from amongst the stock and share holders, making up the issue to £250,000—the limit for the time being.

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The directors propose that the additional capital about to be created shall be issued by allotment when required as preference shares, ranking *pari passu* in all respects with the existing shares of that class—*i.e.*, with the right to cumulative preferential dividends at the rate of £4 per cent. per annum, payable half yearly on Jan. 1 and July 1, and also the right to rank upon the assets of the Company, for the amount of the share only, in priority to the ordinary share capital. The directors have to record, with feelings of deep regret, the deaths of their esteemed colleagues, Mr. William Butler and Mr. Charles Hoskins Low, both of whom had been associated with the administration of the Company for about a quarter of a century, Mr. Butler having been chairman from the inception of the undertaking in 1874, and Mr. Low a director for nearly as long a period. Mr. J. Clifton Robinson, C.E., and Mr. Samuel White have been elected to fill the vacant seats at the Board, and the latter appointed managing director in succession to Mr. George White, who has been elected to the chairmanship. Mr. Henry F. Cooper has been appointed secretary. Mr. Joseph Wethered, director, and Mr. Solomon Hare auditor retire at the ensuing meeting, and offer themselves for re-election

The annual meeting of the Company was held at Bristol on Thursday week, Mr. George White (chairman) presiding.

The Chairman, in moving the adoption of the report, stated that the receipts for the past year could not fail to be satisfactory inasmuch as during a part of the year the lines were in a state of upheaval, and the traffic over several of the sections was carried on under exceptional disadvantages. There was still some work at one or two of the old depôts, and the clearing up of various matters inseparable from the completion of so large a work as had been involved in replacing the horse cars by electric traction. They saw sufficient indication of increased traffic that they had considered it expedient to make provision for the early delivery of additional rolling stock. The Company carried last year 27 millions of passengers, and the total in the new year would probably be 40 millions. The central power station had been visited by men of the highest eminence in the electrical world, who had expressed their profound admiration at the work of their engineers (Messrs. Clifton Robinson and H. Parshall), who had given them the most complete system which had ever been devised in that or any other country.

Mr. J. Wethered seconded the motion, which after some discussion was carried.

Subsequently a special meeting was held, and approval given to increasing the capital of the Company to £1,000,000 by the creation of 25,000 new shares of £10 each.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The ordinary meeting of the proprietors of this Company was held on Tuesday at the offices, 38, Old Broad-street, E.C.

Sir Robert Herbert, who presided, said he had the pleasing duty of announcing a dividend that, with bonus, amounted to 17½ per cent., free of income tax. Moreover, the Company, which had earned a net profit of £100,195 was able, with the assistance of the amount brought forward from the previous year, not only to pay this large dividend, but to carry forward £75 564. The Company had been busily employed in laying cables, repairing cables, and supplying store cable for companies to keep in stock. Their factories had been fully employed and new machinery had been laid down. A large amount of money in hand, as the amount of the reserve showed they possessed, was, the Chairman pointed out, necessary to them. They had, for instance, now to deal with the great Pacific cable, which would naturally entail upon them heavy outlay before they could receive their remuneration for the work. That cable had to be completed by the end of 1902, and the smaller portions by the middle of 1901; so it was desirable they should have their pockets full of money to meet all the expenses of that somewhat trying period. Out of their profits the Company contributed £10,000 to the pension fund for the staff in accordance with a plan which so, say, the junior clerk starting at £100 a year who paid £10 in the first year, gave a pension of £5 a year at the age of 65; and every year's service and additional payment would provide, with the contributions of the Company, for a proportionate increase in the pension.

The report was adopted by acclamation. Admiral Sir A. H. Hoskins and Mr. Colin F. Campbell, the retiring directors, were re-elected, and the proceedings closed.

ELECTRIC RESISTANCE AND HEATING.

An extraordinary meeting of the shareholders was held at Winchester House, E.C., on Tuesday, for the purpose of considering a resolution for the voluntary winding up the Company.

Mr. Cyril Wanklyn (the chairman), in moving the resolution, explained that if they continued to carry on the business of the Company with little or no funds they must incur a heavy moral and possibly a legal responsibility. As it was, their liabilities amounted to between £1 500 and £2,000, and it was doubtful whether the assets which could be immediately realised would cover that amount. They had considered the possibility of reconstructing the Company on many occasions, but it was impossible to do so without some adequate guarantee with regard to the provision of new working capital. The only guarantee offered up to the present was £5,000, and the directors were of opinion that unless they could make a new start with about double that amount they would only be inviting a repetition of the present state of affairs. One cause of their present position was that they did not receive enough capital to develop the patents. Another cause was that the process was undoubtedly represented as being in a much more advanced state than was actually the case when they came to test it by putting it into actual use. He would mention two or three points in which the directors were grievously disappointed. First of all, they were given to understand by experts that these resistances would work sparklessly, but from tests carried out it was found that the application of electricity to these resistances produced considerable sparking, which was not only dangerous, but detrimental to the resistances themselves. Another defect was that of jumping. As the sliding contact moved round the ring it "jumped," and on enquiry they found that this was due to their manager having built the ring in sections instead of as a continuous whole. The last defect he would call attention to was that of heating. After a fairly lengthy trial the rings became red hot, rendering them not only dangerous but very liable to speedy deterioration if used for any length of time. All the defects had now been overcome, and he did not by any means regard the position of the Company as hopeless. Since the production of the last ring the prospects of the Company in the future—and he trusted it had a future—were infinitely better than they were some month ago. He must admit that the directors launched the process before it was commercially proved, but if they made a mistake they made it in excellent company, for Messrs. Ganz, of Budapest, and Messrs. Verity, of London, were also led away by the reports submitted to them. If the motion were passed that day—and he hoped it would be, because it was absolutely the only course they could take—he also hoped that arrangements might be made whereby the business of the Company could be still carried on. He could assure them that the interests of the present cash shareholders would be preserved, and this could only be done by offering the shareholders the right to subscribe to the shares in the new company with a small assessment on them.

Captain E I Bax in seconding the resolution, said he was assured of the future success of the process. Every engineer to whom he had shown the material believed in its capabilities.

The resolution for the voluntary winding up of the Company was then unanimously adopted, Mr. Wm. Chaplin, the secretary, being appointed liquidator.

GALLOWAYS, LIMITED, MANCHESTER.

Mr. Chas. J. Galloway, presiding at the annual meeting of the Company on Tuesday, stated that the extensive structural alterations and additions at the Knott Hill works were now rapidly approaching completion, and the directors looked with confidence to very satisfactory results therefrom.

The report recommending a dividend of 6 per cent. was adopted.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The report of the directors to be submitted to the members at the thirty-seventh ordinary meeting to be held on Feb. 26, 1901, at 1 p.m., states that the accounts for the year show a net profit of £100 195. 16s. 9d., after charging the interest on the debentures. To this sum must be added £53,803 6s 1d. brought forward from last year, making a total of £153 999. 2s. 10d. From this amount is deducted the interim dividend of 5 per cent., paid July 17, 1900, amounting to £22,410, leaving £131,589. 2s. 10d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, together with a bonus of 6s. per share, absorbing £56,025, being at the rate of 12½ per cent., and making with the amount already paid a total dividend for the year of £2. 2s. per share, or 17½ per cent., free of income tax, leaving £75,564. 2s. 10d. to be carried forward to the next account. The business of the Company during the past year has been satisfactory, and the factories have been fully occupied in the manufacture of submarine telegraph cables and of insulated wire. The Company's steamships have been employed in the laying of submarine cables, and also in the carrying out of repairing operations. The factories at Wharf-road and Greenwich and the steamships have been maintained in a thoroughly efficient condition. The directors propose to add a further sum of £10,000 to the pension fund established in 1899 for the benefit of the Company's staff. The retiring directors are Sir Anthony H. Hoskins and Mr. Colin F. Campbell, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane, Jackson, Jefferys, and Wells), and Mr. Patrick A. Clegg (of the firm of Messrs. Welton, Jones, and Co.), who retire, offer themselves for re election.

YORK TRAMWAYS.

The report of the directors for the half year states that the gross receipts amount to £2,273. 19s. 7d., and the working and general expenses to £1,773. 12s. 10d., showing a balance of £500. 6s. 9d, which is proposed to appropriate as follows: interest on 5 per cent. debenture stock (less income tax), £145; dividend at the rate of 6 per cent. per annum (free of income tax) on share capital, £266. 5s; balance carried to reserve fund for renewals and contingencies (bringing the fund up to £1,066. 7s. 1d.). £89. 1s 9d. The number of passengers carried during the half-year has been 511,697. The contract for the purchase of the undertaking by the York City Council has been sealed by the Council and the Company, and its provisions, which were approved by the shareholders at the extraordinary general meeting held in December last, became effective on the 29th ult.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candl at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

355. In the event of a short-circuit occurring at night on a low-tension distributing network, what is the best course to pursue?—A. K. T.

356. Describe a tramway scheme with distribution carried out on the three-wire system at 1,000 volts. Consider insulation and balancing difficulties; also saving in copper as compared with two-wire system at 500 volts.—A. J., SWANSEA.

ANSWERS.

Question No. 349.—What is the method of calculating the sizes of cables and mains for two-phase and three-phase currents?

Best Answer to No. 349 (*awarded* 10s.).—In order to determine the sizes of cables to transmit a given power it is necessary to know (*a*) the current to be carried by each line, and (*b*) the permissible voltage drop between the beginning and end of the line.

The current in each line is as follows, according to the particular arrangement of lines in use:

Let W = the total apparent watts to be delivered $= \frac{\text{Total true watts to be delivered}}{\text{Power factor of the load}}$;

V = voltage measured between two lines, as shown in Figs. 1 to 4.

Then

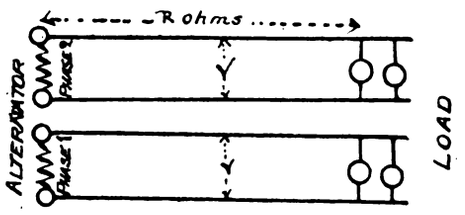

FIG. 1.

1. For a four-wire two-phase transmission, as in Fig. 1:

The current in each of the four lines $= \frac{W}{2V}$

and all four lines should be made of equal section

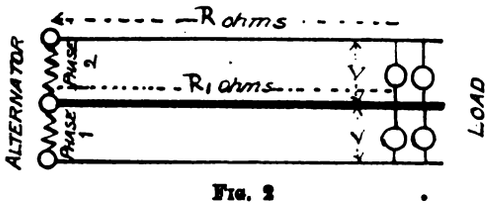

FIG. 2

2. For a three-wire two-phase transmission, as in Fig. 2:

The current in each of the two outer lines $= \frac{W}{2V}$;

the current in the common centre line $= \frac{W}{\sqrt{2}V}$.

The section of the centre line should, therefore, be made $\sqrt{2}$ times as large as either of the outer lines.

3. For a three-phase transmission with three lines, as in Fig. 3:

The current in each of the three lines $= \frac{W}{\sqrt{3}V}$,

and all three lines would be of equal section.

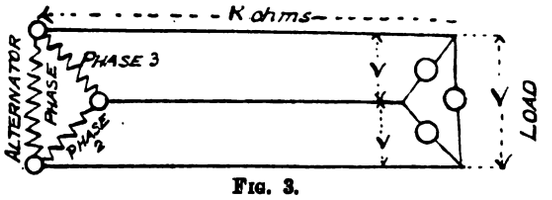

FIG. 3.

4. For a three-phase transmission with three main lines and a fourth neutral line, as in Fig. 4:

The current in each of the three main lines $= \frac{W}{3V}$,

where V is the voltage between any one of the main lines and the neutral wire, and is equal to V_1, the voltage between any two main lines, divided by $\sqrt{3}$.

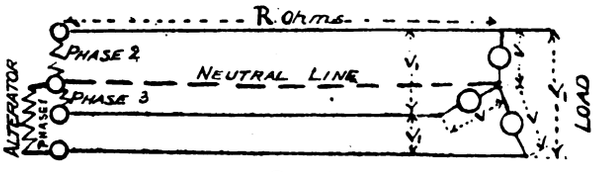

FIG. 4.

All the above values are calculated on the assumption that the load is equally distributed amongst the phases. If the load consists entirely of motors this would naturally be the case, and even in the case of a mixed lighting and power load great care is usually taken to ensure equal distribution of the load, as any distinct departure from this state leads to bad pressure regulation. In the case of a three-phase transmission which has an unevenly distributed load, the four-wire arrangement (Fig. 4) should preferably be used; whilst for a two-phase unequally loaded case, the four wires (Fig. 2) are best. The section of the neutral wire in Fig. 4 is quite indeterminate, depending entirely on the closeness with which the phases are balanced; and if the balancing is exact, it can be dispensed with altogether.

Turning to the second point—the pressure drop—the determination is considerably more involved than for ordinary continuous-current lines. This arises from the fact that the drop depends not only on the ohmic loss in the lines, but also on the inductive drop and on the power factor of the load.

The ohmic loss can be calculated as follows:

Let C = the current in each main line determined as above;
R = the resistance of one main line;
v = the ohmic loss in voltage at a current = C amperes.

Then for a two-phase four-wire system (Fig. 1)

$$v = 2RC;$$

for a two-phase three-wire system (Fig. 2)

$$v = RC + \sqrt{2}\,C R_1 \cos 45\text{deg.}$$
$$= C(R + R_1);$$

where R_1 = the resistance of the central line, and $= \frac{R}{\sqrt{2}}$, if all the lines are worked at the same current density, as is usually the case.

For a three-phase three-wire system (Fig. 3)

$$v = 2CR \cos 60\text{deg.},$$
$$= RC.$$

And for a three-phase four-wire system (Fig. 4), assuming all three phases equally loaded, and no current in the neutral wire: $v = RC$.

The inductive drop depends on the current in the line, on the size of the wire, and on the distances apart and relative positions of the different wires, and may be readily obtained for any given conditions by the aid of such a table as that published in the *Electrical Engineer* for June 25, 1897, p. 813. The inductive drop in each phase

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of a two-phase four-wire, two-phase three-wire, three-phase three-wire, or three-phase four-wire (equal load distribution) system may be taken as practically the same as in a single-phase system transmitting one-half the apparent power at the same voltage and periodicity. This is on the assumption that the lines are properly arranged on the posts to prevent interference between the different phases, as described in the above-mentioned paper.

Having decided the distance apart of the wires and the arrangement of wires on the parts, a size of wire (giving a reasonable current density) must be tentatively selected. The ohmic drop and the inductive drop must then be obtained as described above, and combined together by the following diagram in order to determine the net resultant drop. Set off A B (Fig. 5) to represent the current in

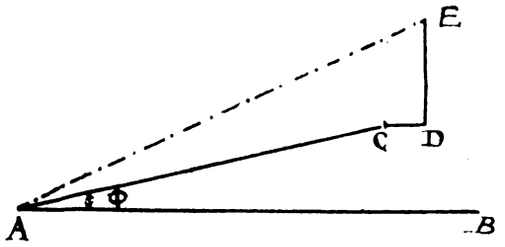


FIG. 5.

one phase. Draw A C (to represent the required voltage at the end of the line to some scale) at an angle ϕ to the line A B, such that cos ϕ = the power factor of the load for which the drop is to be determined. From C set off C D parallel to A B and equal to the ohmic drop to the same scale as before. From D draw D E at right angles to A B and equal to the inductive drop. Join A E. Then the difference between A E and A B is the total drop, and if this exceeds the permissible amount, the calculation must be repeated with a larger wire or with the wires placed further apart.—Q.

Answer to No. 349 *(awarded* 5*s.).*—The size of cable depends on (*a*) the system to be used, (*b*) the working pressure, (*c*) the power transmitted, (*d*) the loss permissible in the line. The total weight of copper required for transmission by two-phase currents employing four wires is, with the same loss in the line and same working pressure, exactly the same as required for single-phase transmission, though in the former case each wire has, of course, half the sectional area. This is on the supposition that the same type of motor is used, as it would not do for comparison to assume non-synchronous motors in one case and synchronous motors in the other. Call this weight 1. If for the two-phase transmission we use three wires instead of four, making the third, which replaces two, common to both circuits, this third wire need not be double the area of each of the other two, but only 1·4 times, and under these circumstances the weight of copper will be ·85 against the former 1. If three-phase transmission with three wires is used, the figure for the relative weight of copper depends entirely upon what is assumed as the standard of comparison with reference to the strain upon the insulation of the line and the apparatus connected to it.

Assuming there is between any two of the three wires the same difference of potentials that there is between each pair of wires comprising a circuit of the two-phase system, the weight of copper is represented by the figure ·75. So far, the weights are :

1. Single-phase system, two wires	1·0
2. Two-phase system, four wires	1·0
3. Two-phase system, three wires	·85
4. Three-phase system, three wires	·75

The second factor determining the size of conductors is the pressure to be adopted, this being one of the first things which has to be decided when a transmission scheme is being worked out. The pressure influences very materially the cost of line construction, as the weight of copper in the conductors is, for transmission of the same power with the same loss in the line, inversely as the square of the pressure. Assuming the pressure is decided upon, the table below gives the current in amperes per brake horse-power necessary to be transmitted. The pressure is in all cases taken at the motor end of the line, the pressure at the generator having to be higher by such amount as corresponds to the loss in the line.

TABLE I.—Current Required per B.H.P. at Various Pressures.

Pressure, in volts.	Amperes.
220	5·0
440	2·5
1,000	1·11
2,000	·55
3,000	·37
5,000	·222
10,000	·111

In the case of two phases, half the above current flows in each circuit. For three phases, the pressure in the table would apply to the difference of potentials between the common junction of the three conductors and either of the lines, and one-third of the current given in the table would flow in each wire.

The current being ascertained, the volts which it is permissible to lose in the line will determine the size of the conductors. In Table II. are given the volts lost in the conductors per mile of transmission for different current densities, and from this, knowing the fall of pressure allowable, the best density to work at can be determined.

TABLE II.—Volts Lost per Mile at Different Current Densities.

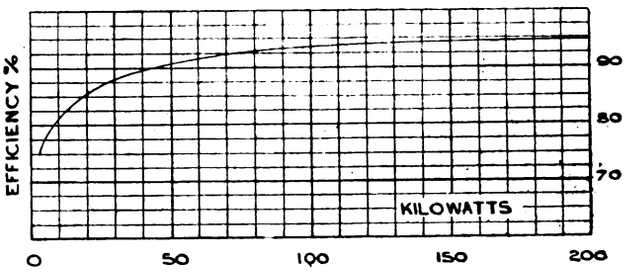
Amperes per square inch of section of conductor.	Loss of pressure in volts per mile.
2,000	172
1,500	130
1,000	86
800	69
700	60
600	52
500	43
400	34
300	26
200	17·2

If the plant is three-phase, the volts lost per mile must be taken as half of what is given in Table II.

The sizes of conductors for carrying any current at any density can be obtained from cablemaker's list.—F. B. A.

Question No. 350.—Would the combined efficiency of a continuous-current steam generating set be the same whether the plant consists of a single generator coupled to an engine, or whether, in the place of the former, two machines each of half the capacity were adopted ?

Answer to No. 350 (*awarded* 7*s.* 6*d.*).—The variation in the combined efficiency of a continuous-current generating set under the conditions named depends upon the output of the machines, and while it may be considerable with very small, will be almost negligible with large generators. Reference to the dynamo efficiency curve below will make



this apparent, and it will be seen that at 200 kw. the rate of gain with increase of size is very slow, since the curve is almost flat at this stage. At 200 kw. the efficiency is 94·95 per cent., and at as large a size as 750 kw. 95·5 per cent. is seldom exceeded, so that for outputs varying from 200 kw. to 750 kw. the gain is less than 1 per cent., and it is obvious that the change in combined efficiency due to the substitution of two machines for one will be slight. To show to what extent the thorough efficiency is affected at the lower outputs, it will suffice to take three cases at, say, 200 kw., 100 kw., and 50 kw. respectively.

Kilowatts, output.	Efficiency, single generator.	Efficiency, two generators.	Difference.
200	94·75 per cent.	93·5 per cent.	1·25 per cent.
100	93·5 ,,	91·0 ,,	2·5 ,,
50	91·0 ,,	87·0 ,,	4·0 ,,

The difference in the horse-power developed by the

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steam-engine will be too small to appreciably affect its efficiency, and this being so the figures in column 4 represent the variation in combined efficiency. It is not within the scope of the question to discuss the difference in the cost of two generators as compared with one, or to mention the difference in floor space occupied, but these and other less important considerations point to the advantage of using a single generator when the system of generation and transmission will permit it.—E. G. B.

Answer to No. 350 (*awarded* 7*s.* 6d.).—This question may be dealt with in two ways: (1) the substitution of two generators for the one, both being driven off the same engine; (2) the substitution of two complete steam plants in place of one. The question is very vague and wanting in detail, for much must depend upon the size of the plant; results obtained from a comparison made between a 5-kw. and 10-kw. steam plant would be quite inapplicable, when considering the difference between a 500-kw. and 1,000-kw. steam plant.

1. If we consider that it is only a question of making one engine drive either one or two generators we eliminate all discussion on the engine efficiency, and have only to deal with the generator losses. Now, the chief sources of loss in a dynamo may be tabulated as follows:

1. Mechanical loss due to (*a*) friction in bearings, (*b*) friction between commutator and brushes.

2. Magnetic losses due to (*a*) hysteresis in armature core, (*b*) closed local magnetic circuits in pole-pieces.

3. Electrical losses due to (*a*) shunt current, (*b*) compound current, (*c*) armature current, (*d*) heating of brush gear, etc., due to the passage of the current.

With regard to the mechanical losses, if the bearings are made so that x kw. may be transmitted by the shaft without undue heating, there will only be very little extra loss provided the bearings are properly lengthened and the shaft increased if $2x$ kw. are transmitted; but if for the second x kw. a second machine is added, the mechanical loss will be exactly doubled, since all the bearings and moving parts are doubled. Whilst the friction due to the brushes may remain the same, it will probably increase slightly, as the number of brushes with two machines will probably be more than that put on one of double the capacity, a margin in each case being left for temporary overload. So that we see the mechanical loss will be increased to a certain amount. With regard to the magnetic losses, the hysteresis effect is dependent upon the mass of iron, the induction across the iron, and the number of reversals per unit time; and according to the design of the machine these losses may be more or less for one machine than for two, but with well-designed generators we may consider these losses equal for the two types.

The same remark applies to a great extent to all the electrical losses, with the exception of the shunt current, and they may be considered equal if proper sizes are adopted. The percentage of the shunt current to the total output is higher for a small machine than for a large one, and may vary from 12 per cent. to 1·25 per cent., according to the size of the generator. So that we finally find that the efficiency of the one-generator arrangement will be higher than that of the two generators, owing to the fact that in the latter arrangement there are (1) greater mechanical losses, due to multiplication in the number of bearings; (2) greater electrical losses, due mainly to the higher percentage of the shunt current.

Attention must be drawn again to the fact that much depends upon the size of the generators. With a 10-kw. or 20-kw. dynamo an efficiency of 88 per cent would be good, while a 40-kw. generator might have an efficiency of 91 per cent., where a saving of 3 per cent. would be effected with the one-generator arrangement. But many firms will build a 500-kw. generator having an efficiency of 97 per cent. or even more, and if in place of two of these a single generator of 1,000 kw. were installed, it would be impossible to get 3 per cent. increased efficiency or anything like it. The increased efficiency would be there if equal care and skill were exercised in the design and building of all the machines, but it is possible that it might be so microscopic as to be hardly worth consideration, so that we arrive again at our first remark—that much depends upon the size; with all sizes the one-generator type will be the most efficient, but if the output is large it will not be of much moment which arrangement is adopted. (2) The same argument holds good when we consider two separate plants, except that we have the increased friction in the engines, and this will be of more importance than in the generators, not because of the friction in the bearings, but rather because of the friction in the stuffing boxes and of the piston rings. If the number of these is increased the friction losses must also be proportionally increased, and hence it is certain that there is, with equally well-designed sets, a perceptibly higher efficiency with one large unit over that obtained from two units of half the size.—M.

Answer to No. 350 (*awarded* 5*s.*).—The wording of this question leaves it rather doubtful whether, in the second case, two separate plants, each consisting of an engine and dynamo, are meant, or only that in place of the large generator, two smaller ones are coupled to the engine. Taking the latter as the correct reading, it may be said that as far as the losses between the engine cylinder and dynamo terminals go, it makes little difference to the combined efficiency whether one large or two small dynamos are coupled to the engine, provided, of course, that the dynamos are equally efficient. For instance, if the large dynamo has a full-load efficiency of 92 per cent. and receives 200 kw. from the engine, the power available at its terminals will be 200 − 8 per cent. = 184 kw. Now, if this dynamo is replaced by two smaller one, each having an efficiency of 92 per cent. at full load, and each receiving 100 kw. from the engine, then the power available at the terminals of each will be 100 − 8 per cent. = 92 kw., and 92 + 92 = 184 kw. As, however, with two machines there will be at least one extra bearing, the friction will be increased, and the engine must indicate rather more power before it can supply 100 kw. to each of the two small machines.

The practice of coupling two generators direct to one engine is an American idea, and a survival of the system of driving half a dozen machines from one engine by means of belting and countershafts. Where each circuit is supplied by a separate dynamo, such a system has advantages, as it permits of one large engine being used in place of several smaller ones, with a corresponding gain in economy and floor space. Two dynamos are also sometimes coupled to one engine and connected in series to supply a three-wire system direct without the use of boosters or accumulators. This is a convenient arrangement in very small stations.

In ordinary cases, however, where the circuits are all run in parallel from a common set of 'bus bars, it is more economical to couple the engine to one large generator than to two small ones for the following reasons: The first cost of two small machines is about 25 per cent. more than the cost of one large machine with an output equal to that of the two small ones, the annual charges for interest and depreciation are therefore greater. Then two machines take up more floor space, require more attention, cost more for repairs, and use more oil than one large one. It is also possible that with a small total load it might not be possible to procure two dynamos which would give as high an efficiency as a single machine of double the size, as small dynamos are usually less efficient than large ones. Then with two machines there is always the chance of one of them becoming disabled, in which case the engine must run at half load at a great loss of efficiency, as some engines consume 50 per cent. more steam per horse-power at half load than they do at full load, and a consumption of 25 per cent. more at half load is a common occurrence.—R. D. S.

LEGAL INTELLIGENCE.

CITY OF LONDON ELECTRIC LIGHTING COMPANY v. TH MAYOR, ETC., OF THE CITY OF LONDON.

On Friday, the 22nd ult., Lord Justices Rigby, Vaughan Williams, and Stirling, sitting in the Court of Appeal, gave their reserved judgment in this case. It was an appeal by the Corporation from the decision of Mr. Justice Farwell to the effect that

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the plaintiffs were entitled to a declaration that three several agreements: (1) an agreement dated May 19, 1890, and made by and between the Brush Electrical Engineering Company, Limited, and the Commissioners of Sewers of the City of London; (2) an agreement dated May 28, 1890, and made by and between the Laing, Wharton, and Down Construction Syndicate, Limited, and the said Commissioners; and (3) an agreement dated Feb. 5, 1891, and made by and between the Brush Electrical Engineering Company, Limited, and the said Commissioners, were valid and subsisting. The contracts in question, which were transferred to the plaintiffs by two indentures dated Aug. 21, 1891, were for lighting the City by electricity. The defendants, who were the successors in title and office of the Commissioners of Sewers, contended that the contracts were null and void by virtue of Section 42 of the City of London Sewers Act, 1848, which enacts "That no person, being a commissioner, or a member of the Court of Aldermen or of the Common Council of the City, shall be directly or indirectly interested or concerned in any contract which shall be made or entered into by or on behalf of the Commissioners for the execution of any works by this Act directed or authorised to be done or executed, or for furnishing materials or labour, or for any other matter or thing whatsoever, upon pain that every such contract shall be null and void, and that the person who, being a commissioner, or a member of the said Court of Alderman or of the Common Council, shall be so interested or concerned therein shall for every such offence forfeit and pay the sum of £100 to any person who shall sue for the same, to be recovered in any of the superior Courts by action of debt or on the case." The Act also enabled the Commissioners to contract for the supply of water and to contract with gas companies or other persons to supply gas or light to the City by any other mode (Section 116). By the Act of 1851, which was passed in order to continue the earlier Act (which would otherwise have expired) with such variations and additions as had been shown to be necessary, it was (by Section 53) enacted as follows: "That no person, being a commissioner, who is a shareholder in, or surveyor, solicitor, or agent for any gas company, water company, paving company, or any work, undertaking, or speculation the contracting with or the promotion or carrying out of which shall be discussed at any meeting of the Commissioners, shall be eligible to sit or vote as a commissioner while such subject is under the discussion of the Commissioners." Mr. Justice Farwell was of opinion that the Act of 1848 contemplated that the Commissioners would enter into contracts of two sorts: (1) for the construction of works or supply of materials to the City which would become their own property, and which he called "construction contracts"; and (2) for the supply of water for cleansing or of gas or other illuminant for lighting the City by companies or persons owning waterworks or gasworks or the like, that the contracts in question in this case fell under the second head; that Sections 33 to 42 formed a group of sections dealing with construction contracts; and that notwithstanding the generality of the language of Section 42 that section applied to construction contracts only. Moreover, Section 42 ought to be read with Section 53 of the Act of 1851, and (in his opinion) it would be idle to enact that a commissioner who was a shareholder in any contracting company should not be eligible to vote on the contract if the mere fact of his being a shareholder rendered it impossible that any contract could be entered into. Lastly, he thought that if Section 42 were ambiguous, as he held it was, the more reasonable construction ought to be preferred. He therefore made a declaration in favour of the plaintiffs. The defendants appealed.

Mr. Swinfen Eady, K.C., Mr. Danckwerts, K.C., and Mr. A. J. Walter were for the defendants; and Mr. Cripps, K.C., and Mr. Roskill for the plaintiffs.

The Court allowed the appeal.

Lord Justice Vaughan Williams read the following judgment of Lord Justice Rigby's, in which he concurred: After careful consideration of the provisions of the Act of 1848, of the judgment of Mr. Justice Farwell, and of the arguments addressed to us, I am quite unable to concur in the construction put upon the Act by the learned judge. This, speaking broadly, consists in treating all the sections of the Act from 33 to 42, both inclusive, as dealing only with what the learned judge calls construction contracts, leaving all other contracts—as, for instance, lighting contracts—outside their provisions, with the remarkable result that, notwithstanding the provisions of Clause 42, there is nothing to prevent any commissioner, alderman, or common councillor from having the largest interest in any contract with the Commissioners not a construction contract. In contradiction of this construction, I hold that the sections above mentioned do, in one part or another, deal with every possible contract that the Commissioners can enter into by virtue of the Act, and that the proviso contained in Section 42, whatever its effect, is to be applied to every such contract. His Lordship here referred to the different clauses bearing on the point, and proceeded as follows: It does not require argument to prove that all contracts dealt with in Section 33 are also referred to and dealt with in Section 42, and it is almost impossible to suppose such one-sided legislation as would apply the stringent provisions of that section to construction contracts only, and leave it lawful to any commissioner, alderman, or common councilman to have the largest interest in any contract with the Commissioners that is not a construction contract. As to the meaning of Section 42, the important point for decision is whether a corporator or shareholder of an incorporated company is or is not interested directly or indirectly in any contract entered into with the company. It was admitted on behalf of the plaintiff company that as a general rule he is so interested. But beyond what I think may be fairly called the main contention—viz., that only construction contracts are within Section 42—the plaintiffs have contended, and the learned judge has in their favour held, that the Act of 1851, and particularly Section 53 thereof, proves that under the special legislation affecting the Commissioners of Sewers a shareholder is not considered as being interested in a contract made by his company, though he must necessarily share in any profits or loss that might be the result thereof. Section 53 is a section not relating to concluded contracts, but to discussion and votes antecedent to contracts. It refers only to commissioners, and not to aldermen or common councilmen, though they are dealt with by Section 42 of the Act of 1848. The section was obviously intended to extend still further the disabilities of commissioners, and there is nothing to indicate that any relaxation of the provisions of the earlier statute was intended. There is, in fact, no necessary connection between Section 42 of the earlier and Section 53 of the later Act, and it would be illogical and merely conjectural to assume that the later section should interpret the earlier. The conclusion I arrive at is that a shareholder commissioner, alderman, or common councilman is interested within Section 42, and that the existence of his interest is sufficient to render a contract with his company null and void. The fact that express provision has been made by Parliament that a member of an ordinary municipal council shall not be precluded, by being interested only as a shareholder of an incorporated company, from taking part in making a contract between his company and the corporation of which he is a member, only emphasises the distinction in this respect between ordinary municipal corporations and the City Corporation, as to which no similar parliamentary provision exists, or apparently ever has existed. With regard to the central and western districts, the Brush Company obtained provisional orders, with the consent of the Commissioners of Sewers as local authority, and those orders were confirmed by an Act of Parliament not containing any statutory power of assigning the contracts which might be made with the promoters. The Brush Company entered into contracts with the Commissioners of Sewers, dated, as to the central district, May 19, 1890, and, as to the western district, Feb. 5, 1891, as to electric light. At each of those dates a Common Councilman was a shareholder in the Brush Company, and each of the two contracts was null and void *ab initio*. Notwithstanding this, by a deed dated Aug. 21, 1891, the Brush Company affected to convey the contracts to the plaintiff company, but this assignment could not render valid the contracts which were already null and void. We have only to give effect to the provisions of the statutes, and have not a dispensing power, even if we were disposed to exercise it. With regard to the contract as to the eastern district, dated May 28, 1890, it appears that the Laing, Wharton, and Down Construction Syndicate, Limited, the contracting parties, had no shareholder whose existence would render null the contract; and, although it appears that the Board of Trade might have revoked the provisional order but for the assurance of the Commissioners of Sewers that the syndicate would be financed and the contract taken over by the Pioneer Company and the City of London Company respectively, and that both those companies were disabled from entering into any valid contract with the Commissioners of Sewers, yet, on the assumption, which I see no reason to doubt, that the contract of May 28, 1890, was originally entered into in good faith, I can find no provision in the Acts of 1848 and 1851, or either of them, entitling us to set it aside.

Lord Justice Stirling read a judgment to the same effect.

The Court declared that the first two contracts were invalid, but did not interfere with the third; and, on the ground that each party had in part succeeded and in part failed, no costs were given in either Court.

We are indebted to the *Times* for the above report.

APPOINTMENTS VACANT.

Electrical Engineer, Manchester Corporation Tramways Department, March 9.

Accountant Clerks.—Institution of Electrical Engineers, £200 per annum, March 9. West Bromwich electricity department, £100 per annum, March 13. Details in our advertisement columns.

Motor Inspector, Bradford, must have had first-class experience in fixing and running direct-current motors of all sizes, and be able to carry out repairs, 34s. per week of 50 hours. Details in our advertisement columns.

Electrical Engineer and Manager, Lincoln Corporation, to take entire charge of the electricity works, £300 per annum, March 11.

Shift Engineer, Manchester Corporation, March 4.

Assistant Inspector of Lamps, Islington, £2. 10s. per week.

Charge Engineer.—Plymouth Corporation electricity works, £120 per annum, March 12. Full particulars in our advertisement columns.

Engineer, Manchester Corporation tramways department, to take charge of permanent-way work, March 9. Full particulars in our advertisement columns.

Assistant Electrical Engineer, Lowestoft electricity works, must have had experience in low-tension three-wire system with batteries, £2 per week. Details in our advertisement columns.

Fitter-Driver, Huddersfield power station, 35s. per week, March 11. Details in our advertisement columns.

Electrician, experienced in ship wiring. Details in our advertisement columns.

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CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Sutton Coldfield.—The Corporation invite tenders for house wiring. Tenders by March 11. Details in our advertisement columns.

Shoreditch.—The Council invite tenders for their annual contracts. Tenders by March 12. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for indiarubber-covered cables, etc. Tenders by March 29. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the electrical equipment of 87 cars. Tenders by March 4. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for supplying and fixing trolley wires and attachments. Tenders by March 8. Details in our advertisement columns.

Hastings.—Tenders will shortly be advertised for the supply and erection of the necessary boiler power, feed pumps, etc., which it is estimated will cost about £4,494. 10s.

Ploesti (Roumania).—The Municipality invite tenders for the laying down and working of electric tramways for 30 years. The provisional deposit is £2,000. Tenders by April 3.

Sofia.—The District Finance Department require tenders for various telegraph and telephone materials, amounting to about £2,800. The deposit is 5 per cent. Tenders by March 8.

Buxton.—The Urban District Council invite tenders for a 250-kw. steam dynamo and a Belliss engine coupled to two 43-kw. dynamos. Tenders by March 12. Details in our advertisement columns.

Shipley.—The Urban District Council invite tenders for the supply of house terminal boxes and switch gear, motors, wiring installations, &c. Tenders by March 19. Details in our advertisement columns.

Southampton.—The Corporation invite tenders for insulated electric cables, frames, and covers, including excavation and reinstating of roadways. Tenders by March 11. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for supplying and fixing trolley wires and attachments. Specifications etc., may be obtained at the City Engineer's Office, Municipal Buildings, Leeds. Tenders by March 8.

Warrington.—Tenders are invited for electrical light installation for the new police buildings. Specification, etc., can be obtained from the architects, Messrs. Cackett and Burns Dick, 24, Grainger-street West, Newcastle on-Tyne.

Belfast.—The Harbour Commissioners invite tenders for the lighting by electricity of the harbour office and the harbour workshops, Belfast. Specification, etc., may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by March 4.

Wallasey.—The Urban District Council invite tenders for the overhead equipment of about 10 miles of tramways and for the supply and erection of section boxes and the bonding of rails. Tenders by March 4. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for cast-iron pipes, with the necessary drawing-in boxes and wires, and supplying insulated conductors and drawing the same into the pipes. Tenders by March 8. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for supply of fuel economiser and additional Babcock and Wilcox boilers. Specification, etc., may be obtained from Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen. Tenders by March 15.

Cardiff.—The Corporation invite tenders for steam-pipes, exhaust pipes, injection and overflow pipes, feed pipes, drain pipes, engine-house flooring, and switchboard gallery and central service gangway. Tenders by March 18. Details in our advertisement columns.

Cheltenham.—Tenders are invited for the electric lighting of St. John's Church, Cheltenham. Specifications, etc., can be had from Mr. Weaver, Carlton-place, Hewlett-street, Cheltenham. Tenders by March 25.

Dagenham (Essex).—The West Ham Town Council invite tenders for the erection of a dynamo house at their small pox hospital, Dagenham Essex. Specification, etc., may be obtained at the Borough Engineer's Office, Town Hall, West Ham. Tenders by March 12

Hull.—The Corporation invite tenders for the supply of one steel Lancashire boiler, 30ft. by 8ft., with mechanical stoker, for the tramway power station, Osborne-street, Hull. Specifications, etc, may be obtained from Mr. A. E White, city engineer, Town Hall, Hull. Tenders by March 8.

Stockport.—The Gas and Electricity Committee invite tenders for supply and erection at their electricity works, Millgate, Stockport, of a condensing plant capable of dealing with 20,000lb. of steam per hour. Specifications can be obtained from Mr. S. Meunier, engineer. Tenders by March 6.

Luton.—The Town Council invite tenders for wiring for electric lighting purposes the Council-chamber, town hall, free library, corn exchange, and baths. Sketches of designs and full details of the proposed works to be given. Further information can be obtained of the Borough Engineer. Tenders by March 4.

Coventry.—The Sanitary Committee invite tenders for the work required in connection with the electric lighting of the new buildings at the infectious diseases hospital. Specification, etc., may be obtained at the office of Mr. J. E. Swindlehurst, city engineer, St. Mary's Hall, Coventry. Tenders by March 4.

Huddersfield.—The Corporation invite tenders for motorcarts suitable for conveying about five tons of coal from the local collieries to the electricity works. Further particulars may be obtained from the borough electrical engineer, Mr. A. B. Mountain, Electricity Works, Huddersfield. Tenders by March 5.

Bradford.—The Corporation invite tenders for the works required to be done in erection of a generating station at the electricity works, Valley-road, Bradford. Specifications, etc., may be obtained on application at the office of the Clerk of Works at the Electricity Works, Valley-road, Bradford. Tenders by March 5.

Wimbledon.—The Urban District Council invite tenders for cables, joint-boxes and jointing material, transformers, meters and demand indicators, lubricating oils, and Welsh steam coal, for the year ending March 31, 1902. Specification, etc, may be obtained on application at the Electric Lighting Works, Durnsford-road, Wimbledon. Tenders by March 15.

Bristol.—The Electrical Committee invite tenders for the erection of the superstructure of the Avonbank electricity works, Feeder-road, Bristol. The work comprises a large amount of steelwork, as well as brickwork and concrete work. Specification, etc., can be obtained at the office of Henry Williams, Esq., architect, 24, Clare-street, Bristol. Tenders by March 12.

Barnsley.—The Electric Lighting Committee invite tenders for the electric lighting of the workhouse: (Specification No. 1) (Section A) boiler; (B) feed pump, feed pipes, exhaust injector, steam and exhaust pipes, etc. (Specification No. 2) (Section A) wiring and cables; (B) steam dynamo and booster; (C) switchboard and accumulators. Specification, etc., may be seen at the offices of the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar, London and Manchester. Tenders by March 6.

Bray (Ireland).—The Urban District Council invite tenders for the supply and erection of: (Section A) boiler-house plant—one Lancashire boiler and accessories; (Section B) engine-house plant—(1) one 150-kw. high-speed steam alternator, and (2) one 25-kw. rope-driven alternator and accessories, for the municipal electricity works. Specification, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by March 14.

London County Council.—The following tenders have been received:

Name of firm tendering.	Number of boilers.	Amount of tender. Boilers.	Stokers.	Total.	Times for completion in weeks.	Percentage of efficiency	Type of stoker.
(1) Stirling Boiler Company, Limited, Edinburgh (accepted).	16	£17,953	£3,034	£20,987	35	74·5	Proctor's
	,,	,,	£4,829	£22,782	,,	,,	Chain grate of improved and extra strong pattern
(2) B. R. Rowland and Co., Limited, Redditch.	9	£21,480	£5,166	£26,646	60	75	American underfeed
(3) R. Hornsby and Sons, Limited, Grantham.	18	£26,922	£1,521	£28,443	61	75	Union Ironworks
	,,	£27,874	£3,111	£30,985	,,		Vicars (midfeather wall)
	14	£25,872	£1,215	£27,087	,,		Union Ironworks
	,,	£26,672	£2,756	£29,428	,,		Vicars (midfeather wall)
	10	£24,627	£1,666	£26,293	,,		Union Ironworks
	,,	£26,310	£3,390	£29,700	,,		Vicars (midfeather wall)
(4) Babcock and Wilcox, London.....	18	£26,520	£4,300	£30,820	24	75·8	Chain grate
	14	£29,418	£4,000	£33,418	,,	,,	Ditto
(5) W. R. Renshaw and Co., Stoke-on-Trent.	12	£26,995	—	—	60	—	None
(6) Edwin Danks and Co., Limited, Oldbury.	18	£37,500	£3,200	£40,700	120	—	

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RESULTS OF TENDERS.

Dundee.—The offer of Dick, Kerr, and Co. to supply light railway material has been accepted for the gasworks.

Southampton.—The Corporation have accepted the tender of the Leeds Steel Company, at £8 per ton, for the supply of 20 tons of tramway rails.

Shoreditch.—The Borough Council have accepted the tender of Johnson and Sons, Leicester, at £16,633, for new electricity station, Whiston-street, Haggerston.

Brighton.—The Town Council have accepted the tender of the St. Helens Cable Company, Limited, Warrington, for the supply, delivery, drawing in, and jointing complete of the required feeder cables, distributing cables, test cables, and telephone cables, at £4,045.

Brighton. — The Corporation have accepted the following tenders: Bruce Peebles and Co, Edinburgh, three steam dynamos, £7,530, negative booster £440; R. W. Blackwell and Co, Limited, 59, City-road, London, E.C., tramway switchboard, £745. 10s.

Hackney.—The Borough Council have approved the variation of the specification under the contract with Mr. John Greenwood, so far as relates to the use of white glazed bricks for lining the interior walls of the engine-room from the dado, and sanctioned the use of "Crystopal" for this purpose, at a cost of £750.

Aberdeen.—The British Insulated Wire Company have secured the contract for the electrical equipment of the bathing station tramway route, comprising the supply and erection of all overhead material—the poles being provided by the Corporation—and the supply and laying of lead-covered, paper or fibre insulated cables.

BUSINESS NOTES.

TRACTION.

Middlesbrough.—The extension of the tramway system in the town is to be commenced on March 1 next.

Brighton.—The Town Council have granted a license for the extension of Volk's electric railway on certain terms.

New Malden.—The District Council have approved the heads of agreement with the London United Tramways Company.

Cardiff District and Penarth Tramway Co.—The directors recommend a dividend at the rate of 5½ per cent. per annum.

East Ham.—The overhead wire system has been adopted by the Borough Council for their electric trams, which will begin running very shortly.

Huddersfield.—The question of a Sunday tramcar service was discussed at last week's meeting of the Council, and adjourned for two months.

Merthyr Tydvil.—Major Druitt, on behalf of the Board of Trade, will inspect the new tramlines of the electric railway on the 12th inst.

Watford.—At a special meeting of the Bushey Parish Council the Watford and District Tramways Bill was approved subject to certain conditions.

Bury.—The Joint Water Board have submitted protective clauses for insertion in the Corporation Tramways Bill and the South Lancashire Tramways Bill.

Manchester.—It is reported that parliamentary powers will be sought for in the session of 1902 for the construction of an underground electric railway on the same lines as the Central London Railway.

Kinver.—We understand that an effort will be made to secure the opening of the electric tramway for traffic at Easter. The first tramcar has been run over the line to test certain parts of the roads.

Dieppe-Paris Boat Trains.—The boat trains running between Dieppe and Paris in connection with the 10 a.m. services from London and Paris are now composed exclusively of corridor carriages fitted with the electric light.

Chester.—A rumour is abroad that in consequence of the opposition of the Hoole District Council and the Flintshire County Council to the Tramways Bill, the proposed extensions to Hoole and Liverpool-road and to Stonebridge, Saltney, are to be abandoned.

Bournemouth.—The Local Government Board have sanctioned the borrowing by the Council for the purposes of the tramway undertaking authorised, in respect of permanent way, land, and buildings £106 357; electrical equipment, £45,564; and cars, £22,800 - making a total of £174 721.

Maryport.—The Urban District Council have adopted the recommendation of the General Purposes Committee: that formal consent be given to the West Cumberland Tramway Bill, reserving to the Council the right to oppose any details which might not be arranged by mutual agreement.

Tunbridge Wells.—At a town's meeting on Wednesday afternoon a resolution to the effect that the Corporation be asked to develop a system of electric tramways was rejected by 31 votes against 19. At an evening meeting, as far as could be gathered from the show of hands about as many voted one way as the other.

Londonderry.—At the meeting of the Lighting Committee on Tuesday, the electrical engineer submitted a report on the estimates for the electrical equipment of the tramway system as follows: overhead equipment, £2,250; underground system of feeders, etc., £1,128; rail-bonding, £203; cars, £4,140—making a total of £7,721.

"Big Electric Railway Scheme."—We are informed that Mr. Alfred M. Fowler, of Manchester, is joint civil engineer to this scheme, reported in last week's issue. The proposal, it will be remembered, is to construct an electric railway from Harwich to Port Dinllwyn in Wales, the total cost of which is estimated at 20 millions sterling.

Aberdeen.—During the last 35 weeks there has been a deficiency of £1,110 on the horse tramcar service in the city, whereas the electric service shows a surplus of £522. 16s. 9d. during the same period. In consequence of this financial loss, the car service has been reduced. All the routes are partially affected, the Rosemount in particular.

Scarborough.—The Corporation have received a letter from the electric tramways company offering to hand over their Bill to the Corporation if the latter will pay all expenses incurred up to the present time. A sub-committee has been appointed to meet the representatives of the company so as to ascertain the exact amount of these expenses.

Gosport.—The District Council have decided, subject to the necessary permission of the ratepayers, to apply the rates under their control to the payment of the expenses attending the opposition to the Bill now being promoted by the Portsmouth Street Tramways Company to construct further tramways in the urban district of Gosport and Alverstoke.

Hammersmith.—The consent of the ratepayers has been obtained to the opposition by the Borough Council of the following parliamentary Bills: Charing Cross, Hammersmith, and District Electric Railway; Central London Railway; London County Council (Tramways and Street Widenings); and London United Tramways, Limited.

Dublin.—A Bill has now been deposited for this session on behalf of Arthur Guinness, Son, and Co., Limited, to empower them to construct tramways in the city of Dublin in connection with their St. James's-gate Brewery, and for powers to work the same and its existing tramways by mechanical or other power. The cost of these tramways is estimated at £10,342.

Stirling.—In connection with the tramways question, the Lighting Committee have met Mr. Lea, of the British Electric Traction Company, and discussed the proposals submitted by his company. The committee suggested certain alterations on the terms proposed, and it was arranged that Mr. Lea should communicate with his company and ascertain whether they would agree to the committee's proposed alterations.

Rochdale.—The conference of local authorities on the question of the taking over of the Bury, Rochdale, and Oldham tramway undertaking has appointed a committee to approach the tramway company with respect to the matter. It was reported that Bury declined to fall in with the scheme. The Tramways Committee of the Town Council are considering what type and style of cars to adopt for the municipal tramways.

Edinburgh.—At last week's meeting of the Special Committee on Tramways it was reported that the construction of the Portobello power house was going on rapidly, and that the structure would soon be ready for the roof. Tenders, amounting to between £5,000 and £6,000, were accepted for the boilers which are to furnish the motive power to the machinery. This decision has been confirmed by the Lord Provost's Committee.

London United Tramways.—The engineer's estimates of the cost of constructing the extensions proposed in the company's new Bill amount to £665,943. The London County Council decided on Tuesday to refuse to give its consent, required by the Standing Orders of Parliament, to the construction of such of the tramways proposed in the Bill promoted by the London United Tramways Company as would be situated within the administrative county of London.

Liverpool.—Following upon a report of the city electrical engineer, the Tramways Committee have authorised the general manager to arrange for an adequate provision of indiarubber gloves at police stations, etc., near the line of tramways. The committee have also instructed the engineers to prepare a plan showing the overhead wires at present existing over the tramway lines, and the owners of the same as far as can be ascertained, and to report as to the position of the Corporation with respect to such overhead wires.

Stockton-on Tees.—At the fortnightly meeting of the Rural District Council on Wednesday a letter was read from the Imperial Tramways Company stating that the directors could not entertain the claim of the Council to part of the alleged surplus profits of the company. The Clerk said under the provisional order obtained by the company the surplus profits after 8 per cent. had been paid had to be divided amongst the three Corporations and the Council according to the ratable value. He was authorised to confer with the other authorities interested, as joint action would be necessary.

Private Bills.—The Examiner on General Orders resumed consideration of the Paisley District tramways order on Thursday week. The consent of the Corporation of Johnstone has already been proved. The promoters have failed, however, to obtain the consents of the County Council of Renfrew and of the Corporations of Paisley and Renfrew, and a non-compliance with the requirements of the general order will be reported by the examiner in that respect. It will be competent for the promoters to ask the chairmen of the two Houses of Parliament to dispense with consent of these authorities, and it is expected this course will be followed,

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Leicester.—Messrs. Kincaid, Waller, and Manville have been commissioned by the Corporation to mature a scheme for applying electric traction to the whole of the Leicester tramways, as well as to a large extension of the present system, which has now been sanctioned. It is roughly estimated that the total expenditure on the acquisition of the present lines, and the completion of the new ones, will considerably exceed half a million sterling, if not reach three-quarters. After the experience at Liverpool there is a growing determination on the part of the special committee to declare for the conduit system, though it must entail a large addition to the initial cost.

Sunderland.—Some three weeks ago two of the principal sections of the electric tramways system were completed, but no official from the Board of Trade arrived to make an inspection of these. The Corporation, therefore, took the matter into their own hands, and last week commenced running without the necessary authority. The cars were extremely well patronised, but a peremptory telegram from London was received on Wednesday night ordering the immediate cessation of the service until the arrival of the inspector. Previous to this, a special meeting of the Tramways Committee had decided that it was inadvisable to run cars over the lines which had not yet been inspected by the Board of Trade. Accordingly, instructions were given to the traffic manager, with the result that the cars were immediately withdrawn. We trust that a permanent start may be made soon.

Bolton.—At a meeting of the Tramways Committee last week the consideration of the question of laying a portion of the new tramways on the Demerbe system was deferred for further information to be obtained. A letter was read from the Board of Trade forwarding the certificate of the Board that the Deane tramways were found to be fit for public traffic, together with the order sanctioning the use of electric power thereon. The borough engineer submitted a plan for the proposed relaying of the tramways in the central portion of the borough, and the plan was approved of subject to the suggestions now made. Centre poles were ordered to be placed in Trinity-street, and double-line tramways in Bradshawgate as far as possible. The engineer submitted a plan showing the reduction of passing places proposed to be made near Bob's Smithy, Chorley Old-road, and the plan was approved of.

Stoke-on-Trent.—Mr. Gerald A. R. Fitzgerald and Colonel Boughey, Light Railway Commissioners, have held a public enquiry as to the expediency of granting the application of the Potteries Electric Traction Company, Limited, for an order authorising various extensions of the Potteries light railways. The Commissioners said they did not consider it necessary to postpone their decision. In their opinion the opposition of the North Staffordshire Railway Company, important as it was, was not sufficient to justify them in withdrawing the case from the consideration of the Board of Trade. With regard to the time of purchase, they thought that Stoke should be put on the same footing as the other boroughs—viz., 31 years. As to the little projected extensions to Townsend (Bucknall and Sneyd Green, Hanley), they would be disposed to view them favourably if there was no opposition.

Automobile Demonstrations.—The Automobile Club on Tuesday gave a demonstration of the powers of various machines in the presence of the chairmen and clerks of various county councils and chief constables of neighbouring counties. A conference was afterwards held at the clubrooms, Whitehall-court, when several subjects were dealt with. The question of speed was not raised. The most important point discussed was that of the numbering of motorcars, and the opinion of the members was strongly adverse to any system of numbering. Some 22 county councils were represented. The club also gave a demonstration of motorcars at Chelmsford last week, to which the Highways Committee and other members of the Essex County Council were invited, but these gentlemen did not avail themselves of the opportunity of taking part in the trials. A lecture on the subject was afterwards given. It is proposed to hold a motor exhibition at the forthcoming Essex agricultural show. The East Suffolk Roads and Bridges Committee, before whom trials have taken place, have passed a resolution in favour of the abolition of the speed limit for motorcars, while the Kent County Council have passed a resolution to the effect that they do not consider 12 miles an hour an excessive speed.

Cardiff.—At a meeting of the Tramways Committee last week the Borough Engineer presented a report with reference to the lowering of the Bute-street Bridge in connection with the tramways. He had ascertained that the Board of Trade required, and would insist upon, a clear headway of 6ft. between the top of the car and the underside of the bridge, and, taking an ordinary type double-decked car, it would mean the lowering of the bridge pit to the extent of 15in. Even with the clearance which he had indicated, the Board would require all cars to be brought to a stand before passing under the bridge. The opinion was expressed that it would be quite possible to meet the difficulty to a large extent in the design of the cars. The report was ordered to be printed and circulated for further consideration. The Electrical Engineer reported that a special arrangement had been made by which it would be possible to fix centre poles in Cathedral-road for the carriage of the electric wires. The chief subject of discussion at the meeting of the General Purposes Committee on Monday was the taking over of the tramways by the Corporation. The terms proposed by the company are that they should reconstruct the lines for electric traction by the beginning of 1902, that the valuation of the depôts should stand over until a later date, and that the Corporation should pay all parliamentary and engineering expenses incurred by the company in promoting the several orders. The matter stood adjourned.

London County Council.—At the last meeting of the Council on Tuesday the Highways Committee submitted the following report: "As the designs for the generating station to be erected at the Camberwell depôt could not be proceeded with until the type of the boilers to be used there should have been determined upon, and the amount of space required for them should have been ascertained, we, as the first step towards a commencement being made of the conversion of the tramways for electrical traction, caused advertisements to be issued inviting tenders for the supply of the boilers required for the station. It was stated in the advertisement that tenders for the supply of any type of water-tube boiler which was in successful use on a large scale in actual work, would be considered. The tenders received were referred to us by the Council on Feb. 19, and the following is a list and particulars of them, from which it will be seen that only six firms have tendered, but that, as some have sent in several tenders, there are 13 in all. (See "Tenders.") We referred these tenders to Dr. A. B. W. Kennedy, the electrical engineer under whose supervision the work of reconstructing the lines and the provision of the necessary machinery and plant will be carried out. In a report presented to us this day, Dr. Kennedy states that, as regards the alternative tender of the Stirling Boiler Company, which is the lowest in amount, boilers of the type specified in the tender, and almost identical with those proposed for the station, have been in use in Edinburgh for about two years, and have been thoroughly satisfactory. He further states that the output of the boilers referred to has exceeded the guaranteed amount, and that they have cost very little for maintenance and repairs. The report contains observations with regard to all the other tenders; but Dr. Kennedy states that, as the alternative tender of the Stirling Boiler Company is very much lower than that of any of the other firms, and as the type of boiler specified by the company has, in his experience, given just as good results as those specified in the other tenders, he recommends that it be accepted. Having regard to the opinion expressed by Dr. Kennedy, we recommend that the tender of the Stirling Boiler Company to supply, for a sum not exceeding £22,782, the boilers and mechanical stokers required for the electricity generating station to be erected by the Council at the Camberwell tramways depôt be accepted."

LIGHTING AND GENERAL.

Gillingham.—The Urban District Council have decided to purchase the electric lighting works from the local company.

Share Market.—Electric shares all kept steady during the week. There was a good deal of business in electric tractions.

Middlesbrough.—The Fire Brigade Committee are providing their men with rubber gloves in case of electrical cable accidents.

Skelton and Bretton.—The Urban District Council have decided not to oppose the Cleveland and Durham Electric Power Bill.

Nantwich.—The agreement between the Urban District Council and the electrical engineers, Messrs. Trentham and Peers, has been sealed.

Darlington.—Applications continue to come in for installations of the electric light by private persons, and for power by manufacturers.

Sheffield Markets Electric Supply Co.—We are informed that the general offices of the Company have been removed to 57, Charterhouse-street, E.C.

Huddersfield.—The minutes of the Electricity Committee show that the surplus profit for the year ended Dec. 31 was £110, against £2,828 in the previous year.

Holmfirth.—A conference has taken place between representatives of the South Yorkshire Electric Power Company and the members of the Holmfirth Council.

Derby.—Mr. H. P. Boulnois has held an enquiry into the application of the Corporation to borrow £35,850 for machinery and the extension of electric lighting mains.

Tamworth.—The Guardians are about to institute enquiries as to the lighting of the workhouse by electricity. They are in favour of putting in their own plant.

Western Telegraph Co.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, for the quarter ended Dec. 31, payable 25th inst.

Personal.—We learn that Mr. W. Fisher is resigning his connection with Messrs. Crompton and Co. after a period of 10 years spent in Colonel Crompton's and the company's service.

Barnard Castle.—The District Council are enquiring into the provisions of the Cleveland and Durham County Electric Power Bill, as they might want to supply electric light themselves in Cockfield.

Aberdeen.—The Plans Committee of the Town Council at their last meeting discussed the plans of the new electrical station on the site of Dee Village, the value of which building is estimated at £23,000.

Hartlepool.—The West Hartlepool Corporation propose to apply for a telephone license, and desire to include Hartlepool in their area. The Hartlepool Town Council, however, have decided not to agree to this.

Chelsea Electricity Supply Co.—A dividend of 6 per cent. on preference and 5½ per cent. on ordinary shares for the year has been recommended; £10,000 is transferred to reserve and depreciation fund.

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Books Received.—"Practical Electrical Testing in Physics and Electrical Engineering," by G. D. Aspinall Parr, A.M.I.E.E. Longman, Green, and Co. 8s. 6d.—*Science Abstracts* for February. E. and F. N. Spon, Limited.

Rishton.—The District Council have consented to the application to the Board of Trade by Mr. Charles Chadwell for the granting to him of a provisional order for supplying electrical energy within the urban district of Rishton.

Carnarvon.—Mr. Trotter, of the Board of Trade, held an enquiry on the 26th ult. into the application for an order for the electric lighting of Carnarvon being made by Mr. Peterson, of London, and opposed by the Carnarvon Town Council.

Wireless Telegraphy on the Irish Coast.—A number of stations are to be erected along the south coast of Ireland to enable communication to be made by the Marconi system of wireless telegraphy with passing Atlantic liners when necessary.

Falkirk.—The Town Council are endeavouring, with reference to the Board of Trade's proposal to reduce the maximum unit price from 8d. to 6d., to get the Board to allow the price to remain at 8d., but, failing this, to have it fixed at not less than 7d.

Grimsby.—The public lighting of the streets is to commence on March 31, the end of the Corporation financial year. In the meantime those which are ready are to be lighted on Thursdays and Sundays from 7.30 to 10, and on Saturdays from 7.30 to 11.

Newton Abbot.—Mr. J. C. Wigham, engineer to Edmundson's Electricity Corporation, Limited, who has obtained a provisional order for lighting the borough, visited Newton Abbot on Saturday for the purpose of inspecting sites which have been offered for the works.

Enquiry.—The Board of Trade will hold an enquiry at the Town Hall, Westminster, to-day at 11 o'clock, with reference to the proposed alteration in the proviso to No. B (6) of the regulation made by the Board under the Electric Lighting Acts, 1882 and 1888.

Newbury.—It appears that the Corporation are not able to come to terms with the Urban Electric Supply Company, and are still pressing the Board of Trade for an enquiry so that the inhabitants should have an opportunity of expressing their views on this question.

Aldershot.—The Clerk formally reported at the last meeting of the Council that the Local Government Board enquiry, with reference to the loans of £20 000 and £5,200 for the purposes of the electric light and the parish clerk's land respectively, had been duly held.

Electric Welding Co.—The offices of this Company have been removed from 21, Hindon-street, Pimlico, S.W., to 28, Basinghall-street, E.C. The department for jobbing work has been transferred to Messrs. Smith, Parfrey, and Co., 141, Buckingham Palace-road, S.W.

Fleetwood.—At a meeting of the ratepayers' association last week a committee was appointed to enquire into the question of urban councillors holding shares in the Fleetwood and District Electric Lighting and Power Syndicate. The action of the association is much resented locally.

Post Office Telephones.—The chief exchange from which the Government telephones will radiate is now being fitted up in the building which the savings bank has hitherto occupied in Queen Victoria-street. The Post Office officials expect that the system will be inaugurated in about six months.

Shildon.—The Cleveland and Durham County Electric Supply Company having requested the Council to pass a resolution in favour of their Bill, the Urban District Council have decided to reply that they have already made arrangements for their supply, and they therefore could not support the Bill.

Gloucester.—After a lengthy discussion on the electric light charges, the Electric Lighting Committee have resolved: "That while they are anxious to supply electricity on the most favourable terms, they will make no change in the scale of charges until the result of the first year's working has been ascertained."

Aylesbury.—A resolution to the effect that the Council apply to the Board of Trade for an extension of time for the electric lighting order, and that in the meantime treat for land and ascertain companies willing to undertake the work, was before the last meeting of the Council. After discussion the matter was adjourned.

Pacific Cable.—Mr. Mulock, the Postmaster-General, has given notice of a resolution authorising Canada to contribute five-eighteenths of the £2,000,000 which are to be advanced by the Imperial Government for the laying of the Pacific cable. The estimate of the cost of this undertaking provided for last session was £1,700,000.

Hoylake and West Kirby.—Mr. Ernest Marples, at present engaged as clerk of works, has been appointed electrical engineer. The position was not advertised because when Mr. Marples was appointed clerk of works it was understood that if he gave satisfaction, he should, when it became necessary, be appointed electrical engineer.

Dartmouth.—Mr. J. C. Wigham, engineer to Edmundsons' Electricity Corporation, Limited, who has obtained a provisional order for lighting the borough of Dartmouth by electricity, visited Dartmouth on Saturday last for the purpose of inspecting sites which have been offered for the works. The work will probably be started in July.

Pritchett and Gold.—We are informed that owing to the continued increase in their battery business, this firm have disposed of the business of electrical engineers and contractors lately carried on by them at 15, Hart-street, London, W.C., to Messrs. Braby and Tomlinson, Limited, who will continue at the same address. In future they will devote their whole time to the manufacture of storage batteries at Feltham, Middlesex.

Removals.—The Sturtevant Engineering Company, Limited, mechanical and electrical engineers and contractors, have removed their offices to 147, Queen Victoria-street, E.C.—Mr. Arthur Koppel, manufacturer of portable and permanent railway materials, has removed to 27, Clement's-lane, London, E.C.—The Schattner Electricity Meter Company, Limited, Timberhite, Norwich, has removed to Tyndale Works, Upper-street, Islington, N.

Burnley.—The Corporation Electricity Sub-Committee have approved of a scheme for the extension of the electricity supply works, so as to provide electrical energy for traction purposes in connection with the town's electrical tramway scheme. The scheme provides for two new boilers, the raising the existing chimney 30ft., new accumulators, a traction switchboard, and alterations to buildings, involving an estimated expenditure of £7,345.

Patent Decision.—The case of the opposition to the German patent for Messrs. John Gibbs and Son's (engineers, of Duke-street, Liverpool) safety motor switches, brought by Messrs. the Elektricitäts-Aktiengesellschaft vorm. Schuckert und Co., of Nuremberg, has at length been decided in favour of Messrs. John Gibbs and Son, and letters patent finally granted. The result of this decision will be to considerably enhance the value of Messrs. John Gibbs and Son's patents.

Hanley.—The Hanley electricity works were opened in July, 1894. In the first year the private supply of energy was 55,000 units. In 1900 the supply was 64 000 units, the gross profit being estimated at £3,600. The amount of interest paid out of this sum was £2,100 and £2,148 has been transferred to the sinking fund, leaving £640 deficient. But against this has to be placed the amount paid in the reduction of capital, £7 786. The working last year resulted in a profit of 12 to 13 per cent.

Stock Exchange.—The Stock Exchange Committee have appointed March 5 special settling day for the Brisbane Electric Tramways Investment Company, Limited, 75 000 ordinary shares of £5 each, fully paid, Nos. 1 to 75,000; 75,000 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 75,000; and provisional certificates (fully and partly paid) for £400,000 4½ per cent. first debenture stock, and have also ordered the said securities to be quoted in the official list. Applications have been made to the Exchange Committee to allow the following securities to be quoted in the official list: British Insulated Wire Company, Limited, further issue of 30,000 ordinary shares of £5 each, fully paid, Nos. 40 001 to 70 000; and 30,000 6 per cent. cumulative preference shares of £5 each, fully paid. Nos. 40,001 to 70,000; Nernst Electric Light, Limited, 115,000 7 per cent. preference shares of £1 each, fully paid, Nos. 1 to 115 000 (renewed application); W. T. Henley's Telegraph Works Company, Limited, further issue of 5,000 ordinary shares of £5 each fully paid, and 5,000 4½ per cent. cumulative preference shares of £5 each, fully paid.

Okonite Tape.—The following details of the procedure to be adopted when insulating joints in electrical conductors with okonite tape will be of interest to those who are not already familiar with the tape in question. We may say that okonite tape as at present supplied by Messrs. Geipel and Lange is a modification of the well-known insulating compound introduced by the Okonite Company. To secure a tubular, waterproof, high-insulation joint with this tape it is necessary to take the usual precautions of removing the damaged rubber near the joint, and thus getting the surface of the dielectric clean and free from the fibre of the braiding, etc. The okonite tape is then wound over with a half lap until it covers the conductor, and at least 1in. of the dielectric at each side of the joint. A little heat is then applied from a match or clear flame, and the joint slightly kneaded while still warm. A second layer is then put on wound in the opposite sense and similarly treated. The joint when cooled will now have an insulation resistance equal to the body of a 600 megohm cable. The makers add that this insulation will be permanent and never show signs of the gumminess of ordinary rubber-insulated joints made with rubber solution, etc., to secure adhesion of the layers and turns. Additional layers will secure higher insulation in accordance with the grade of cable used. It is easy to demonstrate the tubular, and, therefore, waterproof nature of such a joint by splitting it longitudinally, when, if properly made, a tape will be found consisting of diagonal short pieces of the original tape firmly jointed one to another. The question of satisfactorily insulating joints affects every person interested in the electrical industry. The central-station engineer has an immense stake in the permanence of his joints, the wiring contractor has an equal stake, as much of work is valued by the insulation tests of the wiring and the permanency of the joints. Beyond the insulating of the joints and its permanence under favourable conditions, is the consideration of the maintenance of the insulation in the presence of chemical compounds. Tests taken in great detail by Dr. J. A. Fleming have proved that okonite is chemically resistant to water, oils, alkalies, and commercial acids, so that there seems to be little to fear from okonite insulated joints even under very adverse conditions. Dr. Fleming's tests confirmed those of the late Dr. John Hopkinson, who was particularly struck with the permanence of this material in oils, a point of considerable importance in view of the wide extension of the use of screwed barrels to contain wires, and the inevitable presence of greasy matters in many situations where electric cables are necessities.

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Ham.—The District Council have assented to the Richmond Electric Light and Power Company's application to the Board of Trade for a provisional order to extend their mains to Ham. It is understood that the average price will be 5d. per unit.

Brighton.—Considerable discussion took place at the last Town Council meeting over the Sanitary Committee's proceedings concerning the rewiring of the abattoir for electric lighting. It was stated that the new work was to be done by contract, whereas before it was done by the Lighting Committee.

Newcastle.—Mr. A. A. G. Maleb has held an enquiry into the application of the Corporation to borrow £10,000. The Town Clerk explained that the loan was needed for the purpose of lighting by electricity the principal thoroughfares in the centre of the city in which the tramways were being laid. Mr. Le Rossignol described the system of electric lighting.

Bridgwater.—The Town Council have been informed by the Local Government Board with regard to their application of last year for sanction to borrow £20 000 for purposes of electric lighting, that unless the Town Council pass a resolution renewing the application, the Board propose to regard the original application as withdrawn. No action has been taken by the Town Council as yet.

R. W. Blackwell and Co.—We have received a somewhat belated but sufficiently large wall callendar issued by Messrs. R. W. Blackwell and Co., Limited, 59, City-road, E.C., agents for the Peckham Manufacturing Company (successors to the Peckham Truck Company), manufacturers of Peckham's system of "single" and "double" electric car trucks, Price friction power brakes, and Ruggles rotary snow ploughs, etc.

London Gazette—The discharge of A. G. Inrig (carrying on business as the Globe Electrical Company), 46, White Post-lane, Victoria Park, London, has been suspended for two years; bankrupt to be discharged as from Jan. 24 1903. His assets were not of a value equal to 10s. in the pound on the amount of his unsecured liabilities, and he had omitted to keep such books of account as are usual and proper in the business carried on by him.

Kingston.—By the Act of last session the Corporation obtained powers to wire consumers' premises, and they are now prepared to enter into arrangements with owners and consumers as authorised by the Act. The work is to be carried out by a contractor. The total cost of each installation is to be repaid by quarterly instal ments spread over a period not exceeding five years, such payments to include 5 per cent. interest on the outstanding capital cost.

Penge.—The Council last week adopted the draft agreement made between the Penge Council and the Lewisham District Electric Supply Company, Limited. The agreement referred to is practically the same as that accepted by the Lewisham Borough Council as regards the price and main conditions, the following clause being added: "The streets to be scheduled for the initial installation of the light shall be Anerley, Beckenham, and Croydon roads."

Bedford.—The Town Council have decided that from March 31 the charge for electric lighting be 5½d. per unit, less a discount of ½d. per unit if the account be paid on or before the date specified on the demand note delivered to the consumers. The Electric Light and Traction Committee have made a contract with the Rev. C H Farrar, M.A., to supply current to his school on condition that he contributes £40 to the total cost of £150 for carrying out the work, enters into a contract for seven years, and guarantees his annual custom of at least £150.

London County Council.—On Tuesday it was agreed to lend the Battersea Borough Council £10,600 towards the electric light installation. The Finance Committee recommended the Council to support the views of the Electrical Trades Union. Instead of 8½d. to 9d. per hour, as at present, wiremen are to receive from 9d. to 10d., and charge men, for a 54 hours' week, are to be remunerated at from 10d. to 10½d. The Council sanctioned the laying of mains along a portion of Sumner-street, Southwark, by the City of London Electric Lighting Company.

Islington.—The Lighting Committee will recommend to day that, having regard to the extension and development of the electric lighting undertaking, and to the capacity and conduct of the chief officials, the Council be recommended to make the following increases of salary: Mr. Albert Gay, the electrical engineer, £100 per annum; Mr. C. H. Yeaman, the assistant electrical engineer, £50 per annum; Mr. Stephen Stone, clerk, £6 per annum; and Mr. H. Knorr, the superintending electrician, £1 per week, latter by annual increments of 5s. per week.

Dalkeith.—The Town Council have adopted an agreement with Messrs Deacon and Co., the solicitors for Messrs. Crompton and Co., for the lighting of the town. Messrs. Crompton will provide the lamps and maintain the same in the streets of the burgh at the charge of 3d. per unit. At the Town Council meeting the readiness of Messrs. Crompton and Co. to carry through the arrangements on the terms offered by their Edinburgh agent, and to thus equip the lamps, although they themselves had never intended this, was most favourably commented upon.

Loughborough.—The Borough Surveyor, as a matter of urgency, last week laid before the General Purposes Committee of the Town Council an application by the Brush Electrical Engineering Company for the consent of the authority to the laying of a pipe across the Rempstone footpath to carry cables between the foundry and the car shops at the Falcon Works, instead of carrying them overhead; and it was resolved, subject to the company entering into such agreement as the town clerk may deem necessary for the protection of the Corporation, to comply with the application.

Ballycastle.—A subscription has been raised by a meeting of ratepayers in order that a competent engineer be employed to examine the various water supplies in the district, and find if sufficient power could be obtained for generating electric light. The following committee are in charge of the proposal: Rev. J. Conway, Dr. M'Ilroy, Dr. Woodside, Messrs. John Byrne, J. P. O'Kane, Daniel M'Kinley, and H. A. M'Alister. During the proceedings Messrs. J. Taggart and J. Dean, of Bushmills, had the court house lighted by electric light from a small dynamo erected by them in Mr. M'Guigan's mill.

Coventry.—The Electric Light Committee on Tuesday recommended an extension of the electric light works at an estimated capital expenditure of £23 200. The expenditure includes £14 891 for works extensions, £3,300 for distribution, and the sum of £5,009 expenditure already incurred. A long discussion took place, but the report was eventually passed. The last quarterly statement shows that the quantity of electricity supplied during the quarter ending Dec. 31 was 125,454 units, against 86,295 units in the same quarter of 1899, the number of consumers being 328 against 198, and the rentals being £2,005. 10s. 7d., against £1,340. 11s. 2d.

Swansea.—At the last meeting of the County Council it was proposed that the town clerk be authorised to undertake, on behalf of the Corporation, to supply the Dock Trustees with current for harbour lighting purposes at a price per unit equal to the present cost to the Trustees, and in the extent of disagreement as to what that actual cost per unit is to the Trustees, that the question be referred to a third person to be agreed upon between the parties. This would have meant the omission of a clause providing that the borough electrical engineer should be satisfied that the price so to be charged covered the cost of production. On a division the motion was lost by 17 to 10.

Cardiff Telephones.—Subscribers to the Post Office telephone service will be glad to hear, says the *Western Mail*, that the Postmaster-General has decided to abolish the terminal charges for speaking to National subscribers in other towns. Up to the present, if a Cardiff Post Office subscriber had wished to speak to a National subscriber in Newport, the charge would have been 6d. for three minutes' conversation. This charge is now to be reduced to 3d., which is the same amount which a Post Office subscriber in Cardiff would pay for speaking to a Post Office subscriber in Newport. Therefore, a subscriber to the Post Office service can now speak to subscribers to the National in other towns without extra charge.

Bath.—The Electric Lighting Committee recently recommended the Council to adopt a report of the engineer (Mr. G. F. Metzger) proposing that in all £11,500 be laid out in extending the plant at the works in order to cope with the increasing demands for lighting The power at the works is limited to 30,000 8 c.p., and already 28,000 8 c.p lamps are in operation, so that if the applications come in for lighting like they had come in recently in the course of a very little time the committee will have to refuse business. After discussion last week it was agreed to withdraw the report so far as it referred to the extension of the plant, with the understanding that the mayor would render every assistance in the future in facilitating its being carried out.

Catalogue.—Messrs. Ludw. Loewe and Co, Limited, announce that on Jan. 1 last they took over the agency for the Bullard Machine Tool Company's product, makers of vertical boring mills. These machines are stocked by Messrs. Ludw. and Co. for delivery, and are exhibited in actual work, fitted with the latest forms of tools, in their showrooms at 30 Farringdon-road, E.C. In the catalogue of the Bullard Machine Tool Company a reproduction of the first 37in. boring and turning mill built by the firm in 1893 is given against a model of the 1900 machine. A comparison of the two convinces one of the great strides that have been made in the improvement of design and workmanship in this direction. The machines are turned out by the firm in sizes ranging from 30in in diameter and 14in. in height to 76in. and 48in. respectively.

Llandudno—The Electric Lighting Committee in their last report, which has been adopted by the Urban District Council, confirmed the receipt of a letter from Messrs. Strode and Co., London, stating that the price fixed by the Council for supplying Lady Forester's Convalescent Home, Llandudno, with electricity was not sufficiently low to enable them to recommend the trustees to give up the erection of their own mains. They asked that the price should be reconsidered in view of the fact that the minimum of £15 000 fixed by the Council would be considerably exceeded. The Council was recommended to supply the trustees at the following rate: 4½d. per unit, with a minimum of 15 000 units; 4d. per unit, minimum 20,000; and 3½d., minimum 25,000. The Manchester Steam Users' Association reported on the safety of the boilers for a pressure of 150lb, which were in good order. For working extra hours on the occasion of the visit of the Incorporated Society of Musicians the sum of 29s. was voted for division among the staff at the works.

Glasgow.—Mr. W. A. Chamen, Glasgow city electric engineer, in a report just issued, states that the cost of opening streets in Glasgow for 2½ years from January, 1898, to November, 1900, amounted to £74,450, and that the sum paid during the same period to the statute labour department of the Corporation for reinstating the streets was £22,880, making a total of £97,330. The cost of the actual mainlaying and of the opening and closing of streets, however, had not been kept separately, as the same men performed both operations, and the question of cost was further complicated by the fact that the wages paid by the electricity department included the construction of manholes and the laying of services to consumers' premises. Approximately, how-

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ever, £37,250 out of the wages paid by the electricity department might be reckoned as the cost of opening and closing streets, which, together with the statute labour charges of £22,880, made a total of £60,000 as the approximate cost of opening and making good the streets during the time named.

Battersea.—The Council are granting an application of the General Post Office for general permission to lay distributing pipes from the main telephone cables in order to reach the premises of the subscribers in those cases in which overhead wires will not be run on the following conditions: The Postmaster-General shall make good any damage which may be done in the execution or maintenance of the work to the satisfaction of the surveyor. The Postmaster-General shall give notice in writing to the Council in case at any time any of the said pipes shall be used or required to be used to connect exchanges of the National Telephone Company, or exchanges of the National Telephone Company and post offices. On receipt of such notice as last aforesaid, the Council shall be at liberty, by notice in writing, to withdraw the consent hereby given so far as relates to any pipes to be used as aforesaid, and the Postmaster-General, if he objects to such withdrawal, shall take immediate steps to obtain a determination of the difference thus arising in manner prescribed by the Telegraph Act, 1878.

Wolverhampton.—Lieut.-Colonel A. C. Smith held an enquiry on Thursday last week into the application of the Town Council for the sanction of the Local Government Board to borrow £58 942 for the purposes of electric lighting. The Town Clerk said that the amount was required for building and foundations, £4,620; boiler-house equipment, £18,140; engine house equipment, £19,580; feeders, distributors, and pilot mains, £15,000; and £1,602, an amount over-spent on a loan of £28,870. The machinery at present in Commercial-road had a capacity of 640 kw. With the two sets on order, together with the two sets which it was proposed to purchase, the capacity of the machinery would be brought to 2 640 kw. The demand for electric lighting in Wolverhampton had been increasing at the rate of 33 per cent. per annum. At the end of March 31 of 1894-5 the total quantity of units sold was 23,372, and in the year ending 1899-1900 the quantity of units sold was 482,277. The Corporation had under consideration the question of electric traction on their tramlines, and for that reason they had to look ahead, so as to make provision for the necessary storage capacity. The item of £15,000 included extensions to the distributing system for the next two years. The total amount of loans authorised was £87,669. 18s. 9d.

Cambridge.—At the annual meeting of the Cambridge Electric Supply Company, Limited, last week the Hon. C. A. Parsons, who seconded the adoption of the report, spoke in highly eulogistic terms of Mr. J. H. Barker, who was going shortly to Newcastle-on-Tyne to manage the Heaton Engineering Works. With regard to his successor, they had every confidence in Mr. H. B. Harvey's ability to succeed Mr. Barker. Mr. Harvey had had three years under Mr. William Hunter at the Newcastle and District Electric Lighting Company, which this year was paying a dividend of 8½ per cent. Mr. and Mrs. J. H. Barker entertained the employés of the Cambridge Electric Supply Company, Limited, on Thursday, who, in order to show their appreciation of the value they set upon Mr. Barker as the virtual manager of the company during the past nine years or more, presented Mr. and Mrs. Barker with a token of their esteem in the shape of a beautiful silver salver. Mr. D. Munsey (chairman of the directors of the electric supply company) occupied the chair. The usual speeches and songs enlivened the evening. The piece of silver bore the following inscription: "Presented to John H. Barker, A.M.I.C.E., M.I.E.E., by the employés of the Cambridge Electric Supply Company, Limited, on resigning his appointment as engineer, March, 1901." On Wednesday evening Mr. and Mrs. Barker entertained the workmen's wives and families to tea and a magic lantern entertainment.

Devonport.—The work at the Corporation's new electricity works in Newport-street, Stonehouse, has been progressing for a considerable while under the direction of Mr. Charles Furness, the Corporation electrical engineer, but only last week saw the ceremony of laying the foundation stone (or rather the memorial stone). The Mayor of Devonport (Mr. Harman J. H. Graves), the chairman of the Stonehouse Urban District Council (Mr. F. Maitland), each wearing his chain of office; the town clerk of Devonport (Mr. A. J. Pilling), the clerk of Stonehouse Urban District Council (Mr. R. R Rodd), Alderman J. B. James, the members of the Electricity Works Committee, members of each Council, the surveyors, and a large number of private residents were present. Amongst the customary speeches it was mentioned that in the first place the estimated expenditure had been about £69,000, but the committee had carefully economised, and it was expected that the outlay would be £7,000 less than the sum that had been mentioned. The Mayor laid the foundation stone, which bore the following inscription: "Devonport Corporation Electricity Works. This stone was laid by his Worship the Mayor, Harman John Howland Graves, Feb. 21, 1901. Alderman J. B. James, J.P., chairman of the committee; A. N. Coles, builder; C. Furness, engineer." His worship was presented with a silver trowel, with ivory handle, by the chairman and members of the committee, and with a silver-mounted oak mallet by the builder.

Sunderland.—An enquiry was held on the 21st ult. by Mr. M. K. North into the application of the Corporation for sanction to borrow £73,035 for purposes of electric lighting. The Town Clerk said that of the £73 035 asked for, all, with the exception of £18,615, was for the erection of a power station and machinery upon what was known as the Hylton-road electric lighting station, a new site, in respect of the purchase of which sanction had already been given by the Local Government Board. The first station, at Dunning-street, had already been charged to its fullest capacity, and the Corporation had had to refuse customers for the electric light. Of course, a considerable quantity of the power was required for the electrical trams, but the new station would be used solely for the production of power for lighting purposes. The loan was divided as follows: buildings, chimney, etc., £20,950; boilers, economisers, pumps, stokers, and elevators, £9,260; two 200 h.p. and three 450-h.p. dynamos, £23,010; switchboard, etc., £1 200; and new feeders, etc., £18,615. Mr. J. F. C. Snell said in 1895 they started with 83 consumers, and now they had 611, and 60 prospective customers had been kept back, but would be taken on if the loan were sanctioned. During the half-year ending Sept. 30, 1899, the Corporation sold 197,000 units, and in the corresponding half of last year the sale was 289,000 units. Since September last the sale had been 630,000 units, and when the year was completed the sale would probably have increased to 1,200,000 units.

Stirling.—The National Electric Wiring Company, Limited, have resolved to terminate the agreement between them and the Town Council so far as regards the supply to any additional customers, but without affecting the terms of the agreement regarding work already done. In reference to the specifications for the new plant at the generating station, Messrs. Kennedy and Jenkin state: "We have included two boilers in the specification, as we consider it advisable to put the two in at once, as they will be required to balance the engine power, as stated in our report. The only saving in delaying the matter would be the interest on the additional capital in 12 months, and the chance of obtaining the second boiler at a slightly lower price a year hence. These expenses will, we think, be more than balanced by the extra expense involved by the contractor having to send to Stirling twice to erect and fix the boiler, and also the steam pipe work having to be carried out on two separate occasions instead of all at once." Mr. Goudie has been instructed to prepare the plans for the additional building at the station. At a meeting of the Lighting Committee Mr. Hanson submitted the following report: "I have received reports from two towns in England where small-current arc lamps are in use for lighting, and although in each case the lamps are satisfactory in their working, it is found that with seven amperes the illumination between the lamps is not sufficient if the posts are more than 60 yards apart. If we may take this as being correct, and I may say that the result agrees with my experience, it will be necessary, if five or six ampere lamps be used, to either rearrange and contract the areas to be lighted, or to be content with a poor light in these districts. The arrangement of lamps proposed in my reports is with posts at an average distance apart of about 75 yards, and if these distances were maintained with five or six ampere lamps there would be dark places between the posts. There is another point in connection with these small-current lamps, and that is that for effective lighting they would have to be hung lower than the present type of lamp. This would, of course, destroy the uniformity of the system of street-lighting, and would be very objectionable in the case of the town eventually deciding to use 10-ampere lamps. As for the trial proposed by Messrs. Kennedy and Jenkin, the only useful trial is, of course, one in position on the streets, but to get this it would be necessary to obtain five pillars suitable for the small current lamps, and erect them first, leaving the remainder to be erected after the trial was completed—say, three months. This course would involve great delay and considerable expense, and is not one that I could recommend. For these reasons I should not advise the use of lamps taking less than eight amperes, which, although they would not give as great a light as the 10-ampere lamps presently used, would probably be sufficient for the districts included in this extension. In this case it would not be necessary to alter the height of the lamps, and the present type of pillar could be employed. The adoption of eight-ampere lamps would effect a saving of about £4 per lamp per annum." The committee, having considered the same, were of opinion that the recommendation of the engineer should be adopted, and that eight-ampere lamps be used. It was agreed to submit the report to Prof. Kennedy before proceeding further.

St. Annes.—During the last few weeks the electricity works have been rapidly proceeded with under the direction of the Council's electrical engineer, Mr. Tiddeman, and it is expected they will be in working order very shortly. The following details of the new works appeared in the *Blackpool Gazette*: The generating station, which is situated north of the gasworks, has been erected by Messrs. Moore Bros., and is a substantial building of red brick, with freestone facings, and contains boiler-house, engine-room, accumulator-room, testroom and workshop, store-room, and engineer's office. The boiler-house contains two multitubular boilers (by Stephenson and Co., Preston), each of 250 h.p., and working at a pressure of 140lb. per square inch. The draught is induced by special machinery (supplied by the Sturtevant Engineering Company, London), which has been placed in the building to take the place of a large chimney, which unfortunately the contractor could not build on account of the unsuitability of the land for the foundations. There is ample room for the introduction of more boilers when necessary. A steam feed pump, feed-water heater, and storage tank to hold 2,000 gallons, complete the boiler-room equipment. The engine-room (which is equipped with a gantry crane by Spencer and Co., Hollinwood, travelling the whole length of the room, and capable of dealing with a load of 10 tons) contains two high-speed compound vertical engines by Willans and Robinson, Rugby, coupled direct to and on the same bed-plate as the two dynamos (supplied by T. Parker, Wolverhampton). The latter, jointly,

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have a capacity of 160 kw., or, in other words, will be capable of supplying an equivalent to 5,000 8 c.p. lamps alight at the same time. The switchboard is of black enamelled slate, and has been supplied by Crompton and Co., Chelmsford. It is suitably framed in teak, and mounted on a platform raised 2ft. above the floor of the engine-room, and railed off. On it are placed all the necessary voltmeters, ampere-meters, watt-meters, regulating switches, automatic cut-outs, fusible cut-outs, reversing switches, rheostats, feeder connections, etc. The accumulator-room contains a battery supplied by the Tudor Accumulator Company, Dukinfield, and consists of 260 cells of 300 ampere-hour capacity, arranged on single-tier stands, and fitted with all necessary cable connections and accessories. The services will be laid from the mains to the consumer's premises where required, and safety fusible cut-outs and meters fixed free of charge to the consumer (in cases where the service is of greater length than 20 yards, the Council have the option of charging a fee for such connection). Meter rents are to be charged at a rate to be decided on all meters so fixed, but the consumer, if he so wishes, can buy his own meter. The system of supply is that commonly known as the three-wire low-tension direct-current, with a pressure of 480 volts across the outer wires; consumers being supplied at a pressure of 240 volts. The mains have been laid by the British Insulated Wire Company in all the streets where it is intended to at present place the light, and 30 arc lamps of 620 watts each, along with 150 incandescent lamps of 32 c.p., are already fixed in their places. The mains are laid on the solid system in wooden troughing. It is proposed to charge consumers on the Brighton system at 7d. per unit for the first hour of burning every day, and 4d. per unit for all energy consumed afterwards. This system of charging will encourage the long-burning customer, as he gets his light at a cheaper rate. It is also proposed to charge the street lamps at a fixed rental per lamp per annum, and thus save the cost of meters for this purpose. The local contractors who have been engaged in the work are included in the following list: general contractors, Messrs. Moore Bros., St. Annes; brickwork, Mr. J. Hull, St. Annes; plumbing, Mr. B. P. Smith, St. Annes; painting, Messrs. Matthews and Ratcliffe, St. Annes; plastering, Messrs. Gillett and Sutton, St. Annes.

PROVISIONAL PATENTS, 1901.

FEBRUARY 18.

3429. Improvement in ducts of stoneware, clay, concrete, or other plastic material for carrying electric or other cables for light, power, traction, telegraphs, telephones, etc. William Garnett, The Laurels, Porchester, Hants.

3434. Improvement in electrical switches. Maunsell Mercier and William Osborne Andrews, 337, Lower Broughton-road, Manchester.

3438. An apparatus for recording the time an electric car passes a station. Christopher John Spencer, Sunbridge-chambers, Bradford.

3450. Improvements in accumulator plates. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, London.

3451. Improvements in the electrolytic break. Mortimer Arthur Codd, 5, Roxborough-park, Harrow-on-the-Hill.

3468. Improvements in or appertaining to electric alarm clocks. Sönke Paulsen, 89, Princess May-road, London.

3481. Improvements in apparatus for wireless telegraphy. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

3487. Improvements in or connected with the carrying of strikers upon motor vehicles for mechanically operating electric switches. William Kingsland, 33, Chancery lane, London.

3488. Improvements in or connected with electric ignition apparatus, particularly applicable to explosive engines. Frank Frederick Wellington, 33, Chancery-lane, London.

3491. Improvements in arc lamps. Joseph Alberto Rignon, Tito Livio Carbone, and Alfonso Moreno, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3493. Improvements in the method for obtaining electric currents from the earth. Emil Jahr, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3494. Improvements in electrical glow lamps. Arthur Couch, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 19.

3549. Process of simultaneous and separate extraction of hydrogen and oxygen gases from the body water by electrolysis. Charles de Ricaris, 4, Rue Beethoven, Paris, France.

3554. Improvements in and connected with apparatus for transmitting and receiving electromagnetic waves or impulses. James Tarbotton Armstrong and Axel Orling, 40, Varbry road, Stamford-hill, London.

3556. An electrically-lit watch or clock case. Henry Vaughan Manger, 110, Hatton-garden, London. (Complete specification.)

3563. Improvements relating to electromagnetic driving mechanism. Jean Soulat, 45, Southampton-buildings, Chancery-lane, London.

3570. Improvements in telautographs and methods of telautographic transmission. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (The Gray National Telautograph Company, United States.) (Complete specification.)

3576. Improvements in electric switches. Peter Heinrich Felix Spies and Jacob Norden, 53, Chancery-lane, London. (Complete specification.)

3613. Improvements in and relating to electric percussive rock drills or the like. Albert Moore Barnes, 1, Queen Victoria street, London.

FEBRUARY 20.

3636. Improvements in devices for connecting electrical circuits to earth in case of emergency, chiefly for use with overhead wires. Edward Massey Holingsworth, Alexandra Villa, Prescot-road, St. Helens.

3660. New or improved automatic guard for electric street cars. Adolph Königslöw and Carl Pilgrim, 115, Cannon-street, London

3669. Magnetic toy. Edward Alaric Falconer, 151, Adelaide-road, Hampstead, London.

3679. Improvements in electric switches. Frederick Hagger Headley, 322, High Holborn, London.

3686. Improvements in electrical switches. William Henry Fullarton Murdoch, 53, Chancery-lane, London.

3699. Improvements in trolley heads for use in connection with overhead systems of electrical traction. John Alexander Orme, 46, Lincoln's-inn-fields, London.

3710. Improvements in or connected with the regulation and starting of single-phase and polyphase alternate-current motors with magnetic rotating fields. Paul Jacques Mathurin Girault, 47, Lincoln's-inn-fields, London.

FEBRUARY 21.

3713. An improvement in electrolytic brakes. Edmund Henry Howlett, 4, Wright-street, Hull.

3744. Improvements in means for protecting or guarding overhead electric trolley or like electric wires. Edwin Quarmby and Ernest Albert North, Market-place, Huddersfield.

3753. Improvements in connections for electric conductors. Joseph Devonport Finney Andrews, 75, Fulham Park-gardens, Fulham, London.

3763. Improvements relating to Rontgen tubes. Carl Heinrich Florenz Müller, 45, Southampton-buildings, Chancery-lane, London.

3793. A new and improved compound or material for insulating electrical wires. Hartwell William Webb, 11, Queen Victoria-street, London.

3794. A new and improved die or mandrel and mounting therefor for facilitating the uniform coating of electrical wires with insulating material in a viscid state. Hartwell William Webb, 11, Queen Victoria-street, London.

FEBRUARY 22.

3796. Improvements in surface-contact electric traction systems. William Aitken, Pine Glen, Muswell-avenue, Muswell Hill, London.

3797. Improvements in or connected with the welding or uniting of aluminium surfaces. Sherard Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

3799. An improved method and apparatus for the prevention of accidents from trolley wires. Robert Cornelius Quin, Ambleside, Palatine road, Blackpool.

3803. Improvements in electrically-illuminated letters for signboards. George Smith and Herbert Hampton Hall, 57, Barton-arcade, Manchester.

3823. Improvements in and connected with conduits for electric wires and cables. Richard Ames, 82 Mark-lane, London.

3832. Improved steadying resistance for Nernst lamps. Charles Cornfield Garrard and the Nernst Electric Light, Limited, 82, Victoria street, London.

3833. Improvements in Nernst lamps. Bernard Mervyn Drake, Charles Cornfield Garrard, Eustace Graham Sheppard, Maurice Solomon, and the Nernst Electric Light, Limited, 82, Victoria-street, London.

3834. Improved means for starting electromotors with rotating fields. Paul Jacques Mathurin Girault, 47, Lincoln's-inn fields, London.

3860. Improvements in electromagnets. Eustace Graham Sheppard, Maurice Solomon, and Nernst Electric Light, Limited, 82, Victoria-street, London.

FEBRUARY 23.

3881. Improvements relating to overhead conductor electrical traction systems. Charles Frederick Elliott, 10, St. George's-crescent, Liverpool.

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3929. Improvements in or relating to electric lamps. Ernst Andreas, 111, Hatton-garden, London.

3930. Improvement in the art of telephony. Orazio Lugo and John Arthur Barratt, 1, Temple gardens, London.

3933. Improvements in and relating to means for heating the ironing roller or rollers of ironing machines by electricity. Frederick Hagger Headley and Charles Hart, 322, High Holborn, London.

3935. Improvements in or in connection with the laying of underground conductors for distribution of electrical energy. Frank Jones, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on March 16.

1900.

1133. Incandescent electric lamps. Boult. (Sauvalle.)

3390. Typewriting, typesetting, or analogous machines and telegraphic apparatus. Dundas and Kershaw.

3588. Device for finding the electric poles. De Mare.

3917. Electricity meters. Lorwa.

4803. Electric incandescent lamps. Fessenden. (Date applied for under International Convention, Aug. 25, 1899.)

5137. Incandescent electric lamps. Gale.

5187. Automatic telephone call recorder. Lamkin.

5191. Electric heating systems for cars. Westinghouse Brake Company, Limited. (Newell.)

5650. Method and apparatus for determining the size and position of bodies by means of Rontgen rays. Thompson. (Voltohm Electrical Company.)

7070. Telephones. Kneale and Hartley.

7272. Carbon electrodes. Baker.

7285. Electric railways operated on the conduit system. Parsons, Belfield, and Chapman.

7737. Arc lamps. Tribelhorn.

11560. Electric incandescent lamps. Wurts and Hanks.

13751. Automatic device for the safe operation of electric conductors, with or without guard wires. Sintas y Orfilo and Schultz.

14893. Electrical measuring instruments. Atkinson.

15951. Automatic switch for groups of transformers with members of various capacity. Schlatter.

17757. Electrode plates. Thompson. (Akkumulatoren und Elektricitäts-Werke Aktiengesellschaft vorm. W. A. Boese und Co.)

22926. Electric wave telegraphs. Boult. (American Wireless Telegraph Company.)

22698. Process of extracting and reducing metals by electrolysis. Frasch.

1901.

1471. Electric arc lamps. Bogia.

1485. Electrical measuring instruments. Ball.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Feb. 23	547	461	+ 86	25,850	22,448
Birmingham Trams.	,, 23	4 085	4,127	- 42	30 953	—
Blackburn Corp'rat'n	Jan. 13	1 191	—	—	2 724	— *b*
Blackpool Corporatn.	Feb. 21	166	133	+ 33	29 520	21,725
Blackpool-Fleetwood	,, 23	139	143	- 4	1,089	1 112
Bolton Corporation..	,, 24	1,224	845	+ 379	21 418	5,771
Bradford City Trams	,, 24	780	372	+ 408	5,903	2,702
Bristol Tramways Co.	,, 23	3,462	2 648	+ 814	—	—
Carlisle Tr'mw'ys Co	,, 23	103	—	—	853	—
Central London Ry.	,, 23	5,941	—	—	48 779	—
City & South London	,, 24	2 048	1,115	+ 933	16 088	9,014
Cork E. T. and L. Co.	,, 21	327	307	+ 20	2,498	2 209
Dover Tramways ...	,, 23	145	141	+ 4	1 214	1,170
Dublin & Lucan E.R	,, 23	71	56	+ 15	561	413
Dublin U.T., elec. cars	,, 22	2 932	2,880	+ 52	—	—
Dublin S.D. Electric	,, 22	64	613	+ 28	—	—
Dundee Tram Co. ...	,, 20	434	360	+ 74	—	—
Glasgow Corporation	,, 23	8,034	8,270	- 236	—	—
Halifax Corporation	,, 24	688	566	+ 122	35 736	28,112
Huddersfield Corp'n.	,, 23	633	614	+ 18	32 464*b*	29,964
Hull Corporat'n E.S.	,, 23	1 446	720	+ 726	64 192*b*	—
Liverpool Corporat'n	,, 16	7,576	6 241	+1,335	54 442	45 688
Liverpool Overhead	,, 24	1,420	1,360	+ 60	11,757	11,500
Portsmouth Corpn..	,, 23	506	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	,, 24	2,816	—	—	—	—
Southampton Trams	,, 21	498	324	+ 174	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways.	,, 22	381	244	+ 137	2 766	1,784

b Since April 1, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	–	11-13
——— 40,001-70,000	5	..	10½-10¾
——— 6 per cent. Cum Pref., 1-40,000	5	..	5½-6½
——— 5 per cent. Mortgage Debentures	100	–	100-105
British Electric Works, Ordinary, 50,001-95,000	1	..	1/16-3/16
——— 6 per cent. Cum. Pref., 1-50,000	1	–	3/16-5/16
——— 4½ per cent. First Mortgage Debentures	108	–	85-90
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4¼ 4⅜
Brush Electrical Engineering, Ordinary	2	–	1⅝ 1¾
——— Non. Cum., 6 per cent. Pref.	2	–	2⅛ 2⅜
——— 4½ per cent. Debenture Stock	100	..	105-110
——— 4½ per cent. 2nd Debenture Stock	100	–	101-103
Callender's Cable, Debentures	100	–	109 113
——— Ordinary	5	–	15 16
——— 5 per cent. Pref.	5	–	5¼ 6
Crompton and Co.	5	–	2½ 3½
——— 5 per cent. Debentures	—	–	100-103
Edison and Swan United, Ordinary	3	–	1½-2
——— 5 per cent. Debentures	5	–	3½-4½
——— 4 per cent. Deb. Stock, Red.	100	–	88-90
——— 5 per cent. Second Deb. Stk., Prov. Certs.	—	–	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1⅛ ⅛
——— 7 per cent. Cumulative Pref.	2	–	2⅛ 3
——— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
W. T. Henley's Telegraph Works, Ordinary	5	–	16 17
——— 4½ per cent. Preference	5	–	5¼ 6
——— 4½ per cent. Debentures	100	–	109 113
India Rubber, Gutta Percha, and Telegraph Works	10	–	20½-21½
——— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	12	–	41-45
——— 5 per cent. Bonds	100	–	101 104
Telegraph Manufacturing, Ordinary	5	–	11-12
——— 5 per cent. Cum. Pref.	5	–	5½-6
Willans and Robinson, Ordinary, 1-80,000	5	..	10½-11½
——— 6 per cent. Cum. Pref., 80,001-90,000	5	–	6⅞-7½
——— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	–	⅞-1
——— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	..	70-75
Bournemouth and Poole, Ordinary	10	..	12½-13½
——— 4½ per cent. Cum. Pref.	10	..	10-11
——— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	–	7⅞-8⅛
——— 7 per cent. Preference	5	–	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	–	6⅞-7⅛
Charing Cross and Strand	5	..	9½-10⅛
——— 4½ per cent. Cum. Pref.	5	–	5⅛-5⅜
Chelsea Electricity Supply	5	–	6¼ 6⅜
——— 4½ per cent. Debentures	100	–	105-112
City of London, Ordinary	10	..	7-8
——— 6 per cent. Cumulative Pref.	10	–	13-14
——— 5 per cent. Debenture Stock	100	–	122-127
——— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	..	101-103
County of London and Brush Provincial, Ordinary	10	–	8¾-9⅛
——— 6 per cent. Cum. Pref.	10	–	11½-12¼
——— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	106 109
Edmundsons Electricity Corporation, Ordinary, 1-17,400	5	–	4¾-5⅛
——— 4½ per cent. First Mort. Deb.	100	–	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7⅛-7½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9½-10½
London Electric, Ordinary	3	–	1½-2
——— 6 per cent. Pref.	5	–	4-5
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	13-14
——— ,, 85,001-98,769	5	–	7-8
——— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
——— 3½ per cent. Mortgage Debenture, Red.	100	–	96-99
Notting Hill Electric Lighting	10	–	15½-16½
Oriental, 1879	1	–	1⅛-1⅜
——— £5 Shares	5	–	7-7½
——— £4½ Shares, New	4½	–	5⅜-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	–	5¾-6⅛
River Plate Electric Light and Traction, Deb.	100	–	65 75
Royal Electrical Company of Montreal	$100	–	170-190
——— 4½ per cent. First Shares Mortgage Debentures	$100	..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
——— 6 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	–	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	14-15
——— 7 per cent. Pref.	5	–	8½-9½
——— 3½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	–	12-13
——— 20,001-100,437	5	–	12-13
Electric Railways.—			
Central London, Ordinary	10	–	9½-9¾
——— Pref. Half-Shares	5	–	4¾ 5⅛
——— ,, ,, deferred	5	–	4 4⅜
City and South London, Consolidated Ordinary	100	–	46-50
——— Ordinary	10	–	4-5
——— 4 per cent. Debenture Stock	100	–	115-120
——— 5 per cent. Pref. Stock '91	100	–	132-137
——— ,, ,, ,, '96	100	–	127-132
Liverpool Overhead, 5 per cent. Pref.	—	–	13½-13¾
Waterloo and City, Ordinary	100	–	93-96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-16
Brisbane Tramway	100	–	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	–	9⅞-10⅛
British Electric Traction, Ordinary	10	–	14½-15⅛
——— 6 per cent. Cm. Pf. 80,001-90,000	10	–	1⅛-12⅛
——— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5-5⅛
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4⅛-5
——— 5 per cent. Deb. Stock, Red.	100	–	104-107
——— Prov. Cert., all paid	100	–	96 99
Kidderminster and District Lighting and Traction, Pref.	5	–	3½-4
New General Traction, Ordinary	5	–	3½-4
——— 6 per cent. Cum. Pref.	10	–	4⅞-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10⅞
——— 5 per cent. Cum. Pref.	10	–	11½-12⅜
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11⅜ 12⅛
——— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
——— 4½ per cent. Debenture Stock	100	..	106-108
Telephones.—			
National Telephone, Ordinary	5	–	3⅛ 3⅜
——— 6 per cent. Cum. First Pref.	10	..	12-14
——— 6 per cent. Cum. Second Pref.	10	..	11-13
——— 5 per cent. Non. Cum. Third Pref.	5	..	4⅜-5
——— 4 per cent. Deb. Stock, Red.	100	..	98-101
——— 3½ per cent. Deb. Stock, Red	100	–	94-97
Oriental Telephone and Electric Company	1	..	⅞-1⅛

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Supplement to "The Electrical Engineer,"

MARCH 1, 1901.

LOWESTOFT ELECTRICITY WORKS.

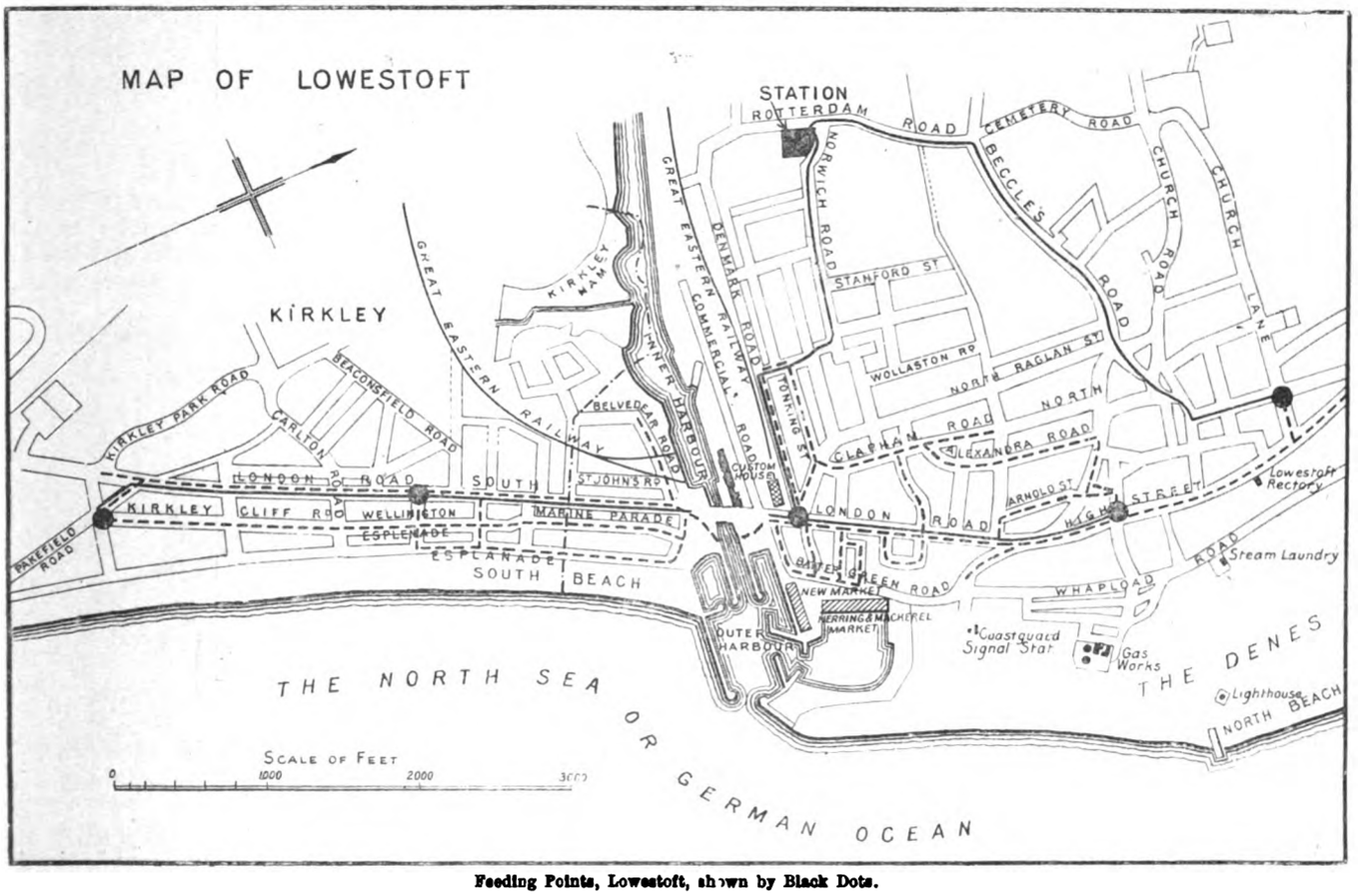
Mr. W. C. C. Hawtayne, M.I.E.E., is Dominion born, having as his birthplace Quebec. He was educated at Dover College, and subsequently at the School of Electrical Engineering and Finsbury Technical College. His professional life commenced with the United Telephone Company, he afterwards becoming district engineer to the Northern District Telephone Company. Subsequently he joined the staff of the London Electric Supply Corporation, and then went to Messrs. Crompton and Co. at Chelmsford. In 1890 he joined the Brush Company, and after varied experience commenced consulting practice in 1892. At the present time Mr. Hawtayne has a number of schemes in hand, though some, like that of Lowestoft, are almost or quite complete.

MR. W. C. C HAWTAYNE,
CONSULTING ENGINEER, LOWESTOFT.

ALDERMAN J. BECKETT,
MAYOR OF LOWESTOFT.

COUNCILLOR FRY,
CHAIRMAN ELECTRIC LIGHTING COMMITTEE.

Mr. G. A. Bruce, A.M.I.E.E., served an apprenticeship of 4½ years at electrical and mechanical engineering. His first appointment was at Newcastle, at the Elswick Works of Sir W. G. Armstrong, Whitworth, and Co., Limited. He was then employed in the ordnance department and in the manufacturing department in the construction of alternators, direct-current



Feeding Points, Lowestoft, shown by Black Dots.

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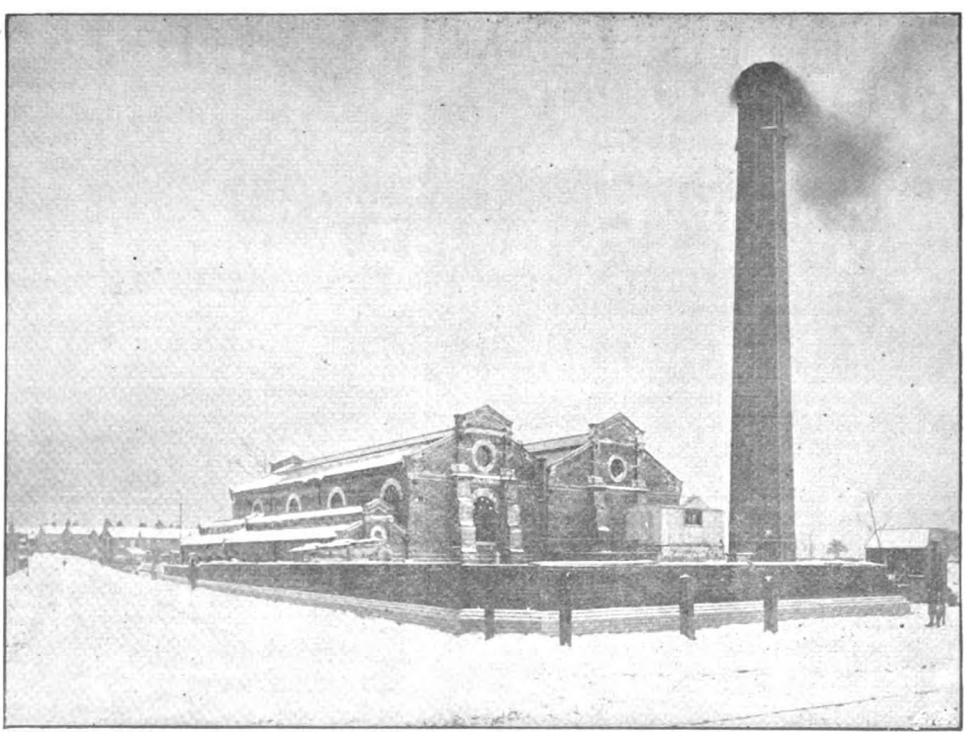
machines, and motors. From this position he was subsequently transferred to take charge of the ship-lighting and power at both the Elswick and Walker shipyards. On leaving this company he took up a more responsible position as electrical engineer to Messrs. Harfield and Co., Limited, of London and Blaydon, and subsequently left them to become assistant engineer to Mr. Hawtayne, and while with Mr. Hawtayne was closely connected with the work at Lowestoft. From this connection he was deemed a most

MR. G. A. BRUCE, ELECTRICAL ENGINEER, LOWESTOFT.

suitable man to be given charge of these works, and thus became the electrical engineer to the Corporation.

Is there a good history of Lowestoft? was the question put to a member of the Council by a stranger while dining together at "The Royal"—common guests to a genial host. The reply was, "Gellingwater's; new edition." This interesting little volume is now before us, but while it is great in interest, it fails just where most local histories fail, in that it does not trace the development of the "work" of the governing body, and it has no index. However, we gather from it that the charter of incorporation was officially received in September, 1885, that the sewerage of the town has been brought up to date, that street improvements have been made, and that the water and gas are in the hands of companies. Probably the latter fact, together with the attempts made by electrical companies to obtain possession of Lowestoft, spurred on the Council to take up the question of electric lighting themselves, to obtain an order, and inaugurate the works formally opened last week. Maps two or three centuries old spell the name of the town Lestoff or Lestoffe, and while Gellingwater calls the peninsula upon which the town stands Lothingland, Camden tells us that 300 years ago some called it Lovingland, and some more truly Luthingland. Of the town this author tells nothing, except in these words: "A little town hangs (as it were) over the sea."



Lowestoft Central Station.

BUILDINGS.

The site chosen for the central station is perhaps very suitable as regards position, but the subsoil is not good for foundations to carry heavy weights or moving machinery without artificial assistance. The situation is adjacent to the Norwich-road, upon what is known as Smith's Marsh. Some experience had been obtained as regards the foundations from the building of the refuse destructor, the chimney shaft of which also serves as the shaft of the electricity works. Singular to say, a firm foundation was found for the shaft, while that of the works about to be described was of another character.

The buildings were designed by Mr. A. E. Pridmore (London) and erected by Messrs. Hawes and Co. (Norwich). They consist of an engine-house 80ft. by 30ft., a boiler-house the same length, but 8ft. wider, an accumulator-room, offices, workshops, stores, and lavatories. The accompanying plan will show the arrangement adopted, and the photograph will give some idea of the station. It is built of red brick with stone facings. The ground below the engine-house was excavated to a depth of 4ft. and the whole concreted, the concrete being tied together with iron rails, and on this the machinery is erected. Three lines of 1½in. bolts have been embedded in this concrete raft foundation, to which girders can be fixed for mounting additional machinery. The boiler-house is also provided with a concrete foundation over its whole extent. The engine-house is built in bays with brick piers supporting a gantry which carries a travelling crane.

Crane.—The crane is by Carrick and Ritchie, of Edinburgh, is one of their standard eight-ton type, and constructed to carry a safe test load of 13 tons. The main carriage consists of two steel beams, fitted into cast-iron end carriages of a box section. These carriages are mounted on double-flanged rail wheels, fitted to steel axles running in double bearings. Travelling gear is fitted to both ends of the crane, so that it shall run parallel along the rails. The crab has single and double purchase lifting gear, having a special quick lift for loads up to three tons.

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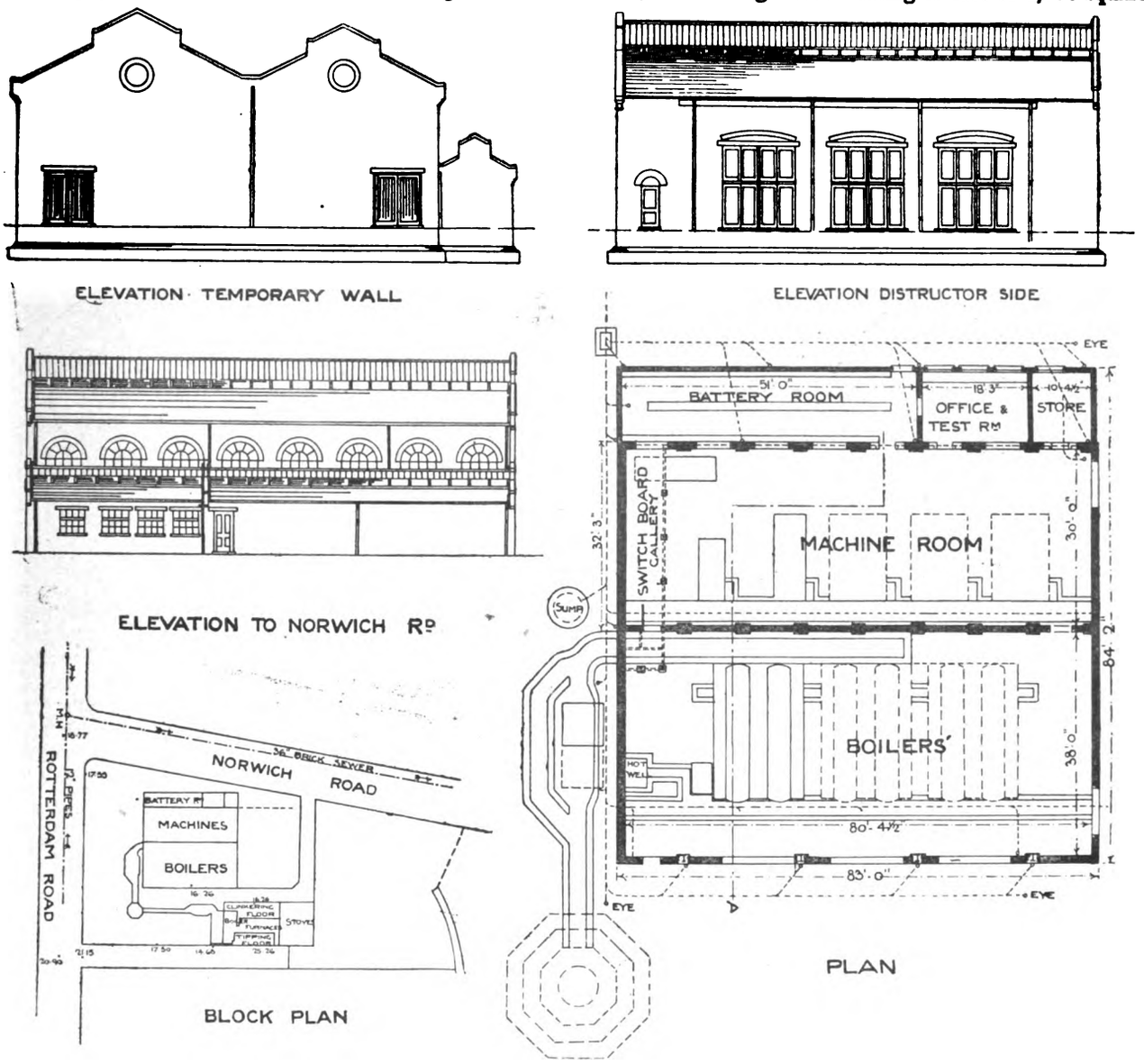
The load is lifted by a steel-wire rope, and return block, and swivel hook, and the hook runs in ball bearings. Traversing gear is fitted to the crab of such power that two men can move it with the full load. All the motions are worked from the ground. All the shafts run in bearings fitted with covers, a very desirable object, so that any shaft can be taken out for examination or repair without taking the crab to pieces, as in cheaper designs. The span of the crane is 28ft. 7in.

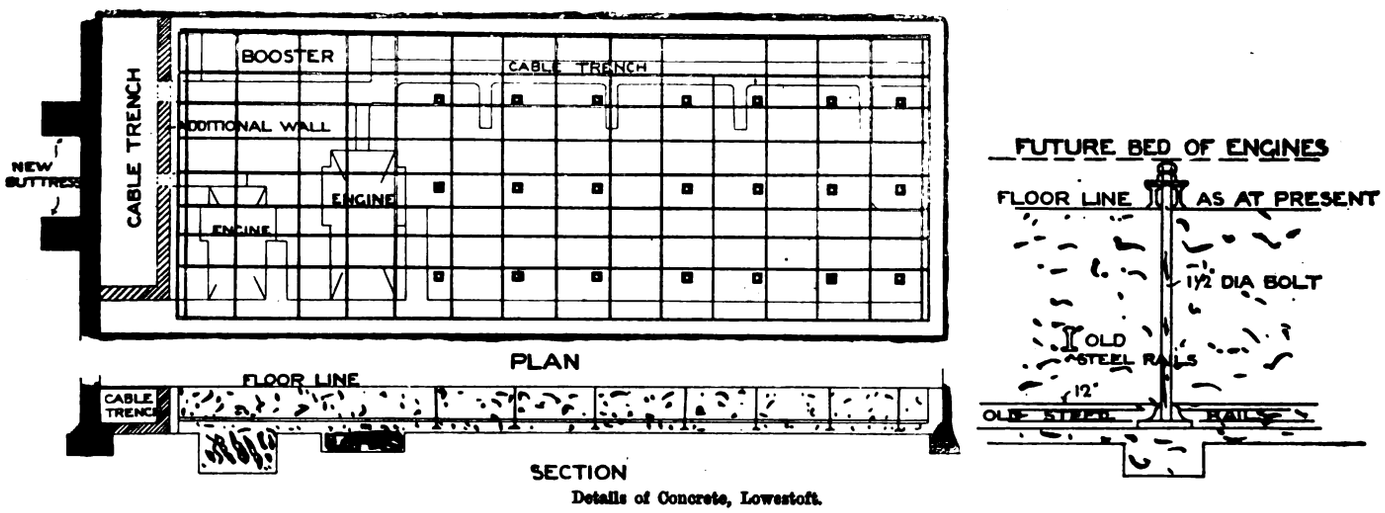
Shaft.—The chimney shaft is of red brick, 120ft. high, and 8ft. internal diameter at the top, lined throughout with firebrick.



Details of Central Station, Lowestoft.

Boilers, Economiser, etc.

Boilers.—This plant consists of four Babcock-Wilcox boilers, each having a total heating surface of 1,790 square feet, set in two batteries of two boilers each—one set being installed, the other being on order. Each boiler is composed of eight sections of tubes, each section 10 tubes high; the bottom row of tubes so arranged as to form a double-combustion chamber, constituting what is called the "Scotch furnace," for burning bituminous fuel. The tubes are 4in. diameter and 18ft. long, and there is one steam and water drum on each boiler 42in. in diameter and 23ft. 7in. long. The boilers are constructed for a



Details of Concrete, Lowestoft.

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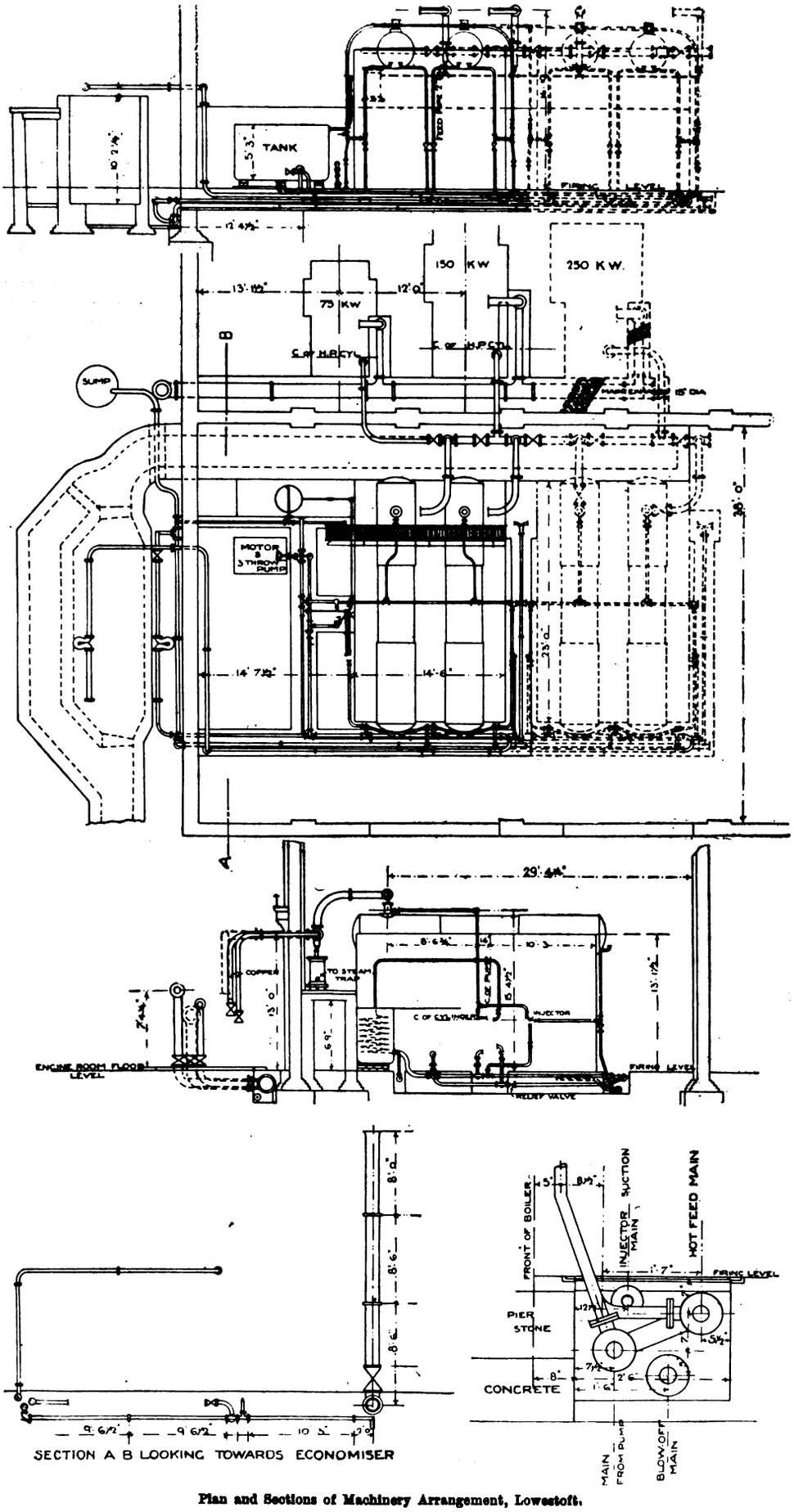
daily working pressure of 200lb. per square inch. The two boilers now being erected are fitted with steam superheaters. The fittings are of Messrs. Hopkinsons' make. There are two feed pumps, each capable of supplying 1,500 gallons of water per hour—one being driven by steam, the other by a motor, which latter can be worked from accumulators if necessary.

Economiser, etc.—A Green's high-pressure economiser is placed in the main flue leading to the chimney containing 96 tubes, representing nearly 1,000 square feet of heating surface.



Plan and Sections of Machinery Arrangement, Lowestoft.

A feed tank of 1,000 gallons capacity is provided, also a tank for a reserve of water having a capacity of 7,000 gallons.

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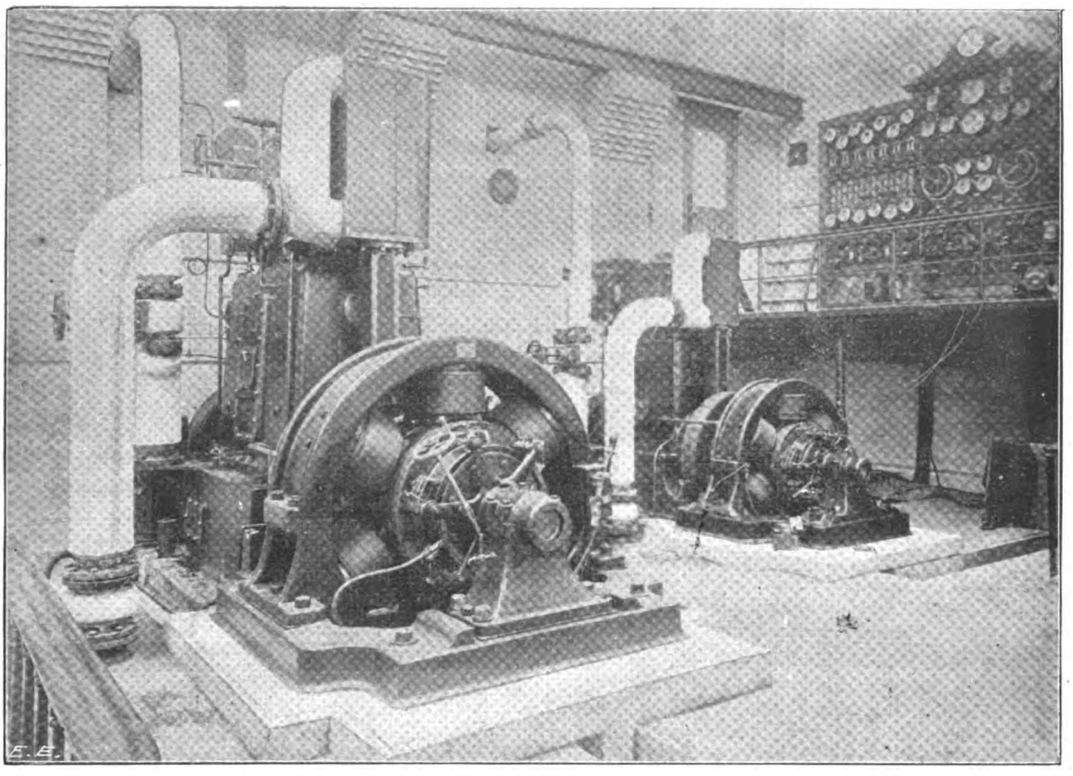
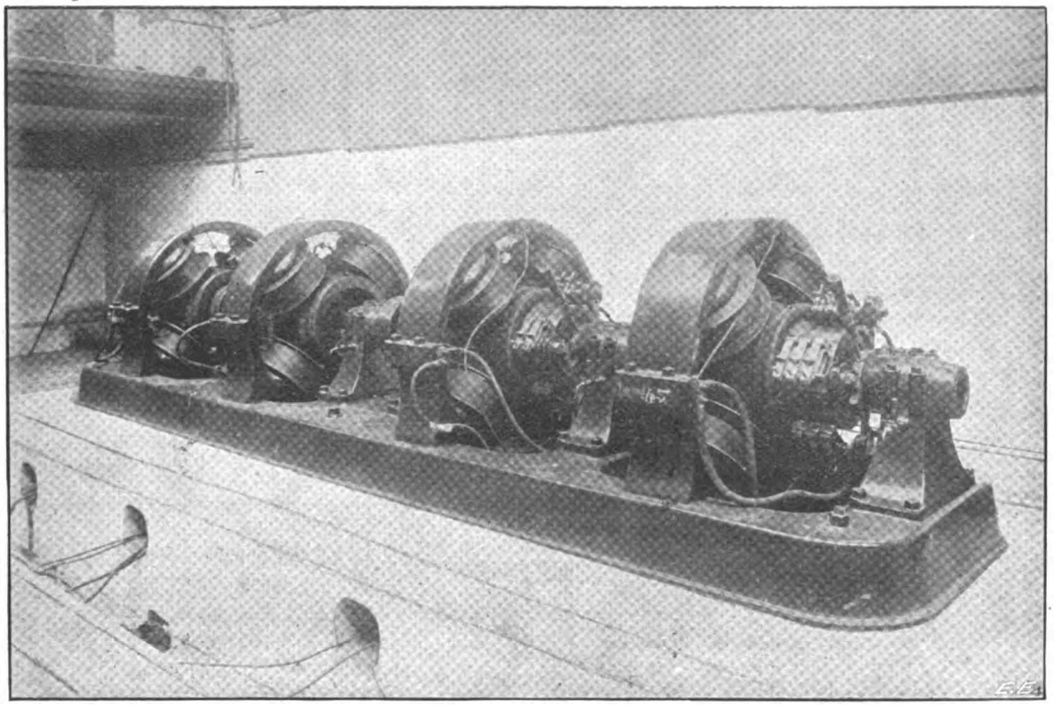
ENGINES.

The engines are of the Musgrave enclosed type, with cylinders arranged side by side, provided with large oil-tight doors, specially designed to afford easy access to all the internal parts. The cylinders are mounted on the top of the standard, and are fitted with the firm's improved piston valves, the high-pressure valve being controlled by an automatic governor. The high and low pressure cylinders are made in one casting with receiver cast on in the form of a belt. Separate liners are forced into the cylinder barrels and valve chambers. Separate eccentrics are used for working the valves so that each valve can be adjusted by its own eccentric. The crankshaft and cranks are of Siemens steel forged in one piece, the cranks being placed at right angles and balanced. The crankshaft is prepared at one end for coupling direct to the dynamo shaft.

The crankshaft pedestals are cast with the foundation plate and fitted with bell metal steps lined with white anti-friction metal. Special care has been exercised in designing the lubrication arrangement of the engine, as this is a very important point in the satisfactory working of quick-speed engines. The system the firm have adopted is on the forced lubrication principle, and all the working parts are lubricated by this system without moving joints. The engines are fitted with all the usual fittings. The engine for driving the 75-kw. generator has cylinders 10in. and 16in. diameter, with 9in. stroke, and runs at 400 revolutions per minute; while the engine for driving the larger—150-kw.—generator has cylinders 14·5in. and



Combined Sets, Lowestoft.



Booster Sets, Lowestoft.

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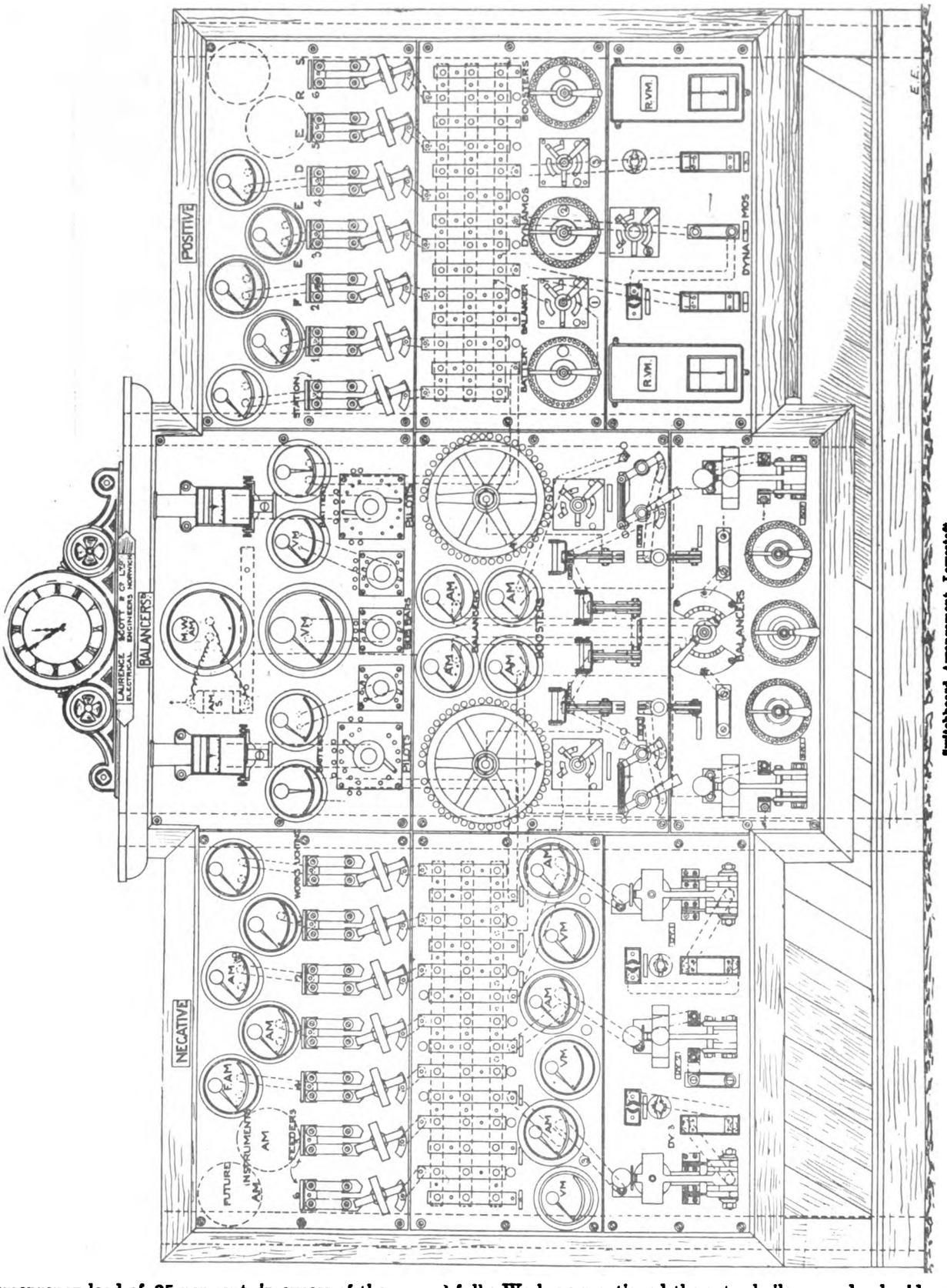
23in., with 11in. stroke, and runs at 330 revolutions per minute.

Dynamos.

The dynamos are of the British Thomson-Houston Company's make. One of the dynamos is capable of developing 150 kw. at 330 revolutions per minute, and the other 75 kw. at 400 revolutions. Each set is also capable of giving an emergency load of 25 per cent. in excess of the normal full load for one hour without injury. This is a consideration, for the peak of the load of an electric lighting station is of short duration, and may be often treated almost in the light of an emergency load, so that these machines can really do more than would appear possible at first sight. Owing to the probability of the early introduction of electric tramways into the borough, the dynamos have been designed for either traction or lighting purposes.

Extensions

In consequence of the manner in which the light has been taken up, the outlook is very favourable, and, as is so often the case, extensions of the first tentative estimate had to be arranged before the completion of the first instalment. We have mentioned the extra boiler on order, besides which Messrs. Browett, Lindley, and Co. have on order an enclosed high-speed self-lubricating two-crank vertical engine, having cylinders 16in. and 26in., with 11in. stroke, to run at 350 revolutions, driving a 250-kw. dynamo. The dynamo is of the multipolar type, by the Lancashire Dynamo and Motor Company.



Switchboard Arrangement, Lowestoft.

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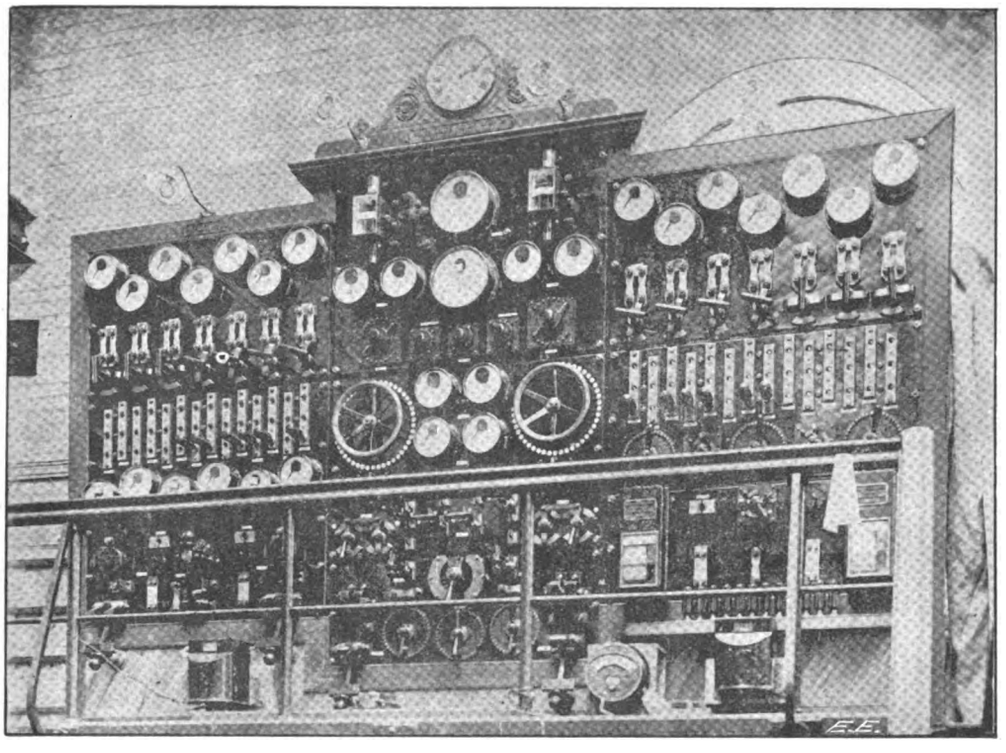
ACCUMULATORS.

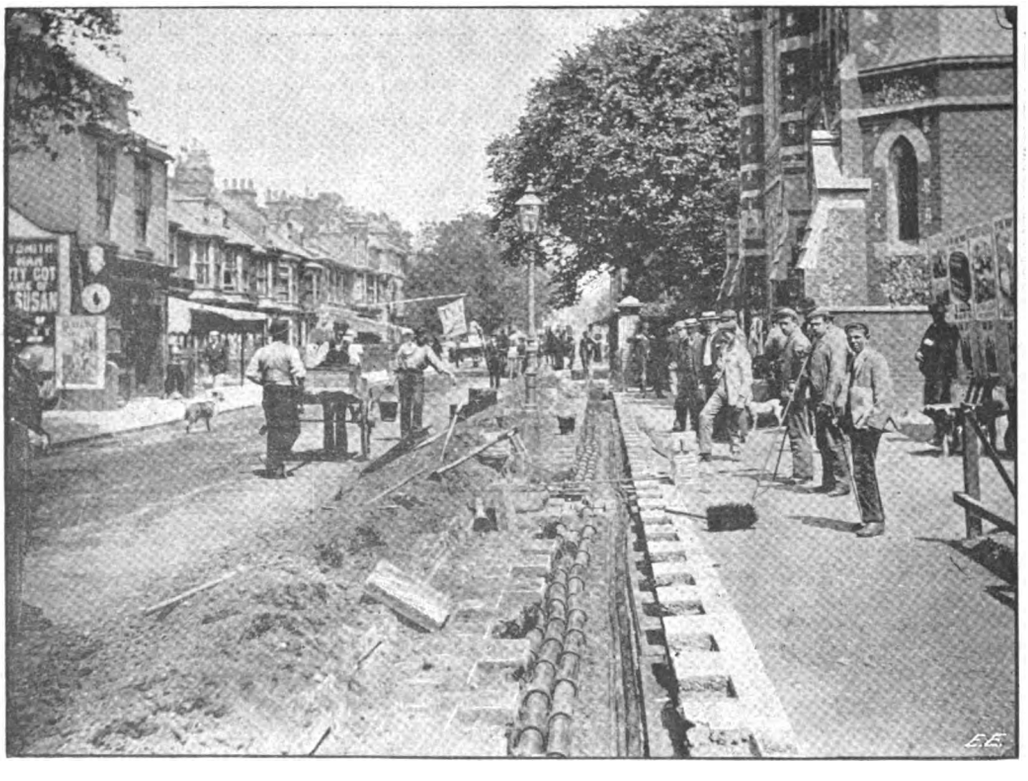
Two batteries, manufactured by the Chloride Electrical Storage Company, are installed, each consisting of 135 cells, 45 of which are regulators. The normal discharge rate is 100 amperes for four hours, and in case of emergency the cells can be discharged at the rate of 270 amperes for one hour. The containing boxes are of glass, each containing 12 positive plates and 13 negative plates, which are suspended in the boxes on glass hangers. The cells are supported on the usual pitch-pine trays and glass oil insulators, and are arranged in three tiers. The stands consist of pitch-pine bearers mounted on cast-iron frames.

SWITCHBOARD.

The switchboard is of the usual type for low-tension work, and is constructed of enamelled slate, supported on an iron frame, with a moulding round the sides, which is the only woodwork. The dynamos, feeders, boosters, and batteries can all be connected by a plug board having three 'bus bars at the back. The centre panel of the board is that connected with the middle wire of feeders. The centre panel contains the cell-regulating switches, also the throw-over switch, by means of which the cells, after being plugged on, are thrown on to the 'bus bars direct. Two throw-over switches are provided for the boosters No. 1 and No. 2, the fields of the same being excited off the 'bus bars. There is also the double-pole starting switch for the balancers and the field rheostats of the latter and of the booster on this panel. The



Switchboard, Lowestoft



Street Work, Lowestoft.

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board allows of six feeders being connected, four of which are in use, also the station circuit. Instruments and cut-outs are also provided for three machines, two only being in use at present. Arrangements have also been made that any one feeder can be boosted up separately. The switchboard was manufactured by Messrs. Laurence and Scott, of Norwich.

Street Work, Lowestoft.

MAINS, FEEDERS, DISTRIBUTORS, ETC.

The whole of the mains cable was supplied and laid by Messrs. Callender. The feeders consist of four armoured cables laid direct in ground, and run to the following feeding points: No. 1 feeder, ·3, ·3, and ·3 square inch triple-concentric to London-road North; No. 2 feeder, ·4 square inch concentric to High-street; No. 3 feeder, ·25, ·25, and ·25 square inch triple-concentric to Royal Plain on Southside; No. 4 feeder, ·25 square inch concentric to London-road South. With each feeder is laid a three-core $^{7}/_{20}$ armoured pilot cable to indicate the voltage of each feeding point at the station. The distributors consist of three single-conductor cables of vulcanised bitumen insulation, laid in wooden troughs, and filled up with refined bitumen. The size

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cable used is ·125, ·062, ·125, but a few of the extensions are ·062, ·035, ·062.

(Continued on page 294.)

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NOTES.

The Yukon Telegraphs.—It is reported that the two parties engaged on the building of the Yukon telegraph line from Quesnelle, B.C., to Telegraph Creek have failed to make connections. The line was being built from the northern and southern ends simultanously, and it is asserted that the work of construction has overlapped and the two ends are in different valleys with two ranges of mountains between. It is thought that one of the sections will have to be abandoned.

An English Precedent.—One outcome of the visit of the American Institute of Electrical Engineers to this country last year is that the council of that institute have now decided to follow the English institution's example in holding a conversazione. We understand that if this should prove a success it is likely to become an annual affair. This first conversazione is to be held in April, and while it will be largely social in character, a special feature is being made of electrical apparatus and inventions, which will be accompanied by extensive experiments. A large number of prominent men in the States have already promised the loan of apparatus, and as Mr. W. J. Hammer has that part of the programme in hand its success is assured.

Electricity.—A lecture on this all-important subject was delivered before the Harrogate Naturalist Society at the end of last month. We do not give the lecturer's name, because one cannot be sure how far the local reporter is responsible for the details of the lecture before us. For instance, a statement that "a novel feature of the evening was the brilliant light of the carbon arc lamp" is hardly one we should expect at the present day, even if the lecturer did supply his audience with a full description of the mechanism and principle on which such lamps work. When, however, the reporter goes on to state that "the working of electric belts" was demonstrated, we begin to wonder whether the lecturer was altogether free from blame. Perhaps he explained to his audience the way in which the public had been worked by unscrupulous adventurers who have used electric belts as gold extractors.

Electric Fire-Engines.—With the introduction of electric traction in our large towns, we see no reason why more use should not be made of electrically-driven pumps for extinguishing fires. The steam fire-engines are limited in power, whereas an electrically-driven pump, taking its supply from the tramway wires, could be made to give any desired output. It could also be got to any point on the main routes of a town remarkably quickly when once an arrangement for hastening the ordinary traffic on the lines has been made. We notice that in one town in America a modification of the above proposal has been carried out. In this case a platform on the tramway lines is used to convey a steam-driven fire-engine up to a point near the outbreak. The firemen in charge of the engine thus have a basis of supply, as the platform, besides containing the engine, would have a large amount of the stores which are usually forwarded to a fire in auxiliary fire-cars.

"The Electrical Bulletin."—Messrs. Mather and Platt, Limited, have just brought out the first number of an eight-page periodical, entitled the *Electrical Bulletin*. As pointed out in the introductory remarks, the *Bulletin* will serve to set forth some of the examples of electrical work selected from the practice carried on from the Salford Ironworks. Further, it is intended to describe and illustrate new applications of electricity, and with the object of showing the development of new features, examples of public supply plants will be given from time to time. In the number before us we notice that reference is made to the development of electric generators for public supply works. An illustrated description of the large multipolar continuous-current dynamos which are being constructed for the Salford Corporation occupies the first pages of the *Bulletin*, which also contains a description of an electrically-driven pump. An article on a new form of electrical conveyor completes the interesting issue.

Head-Lights.—We gather that a serious accident recently occurred on an interurban line in America owing to the fact that the head and tail lights on the electric cars were supplied from the ordinary circuits. In this instance the current to the line was interrupted, and the cars were coasting down an incline in order to get as far on their journey as they could in spite of the interruption in the power supply. The first car had got down the incline, and was waiting at the bottom, when the second car ran into it in the dark. A considerable number of passengers were injured in consequence of the collision. It must be remembered that these interurban lines in the States are run more like railways than tramways, and at considerable speed. It therefore becomes most important that an independent system of light for the lamps fixed in front and rear of the car should be adopted. In the case of tramways in British towns, where the speeds are moderate and the streets are lighted, the need for such an independent system of signalling lamps is not so important.

Insulators.—We notice in the *Scientific American* a new insulator which has been devised by Mr. H. W. Woolbert, of Pittsburg, Pa., with the idea of rendering the insulator more durable. In the ordinary earthenware and porcelain insulator a sharp blow will cause the insulating material to fly to pieces, and then the wire falls down on to the cross-arm. Mr. Woolbert, in order to avoid this, has introduced a glass insulator in which wire is embedded much after the same way as sheet glass is often strengthened by the insertion of an iron wire netting. The forms of the insulators are not quite the same as those usually employed, as the glass is moulded to form recesses which support the wire without any binding. The claim of the inventor is that when the glass is broken the iron wire insertion still keeps the parts together, and prevents the wire from dropping on to the ground or on to the cross-arm. The insulation would without doubt be less than when the insulator was unbroken, but it would be considerably more than what would be the case if the wire were to fall.

Aluminium Cables.—The jointing of aluminium cables continues to be a somewhat vexed question, and although a number of solutions have been devised which are said to enable a good joint to be made between lengths of such cable, there is little evidence as to the durability of the joints so made. It will be remembered that at the Institution of Electrical Engineers, a short while ago, one speaker pointed out that any soldering on to aluminium had up to the present been defective, owing to the alloy which was formed at the surface of the aluminium, and which was unstable. The most recent suggestion we have seen on this question is that by Mr. W. C. Heraeus, of Hanau-on-the-Main. This gentleman, who has had considerable experience in working with aluminium, suggests that the wire should be welded together, and he claims to have succeeded in obtaining good joints by such a welding process as before has only been used in the case of iron. Apart from this solution, most of the joints between aluminium conductors which are employed at the present day rely for their mechanical strength on the twisting of the wires. A solder is only employed in filling up the interstices of the joint, and is not relied upon to give any mechanical strength.

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Conduit Tramways.—An ordinary meeting of the Institution of Mechanical Engineers will be held on Friday evening, the 15th inst., when a paper of more than ordinary interest will be read and discussion invited. "Combined Trolley and Conduit Tramway Systems" is the title, and Mr. A. M. Connett the author of the paper, which deals with a subject of particular interest to electrical engineers just now when the overhead system of electric traction is being so generally criticised. From the syllabus of the paper it appears that reference is made to three methods of "mixed" electric traction—trolley and accumulators, trolley and surface contact, and trolley and open-slot conduit. The general type of conduit, side-slot and centre-slot construction, troubles caused by slot switches and side-slot construction, the mechanical and electrical details to be considered in the construction of a conduit, are among the interesting points dealt with. The author then goes on to give information as to the durability and mode of fastening insulators, the precautions to be taken against switch accidents, etc. Devices for raising, lowering, and allowing lateral movement of the plough are described, and the author concludes by giving estimates of the cost of these conduits. An instructive discussion is expected.

Electric Train-Lighting.—The Great Central Railway Company has recently had one of its dining cars equipped with electric light on a system which Messrs. Vickers, Sons, and Maxim are introducing into this country. The equipment consists of a small dynamo which is driven from the car axle, and also a battery of accumulators which are charged by the dynamo when the speed of the train is more than about 15 miles per hour. The chief interest centres round the means by which the voltage on the dynamo is kept constant in spite of variations of speed, as there are no means provided for keeping the speed of the dynamo constant. The regulation of voltage is effected by means of resistance in the field circuit of the dynamo, and this resistance is varied by means of a small motor actuated by a relay. One of the earliest forms of train-lighting in this country was arranged on the same principle, but has not survived the test of time. With the improvement, however, in the design of dynamos, the objection which formerly existed to running machines with their full current output and a weak field has to a certain extent been done away with. In the case in question, also, the accumulators render the dynamo more stable when working under these somewhat trying conditions. Sixteen accumulators are used in each coach, and a sufficient number of incandescent lamps is provided in the cars to give a most brilliant effect. We also gather that the apparatus required for a single coach weighs complete about 1,000lb.

Graphite-Carbon Resistances.—In an illustrated article contributed to the *Elektrotechnische Zeitschrift*, Mr. F. R. Dietze describes in detail the construction of a type of starting switch which since its introduction by a German firm some two years ago has been largely adopted with satisfactory results. A mixture of graphite and carbon is used in this switch as a resistance, whereby exceedingly fine graduation is obtained, in virtue of which the apparatus is claimed to be especially suitable for elevator and crane installations, where the motors must necessarily be started up on load and frequently switched in and out of circuit. It is well known that the gradual and uniform withdrawal of resistance from the motor circuit obtained with a very finely graduated controller tends to minimise the sparking and wear at the commutator. The ingenious manner of employing graphite in the form of a powder as a variable resistance is fully described. It may be mentioned that the switch contact passes through the powdered graphite. The variation, it is claimed, is effected as gradually and uniformly as with a liquid resistance; while the material is not liable, as in the case of a liquid, to either evaporation or decomposition. By adding a larger or smaller proportion of carbon with the graphite, the same apparatus may be adapted to any working pressure between 65 and 600 volts. The author suggests, in conclusion, that in virtue of its incombustibility and other desirable qualities as a variable resistance, graphite admixed with carbon may find further useful applications for switch gears.

Speed Regulation.—A good many inventors working on the question of the regulation of speed of electric motors have tried to reach the desired result by altering the position of the field magnets with respect to the armature. This method of weakening the field in order to increase the speed is, however, mechanically cumbersome, and does not compare favourably in consequence with the ordinary method of inserting resistances in the shunt circuit. We notice that Mr. F. A. Johnson, of Binghamton, New York, has again attempted the problem of moving the field. In his case, however, the arrangements are somewhat novel to any we have seen before. In the illustrations now before us, which appear in the *Electrical Review* of New York, he shows a two-pole enclosed type of motor, in which the upper pole alone is wound with exciting coils. The core of this pole is made hollow except just at the end where it embraces the armature. In the cylindrical space inside the pole a core of wrought iron is placed, and the position of this internal core is altered by means of a hand-wheel acting as a nut on a vertical screw. The inventor claims that by means of the hollow shell, the strength of the magnetic flux at the pole-tips is kept the same even when the internal core is drawn right back. This would hardly seem to be rigidly accurate, but it would apply much more than in the case when the whole magnet is withdrawn. The extra cost of making the hollow magnet of the mechanical gear for drawing back the internal core would seem to us to debar the machine from commercial use. It must be remembered, in connection with such machines, that the percentage change of speed obtained by withdrawing the pole does not exceed that which can be got by inserting resistances in the field-magnet circuit.

The Institution Discussions.—The discussions at the Institution of Electrical Engineers are being much improved by the efforts of the President to restrict each speaker to 10 minutes. We quite agree with him in his remarks last week to the effect that any speaker who prepares his remarks beforehand can easily give his arguments and conclusions within that time. One point, however, in which there is room for improvement is in the selection of speakers. On every occasion this session there has been a superabundance of members who have wished to take part in the discussion, and, in consequence, only those who have sent in their names and are called upon by the President get an opportunity of expressing their views before the meeting. As is remarked at the conclusion of each debate, others who have not been called upon have the *Journal* of the Institution at their disposal for airing their views on the subject. It is very important that the speeches for and against the proposals in discussion should be somewhat equally divided. Taking as an example the discussion of the last two weeks on Mr. Madgen's paper, it could not but be noticed that the one side had the most of the opportunities. This is apt to give a false impression as to the feelings of the Institution. There were in all only two speakers who strongly combated the general conclusions of Mr. Madgen's paper, and neither of these was a municipal engineer of the class from which the opposition of the Power Bills is brought. We do not

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know if these municipal engineers offered to speak, but there were a number present in the room, and we think it would be much more conducive to the general interest of the Institution if they had expressed their views in public instead of confining their opposition to the parliamentary proceedings. As it was, half of the speakers at the discussion were financially interested either as engineers or as promoters of power schemes.

The Yorkshire Power Bills.—The promoters of the two rival power schemes for Yorkshire have recently been interviewed by various chambers of commerce in the towns affected. Much information respecting these Bills and their respective claims for support was elicited by the Halifax Incorporated Chamber of Commerce on Wednesday week. From a report of the proceedings we gather that in the case of the South Yorkshire Electric Power Bill the promoters propose to leave themselves entirely in the hands of the various corporations respecting supply in municipal districts. In this they would follow the precedent of the Power Bills which passed into law last year. The rival Bill, which is called the Yorkshire Electric Power Bill, evidently is to contain a clause which will protect manufacturers in such municipal areas. We gather from remarks which the engineer to the scheme made in answer to the town clerk of Halifax, that in the event of any corporation not supplying power to large consumers at as cheap a rate as the power company would be able to do, it is to be open to the Board of Trade to give the company the right to supply such a consumer. This reference to the Board of Trade seems to us to be a most reasonable suggestion, as it can only be made in the event of a corporation not supplying power consumers at a low rate. It will be obvious that the Board of Trade would be quite able to prevent any undue competition which aims at obtaining consumers with attractive rates with an idea that these rates could afterwards be increased. In the meanwhile, however, the corporations do not favour the reference to the Board of Trade, and prefer instead to be quite independent. This they are not at the present time, and we trust they never will be. The action of Parliament last year in nearly granting a company powers to make good the neglect which the Corporation of Dublin had shown in electric lighting matters was a salutary warning to others.

Exhibition Lighting.—In the American *Electrical Review* for Feb. 16 Mr. Henry Rustin has a good article on the subject of the electric lighting of exhibitions, in which he points out that a more pleasing illumination can be accomplished, both as to evenness of distribution of light and decorative effect, by dividing the individual lights into as many units as possible and still keeping the points of light proportionate in size to the objects to be decorated with light. Referring to the laying-out of the lighting features of the Pan-American Exposition, Mr. Rustin says the authorities selected the incandescent lamp as the illuminant, and established the unit as 8-c.p. and 16-c.p. lamps. The author warns us, however, that it must not be inferred from this that a good illumination could not have been effected if acetylene, illuminating gas, or arc lights had been selected to serve the same end. It is certain, however, that the best results cannot be obtained by entering these several illuminants in competition with each other in decorative lighting The chief advantage which the incandescent light has in an exposition is that it can be burned in any position and almost under any conditions. Again, it is easily made a part of any sculptural, architectural, floral, or even water effect. In decoration work the incandescent light is specially favoured. The arrangements for lighting the Pan-American Exposition are such that it will be possible to reach a gradual increase of lighting leading toward the stately electric tower at the base of the T-shaped courts, and which is to be the climax of the fountain and electrical display at night. The number of lights and the quantity of light will exceed that of any other equal area ever artificially illuminated, and it will be evenly distributed. Beautiful spectacular effects will be produced by the many combinations of light and water, while an impressive scene will be the electric tower basin, which is to be the stage of the display of a combination of 1,500,000 gallons of water per hour in fountains with the light of 100 large-sized searchlights.

Chicago Trams.—A commission appointed by the Chicago City Council to look into the whole question of what are termed street railways in America, has now issued its report. An abstract of this report is given in the *Street Railway Review* for February, and complaints are made in an editorial notice on the recommendations of the committee. One of these recommendations is that in all future franchises granted by the city of Chicago the repurchase clause of the British Tramway Act of 1870 shall be inserted. The editor points out that this repurchase clause, which enables the tramways or street railways to be taken over at the end of a period of 21 years at the then value, has proved disastrous to the tramway enterprises of Great Britain. The introduction of a similar clause in the new franchises is thus strongly deprecated by the editor. With this we agree, but we do think that there are other points in the report which show that the commissioners have avoided the issues which they should have been able to solve. Amongst these is the question of the fares to be paid by the public, and the annual charges to be enforced on the street railway owners on behalf of the town. We gather from the clause dealing with this that the commissioners could not decide as to whether they could insist on a low fare being given to the public, or on a comparatively high rent being paid by the new concessionaires to the City Council. Another point which may give rise to considerable trouble is that of the referendum which it is suggested should be given to the mass of the people. In other words, when any concession is to be given it should be referred to the vote of the ratepayers before being confirmed. This seems to us to be an exceedingly cumbersome way of doing business. Another point in the report deals with the labour question, and suggests that the companies should be forced to arbitrate in the event of labour disputes. It seems to us that such an arbitration would only be binding on the employers of labour and not on the men employed. As this is so, the ordinary procedure in labour disputes should be allowed to stand.

An Electrically Oporated Bridge.—Mr. H. G. Tyrrell describes in the *Electrical World* a new bridge across the Connecticut River at Middletown. The whole bridge is some 1,300ft. long, and consists of four fixed spans and one movable span of 450ft. This revolving span provides two clear waterways, each 200ft. wide. The swing portion of the bridge is operated by three 25-h.p. electric motors of the railway type, one of which turns the span, while the other two are in use in connection with the blocking up of the ends. For this work a much smaller motor would have done, but the engineer, Mr. Tyrrell, considered it well to keep all the motors of the one size. There is also a duplicate set of turning machinery, which can be applied at will to assist the first motor in case of unbalanced wind pressure or a breakdown in the first driving machinery. These two motors are worked independently. The power to operate the bridge is taken from the street mains at Middletown through a cable laid from the river bed, and brought up at the central pier. It was originally intended that the gates at the end

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of the fixed spans should be worked electrically from the operating house, and the full design of the requisite gear was prepared. Up to the present, however, this has not been installed. The two motors which are used to block up the ends of the bridge work on to a pair of toggles at each corner. These are drawn together by two bronze nuts working a right and left hand screw, which is turned by bevel gearing from the motor. To prevent these nuts from jamming, there are electric signals arranged to tell the operator when to switch off the current. The arrangements are such that a lifting force of 50 tons is applied to the bridge and over a space of 1½in. in 10 seconds. To open the bridge requires half a minute on an ordinary day, and the revolving part is so accurately balanced that in calm weather only 5 h.p. is required to turn it. Electric tramway lines are laid across the bridge, the joint at the revolving section being made by an ordinary split rail, which can be adjusted with the seasons in order to minimise the jar from the changing temperature.

Electric Cranes.—An interesting review of the progress made during the past five or six years in the construction of electric cranes is contributed by Alfred Kolben to the *Elektrotechnische Zeitschrift*. He points out how it was first sought to adapt the electromotor to the peculiarities of early types of transmission gears, the single-motor crane marking the period of transition from the old system to the new. But this practice did not always yield satisfactory results. Sometimes the rope pulleys of old cranes were substituted by belt pulleys driven by electromotors, after the winding gears, square shafts, and auxiliary apparatus previously in use had become worn out and consequently unserviceable. But manufacturers at first showed little disposition to discard designs which had been evolved from much thought and experience; hence it was only natural that the most clumsy and dispensable portion of the early type of overhead traveller—*i.e.*, the rope transmission—should be the first to concede its place to the electromotor. Gradually, however, manufacturers began to adapt their designs to the conditions of electric driving, and to-day there is no doubt but that the epoch of the single-motor crane is near its end. A decided majority of modern cranes are so constructed that each of the principal movements is accomplished by a special motor. The endeavour to dispense with transmission gear between motor and machine constitutes to-day a recognised principle of construction. Quick-movement gears are now constructed in order that they may be coupled direct with the electromotors, while for a like reason the motors are designed for slow speeds. Apart from the fact that a large number of workshops, foundry depôts, etc., cannot find constant employment for their cranes, the use of several motors offers the important advantages common to easy and fine control of speed, in addition to which the automatic braking effects which can be obtained with series-wound continuous-current motors are very valuable. In cranes designed for extra high speeds, such as are employed, for instance, in steelworks and foundries, multi-motor cranes come almost exclusively into consideration. The article goes on to describe the constructional features of some typical cranes of modern design, which might be studied with advantage by those interested especially in crane work.

Electric Tramways and Railways.—Mr. R. W. Hogarth delivered a lecture before the East of Scotland Engineering Society last week on "Electricity as a Motive Power for Railways." In this lecture he also gave some data respecting the electric tramways and light railways of this country. Thus he stated that at the end of 1900 some 52 electrical tramways and light railways were in operation, representing about 600 miles of route and much more in track, while 25 undertakings with over 300 miles of route were authorised or under construction. The capital invested by British electric traction companies had risen from 8½ millions sterling in 1897 to 19½ millions in 1899, and over 26 millions in 1900. Eleven municipalities had in 1899 expended some £1,170,000, and this increased in 1900 to 18 municipalities, with an expenditure of some £2,750,000; thus the expenditure more than doubled itself within 12 months' time. As an illustration of a line using electric locomotives, a brief description of the Central London Railway was given, and it was suggested that had a multiple-unit system been adopted the overcrowding now experienced on this line in the mornings and late afternoons might have been obviated by increased service, which for the moment is not possible, since 2½ minutes are required to change the locomotives at the terminals of the line. The lecturer then discussed the reasons which led him to the conclusion that the electric locomotive had no future, and showed that the multiple-unit system on the broad lines of flexibility of operation, safety, economy, and improved service was the system which must necessarily displace the locomotive for passenger lines at least. Some interesting data regarding train acceleration were next given, and the lecturer advocated the use of polyphase high-tension currents for transmission on the longer lines, with continuous-current distribution from sub-stations. He did not think that direct working with three-phase currents (which involved the use of double trolleys) would come into general practice in this country. For railway work the overhead trolley line would be as far as practicable superseded by the third rail fixed alongside the track rails. It was premature just yet to talk of electrically operating main-line railways until further data were forthcoming regarding the actual results obtained on the shorter lines.

Residual Magnetism.—In an article contributed to the columns of a foreign contemporary Mr. Paul Holitscher considers the phenomena relating to the residual magnetism in one and the same iron ellipsoid after it had been reduced to its original state of magnetisation by thorough and controllable demagnetisation. The ellipsoid was composed of Jura iron, the respective lengths of its semi-axes being 18cm. and 0·144cm. A magnetometer was employed to determine the magnetic moment. In the first place, the influence of the duration of the magnetisation on the residual magnetic moment was determined. The fact was disclosed that for increasing periods of magnetisation the residual moment, M_r, increased at first, but after a certain period the "period of saturation" reached a certain limit, at which it remained constant. This time required for saturation increases with the strength of the magnetising force, its maximum limit corresponding to that strength of field for which M_r is a constant value. This fact pointed to the necessity of continuing all magnetisation processes in the further course of the experiments for the period of maximum saturation, which was found to be 2 minutes 30 seconds. These experiments related to the influence of the number of the successive impulses and the method of magnetisation on the residual moment. By magnetising uniformly in one direction the residual moment continues to increase with the number of the successive impulses. The increase is at a quick rate during the initial impulses and afterwards slow, but, contrary to the generally accepted idea, does not attain the maximum with a small number of impulses, since even after a succession of 20 impulses a further succession of 100 impulses causes an additional increase of M_r. When magnetising both ways M_r is independent of the number of the impulses. Similarly M_r is independent of the duration of the magnetisation, but not of the demagnetisation.

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If the latter takes places suddenly, M_r is invariably of less value than if it is effected gradually. The gradual demagnetisation need not, however, be uniformly continued, though no steps greater than 3 per cent. should be made. That for magnetisation uniformly in one direction the residual magnetic moment becomes greater in proportion to the number of the successive impulses was confirmed for each magnetising current, but the ability to increase the M_r produced by the first impulse by frequent repetition varies greatly for different magnetising forces.

A Promising Discovery.—In the course of an article containing numerous graphic illustrations and tables, Mr. Ewald Rash describes in the *Elektrotechnische Zeitschrift* a new method of producing electric light. This method, it appears, consists in establishing an arc between two electrodes of some fire-resisting substance, such as magnesia, lime, oxide of thorium, oxide of zirconium, etc., the arc so produced representing, in virtue of physical qualities differing essentially from those of the carbon arc, an extremely economical source of light. Experiments have shown that such incombustible electrodes of low conductivity will form excellent arcs, provided they are first of all rendered sufficiently conductive by the application of heat from some external source. It is suggested that in arc lamps this preliminary heating might be effected in a simple manner by means of an auxiliary arc of the ordinary carbon type. The watt density at the incandesced ends of the arc formed between the fixed electrolytes is shown by the results of the experiments to be very great (30 to 40 watts per square millimetre and above). Moreover, the temperature of the arc is probably the highest which it is possible to obtain with substances at our disposal. It corresponds to the exceedingly high vapourising and melting temperatures of the stable electrolytes in question. For this reason, alone, it is obvious that the economy obtained must be higher than in the case of any system of lighting hitherto in vogue. The experiments fully confirmed this view. It also appears that the desire for a selective abnormal emission of light is, in the case of this new system of lighting, for the first time fully realised. Hence the production of a light with a spectrum having few invisible ultra-red rays, but, on the other hand, a great preponderance of effective yellow and green rays has been solved. The laboratory experiments embraced the manufacture and testing of electrodes having diameters up to 5mm., all tests having, perforce, to be conducted with alternating currents. It is probable, as in the case of the carbon arc, that greater efficiency would be obtained with continuous currents and larger electrodes. However, the experiments proved that even with alternating currents the useful light yielded by the electrolyte arc is greater than can be obtained with any other known system of artificial lighting. Both electrodes of 2·5mm. and 5·0mm. diameter, yielding an equivalent of from 600 to 1,000 candles, showed an efficiency of from three to four candles per watt. The actual observed consumption, in fact, for these sizes amounted to from 0·25 to 0·3 watt per effective candle, which is equivalent to more than double the economy obtained with the continuous-current carbon arc. It was also proved possible to construct highly economical lamps of the electrolyte type for small powers, say 100 c.p. In other words, the above figures mean that the new light (even when a relatively high price has to be paid for current) may be produced at a much cheaper rate per effective candle-power than incandescent gaslight. It is claimed as an additional advantage that the electrodes for the new light, being incombustible, will have a much longer life than carbon electrodes, and, moreover, require to be only of very small diameter, besides being cheap to manufacture. To quote particular experiments with electrodes 5mm. in diameter and a current of 5·3 amperes, it was found that a voltage of from 36 to 45·5 was required, while the candle-power varied from 700 up to 1,000. The variation in the candle-power does not seem to correspond to variations in the voltage, from which we presume that the light was not absolutely steady. This new proposal opens out a wide field for speculation and experiment, while the success of Mr. Rash seems to warrant hopes for the commercial outcome of his invention. Naturally, the experimental details are not given *in extenso* at this early stage.

False Spectra.—Mr. Theodore Lyman contributes to the January number of the *Physical Review* the results of his experiments on false spectra which can be obtained from the Rowland concave grating. To give the gentleman's conclusions first, he finds from experimental evidence that (1) the first spectrum produced from the Rowland concave grating is not pure, but is complicated not only by underlying spectra of higher order, but by the presence of a number of spectra of lower dispersion than the chief spectrum; (2) the number and dispersion of these false spectra obey no simple law; (3) the number, dispersion, and clearness of these spectra differ with different gratings; (4) the lines due to the false spectra are most clearly visible in the extreme ultra-violet owing to the absence of strong real lines, and are so pronounced as to screen the feeble real line that may occur in this region. In explanation of these conclusions, the author states that it seems probable that in developing the theory of the grating some assumptions have been made which are not according to fact. It is in the error of such assumptions that we must seek the solution of the problem. It is generally assumed in treating the grating that the lines of the ruling are of equal width, and are separated by equal spaces. In the very nature of things it is evident that this cannot be the case, in view of the very minute distances involved and the almost inconceivable rigidity of the ruling engine which would be necessary. These variations, slight in absolute amount, may be a considerable fraction of the distance from line to line. It is clear, moreover, on experimental as well as on the theoretical ground, that these variations are not local, but extend over the whole surface of the grating. It appears, then, that the departure from equal spacing assumed in the theory of the concave grating is not the random departure which is next in theoretical simplicity, but a more or less systematic departure which has emphasised disproportionately certain of the subordinate maxima called for in the conventional theory. If the position of the false maxima occurred in the ratio 1 : 2 : 3, or in any other simple ratio, the phenomena would invite an analytic discussion. As an experimental fact, however, our lines are not harmoniously placed with respect to the slit, nor are they arranged according to any discoverable system. Moreover, they are different in character and position when obtained by different gratings ruled by the same engine. It seems most likely that the phantom lines are due to a number of superposed first spectra of varying dispersions, and that these false spectra owe their existence in some manner to the variation in width and separation of the grating lines. The author also adds that gratings of large radius do not show the false lines with as much clearness as gratings of small radius. So feeble indeed are the false lines obtained with the 21ft. grating, that it is improbable that they would be noticeable in ordinary spectrum investigations. It is impossible, apparently, to predict the nature of the false spectra of one grating from the false spectra produced by another of the same ruling and radius.

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THE QUIN PATENT SAFETY DEVICE FOR PROTECTING OVERHEAD TROLLEY WIRES.

As an outcome of the Liverpool accident considerably more interest has been taken in this device, which for the past two years has been in use in connection with the Blackpool tramways for the protection of the public against any chance of receiving a 500-volt shock. Through the courtesy of Mr. Quin and the British Insulated Wire Company, who have purchased the patent rights and are manufacturing the apparatus, we are able to give herewith some drawings of the apparatus, together with the diagram of connections. Thus Fig. 1 shows the switch pillar, in which four of these Quin automatic switches are placed in order to protect the four sections of trolley wire, which are connected up to the main feeder through the section box in question. The details of the switch gear on

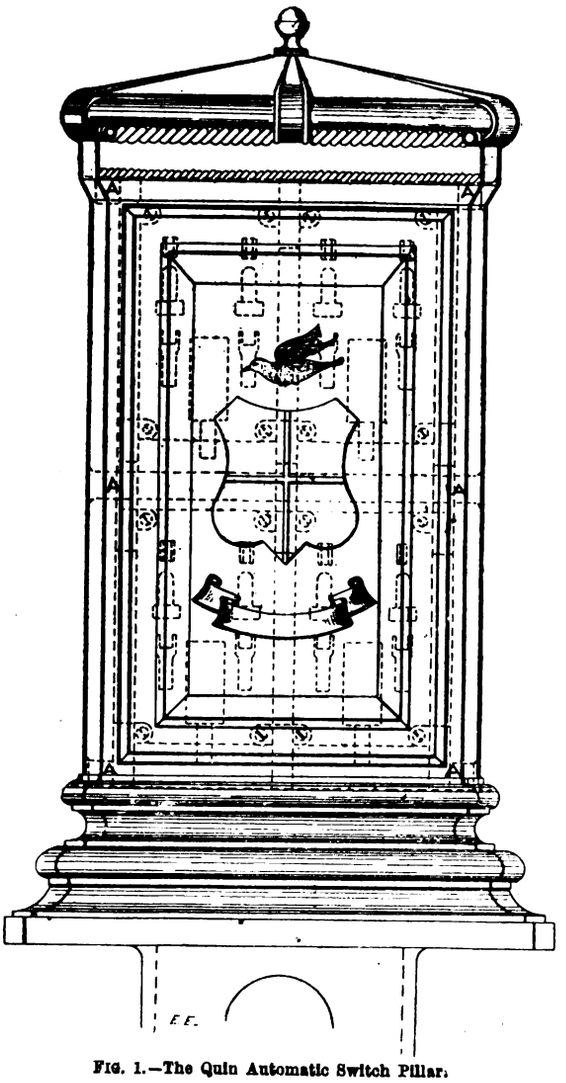

FIG. 1.—The Quin Automatic Switch Pillar.

each of the four panels are shown in Figs. 2 and 3, while Fig. 4 gives a diagram of the connections employed. The object of the device is twofold. The first and most original is that the trolley wires shall be instantly rendered dead in the event of a fracture occurring in any part of its length. The other object of the device in which there is not so much novelty, is that the connection between the feeder 'bus bar and the trolley wire shall be interrupted in the event of an excess current passing through the same. To deal with the first point, Mr. Quin introduces an overhead pilot wire between the switch pillar and the farther end of the section which has to be protected. This wire is brought back to a shunt coil on the switch, which, when energised, holds on the switch lever, which otherwise would fly off and break the circuit. In the event, then, of this pilot wire becoming dead, as would be the case if the trolley wire were interrupted in any part of its length, the shunt coil will lose its magnetism, and the switch will fly off and thus break the connection between the feeder and the section of the trolley wire which is falling to the ground. We notice in the diagram of connections that the pilot wires are shown to be placed overhead, but we should think it would be preferable for many reasons to place them underground, which although slightly more expensive, reduces the number of overhead wires which have to be protected from falling telephone and telegraph conductors. In addition to the shunt coils on each switch, there is also a series coil through which the current from the feeder has to pass on its way to the trolley wire. This acts on the switch much in the same way as all excess current cut-outs, and breaks the circuit when the current through it exceeds a certain predetermined limit. When earthed guard wires are placed over the trolley wire as a means of protection the following alternatives apply. In the first case, if the telephone or telegraph wire in falling only makes connection with the earthed guard wire,

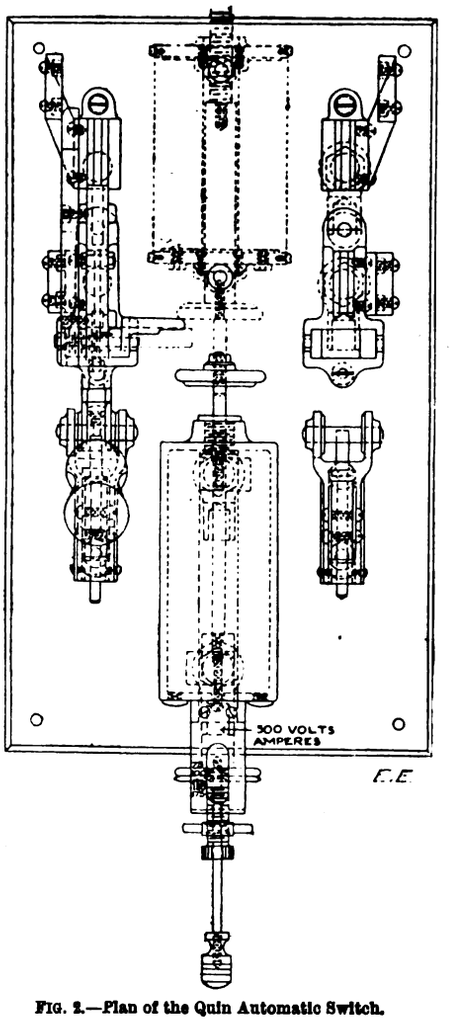

FIG. 2.—Plan of the Quin Automatic Switch.

there is no danger from electric shock to anyone in the street below, although there still remains the mechanical danger which arises from the falling wire. If, however, as is frequently the case, the initial strains in the wire which is falling cause it to coil round both the earthed guard wire and the trolley wire, a short-circuit takes place, which causes the series coil of the automatic switch to act and break the circuit. At some recent experiments carried out at Blackpool it was proved to a large number of gentlemen that the Quin automatic device gave absolute protection against either a trolley wire breaking or against falling telephone wires.

AN AUTOMATIC EARTHING DEVICE FOR TROLLEY WIRES.

Having regard to the fatal accident which recently occurred in Liverpool under circumstances already fully

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reported in these columns, we would call attention to an article by Mr. R. Ulbricht which appeared in the *Elektrotechnische Zeitschrift* for May 7, 1896. An arrangement is

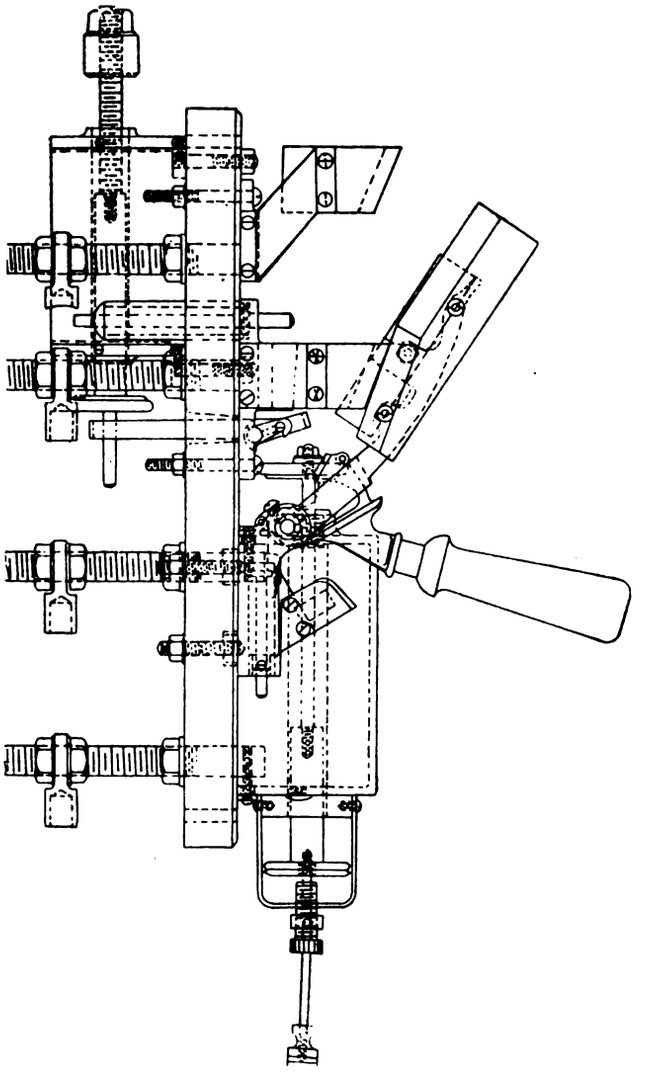

FIG. 3.—Elevation of the Quin Switch.

described therein for guarding against accidents due to the falling of telephone or other wires across trolley lines. It is based on the principle of a momentary connection between the trolley wire and earth causing a direct connection between the same, which remains until the apparatus is reset by one of the tramway officials. The efficiency of the system is largely dependent on the employment of an automatic earthing device of very simple construction, which may serve to protect simultaneously several points crossed by telephone or other wires. The arrangement is diagrammatically shown in the accompanying sketch. Momentary contact between a telephone wire, the trolley line, and one of the earthed guard wires is sufficient to complete the earth connection through *a b*. This causes the automatic cut-out provided in the generating station for the protection of the line to act, while the short-circuit indicator will continue to indicate the disturbance until the earthing device in the proximity of the trouble has been reset.

The arrangement has been largely adopted and was subjected to a severe test in Leipzig, where the falling wire was on the one side connected with the apparatus to be exposed to danger and on the other direct with the rails.

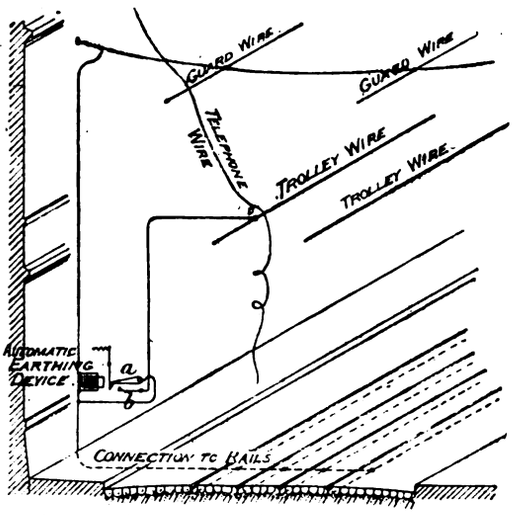

Diagram of Connections for the Ulbricht Earthing Device.

Between the trolley wire and earth a voltmeter was inserted to enable the degree of security afforded the street traffic to be gauged. The automatic earthing device, although of only temporary construction, worked without a hitch. At each fall of the telephone wire across the guards the voltmeter immediately registered zero. The protection afforded was so complete that when a fuse of only eight ohms resistance for a maximum current of one-third of an ampere was inserted in the falling wire, it did not melt. In the last test the falling wire fused the guard wires, which had been previously weakened in many places by partial fusion, but the momentary contact had sufficed to establish a dead earth connection on the trolley wire.

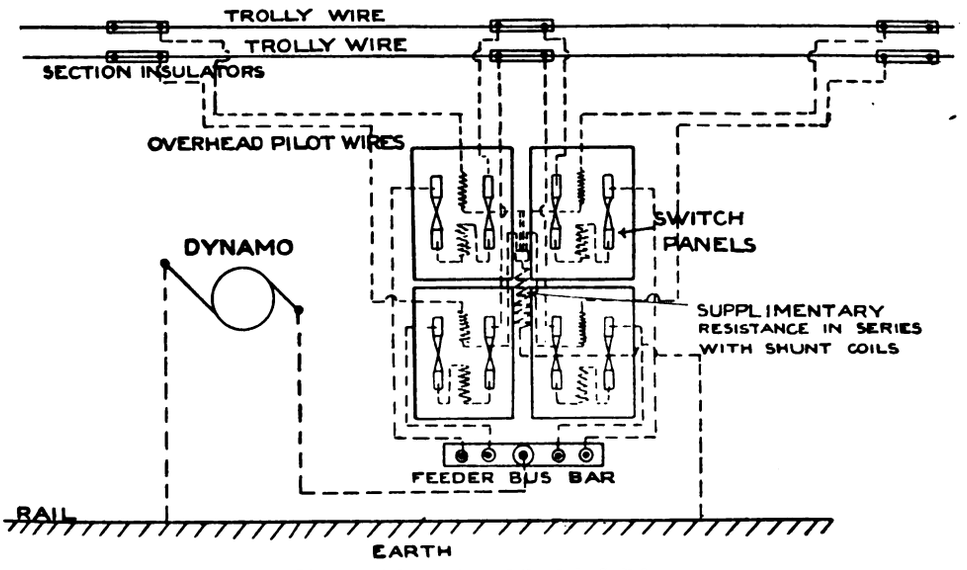

FIG. 4.—Diagram of Connections of the Quin Switch.

An additional advantage claimed for the automatic earthing device is that it enables the guard wires to be of relatively small diameter, since they have to carry but a momentary current, and by suitable arrangement may be

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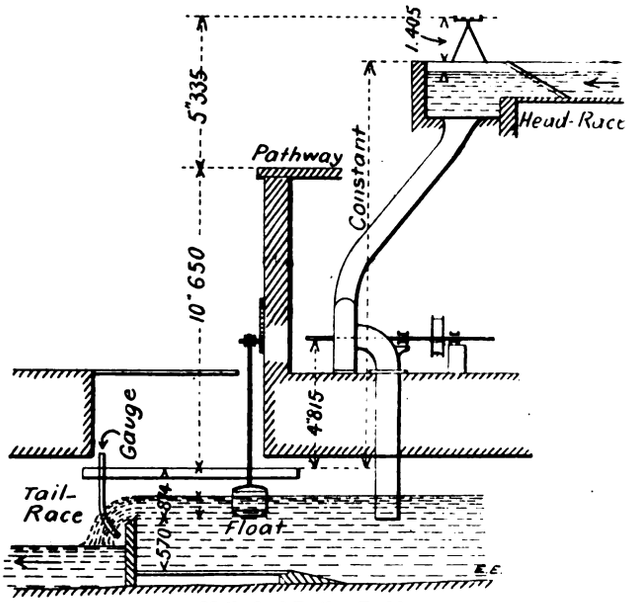
made to do their duty even should a large fall of telephone wires cause them to break. Further, the automatic device may be tested daily as to its condition in a similar manner to that in which automatic cut-outs are tested, though in doing this contact between *a* and *b* must naturally be prevented.

A SATISFACTORY TURBINE TEST.

Our attention has been directed to some very satisfactory results which were obtained as the outcome of a test undertaken to determine the efficiency of two newly-erected turbines. The turbines were constructed by Messrs. Hemmer Bros., Limited, of Neidenfels. They are of what is known as the Francis reaction type, provided with the above-mentioned firm's patent turbine wheel, whereby uniform distribution of the water over the same is obtained. The test took place at Messrs. C. Dodero and Co.'s (the purchasers) paper mill at Coazze, near Turin, in Italy, under the direction of two engineers representing the contractors and the purchasers.

The contract was for two turbines, of the "Francis Hemmer" type, designed to pass 77 and 166 gallons of water per second respectively, with an actual fall of 32ft., a further fall of about 18ft. to the lower water-level being



Method of Testing Turbine.

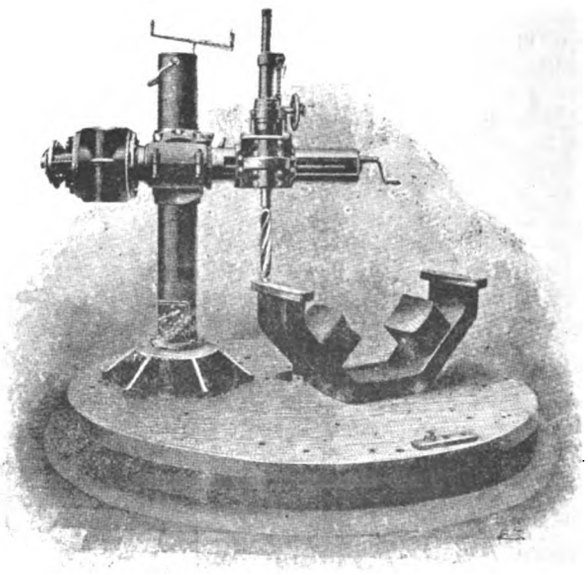
utilised by means of suction pipes, which gives a total fall of about 50ft. It was stipulated that, in view of the rather awkward pipe arrangements and suction, an average efficiency of 75 per cent. should be attained for a quantity of water varying from 100 to 50 per cent., and a maximum efficiency of 78 per cent. for three-fourths of the stipulated quantity of water, the larger turbine to develop 114 b.h.p. at 350 revolutions per minute under these conditions. The upper watercourse is 330 yards long and conducts the turbine water into a reservoir, which is guarded by means of a strainer. The pressure conduit, consisting of a round Monier pipe (cement with an iron skeleton), about 150ft. long, ending in two unions of 31in. and 27in. internal diameter respectively, furnishes the turbine water for both turbines. The turbines have horizontal shafts, which are about 32ft. below the top water-level, whilst the remaining fall, about 18ft., is used by means of suction pipes.

The test under notice was carried out on the large turbine, the turbine water exactly measured, and the apparatus used to ascertain the brake horse-power checked and minutely tested before use. The manner of conducting the test is shown in the accompanying illustration, which, however, it will be seen is not to scale. The results obtained showed 87 per cent. as the highest efficiency, whilst the average efficiency with a flow of water varying from 166 gallons to about 80 gallons per second was 83 per cent. For the half flow of water alone 82 per cent. efficiency was found. The effective horse-power developed with a flow of 173 gallons per second was 118 b.h.p., which represents a far better result than that guaranteed. The efficiency of the turbine with a flow of water of only 55 gallons per second (being one-third of the maximum amount), was 72½ per cent. We believe that the results obtained in this test establish a record for the conditions given, a fact highly creditable to Messrs. Hemmer Bros., Limited, as reflecting upon the good design and workmanship of their turbines.

We are indebted for the above information to the firm's London representatives, Messrs. J. Marx and Co., 133 to 139, Finsbury-pavement, E.C., who, we understand, will be pleased to furnish further details and copies of the charts and schedules taken during the test to interested parties.

ELECTRICALLY-DRIVEN UNIVERSAL PORTABLE DRILLING MACHINE.

This machine is designed with the special object of providing a tool convenient for drilling operations, where the expense of carrying the tool to the work is less than that of carrying the work to the tool. The machine is entirely self-contained, having no connection with any outside apparatus, except the electric leads. It may readily be



Electrically-Driven Drilling Machine.

set up, and can be detached, moved, and started again with a minimum delay. The spindle is direct gear-driven from the motor shaft, thereby ensuring economy of power. The driving gear is of great strength, and the machine is capable of taking heavy cuts considering its size. The machine is so designed that holes may be drilled in any direction—horizontal, vertical, or at any angle—with equal facility. All the adjusting clamps may be loosened at the same time for the necessary adjustments without fear of any part being over-balanced. Holding-down bolts are dispensed with, as it is able to grip any bed-plate or other convenient flat and smooth piece of iron.

As will be seen from the illustrations, this machine consists of a main column fitted with a saddle, which carries a radial arm, on one end of which is mounted the drilling head with its spindle, and on the other end the driving motor. These parts are constructed to give three independent motions of the drill: (1) the saddle and all parts carried by it can be swivelled in a complete circle round the main column in a horizontal plane; (2) the radial arm can be swivelled in a complete circle in a vertical plane; (3) the radial arm, and with it the drill spindle, can be swivelled about its own axis through a complete circle in a plane perpendicular to the arm. Besides these motions the head can be traversed along the radial arm and the saddle can be raised or lowered on the main column. The base of the drill is provided with an electromagnetic clutch arrangement which holds the drill in position when

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placed on any flat and smooth surface of iron, and with a good contact an adhesion of three tons can be obtained. For specially heavy work it is, however, desirable to supplement the magnetic attachment by dogs to prevent creeping. The current for this magnet is taken from the same source as that used for driving the motor, the circuits being connected in such a way that the act of starting the motor magnetises the holding-down coil, thus preventing the tool shifting through carelessness. The main column is 7ft. high and 12in. in diameter, and the lower part of it contains the motor-starting resistance, which is thus effectively protected from injury. A screw runs the whole length of this column, carrying a crescent-shaped nut which projects into a groove in the saddle, providing in this way a ready means of elevating the saddle, while leaving it entirely free to rotate round the column. The radial arm is 8in. in diameter, and on one end is mounted the drilling head with its spindle and on the other end the driving motor. The whole of the driving gear is contained in this radial arm, so that its position in no way affects the driving. The traversing motion of the drilling head is controlled by a screw in the usual way, and it is firmly clamped in position by an expanding wedge gib. The drill spindle is 3in. in diameter, and is bored at the end for No. 5 Morse taper socket, and is provided with power feed by means of a sleeve driven with pinion and two sets of worms and gears directly off the spindle. By disconnecting the power feed by the clamping nut at the centre of the handwheel, the spindle may be fed by hand.

The motor attached is of the Mather and Platt two-pole enclosed type, capable of developing 2 h.p. at 800 revolutions per minute, and is connected to the switch by a flexible cable, and can be wound as desired for working from a 100 or a 200 volt circuit. The motor shaft is prolonged so as to pass through the spiral gear, driving direct on to the drill spindle. This gear has a ratio of 9 to 1, and with back gears of 3 to 1 provided it is possible to run the spindle either at 90 revolutions per minute or 30 revolutions per minute, with the motor running at full speed. Slower speeds can be obtained by regulating the speed of the motor.

The drill, which is protected by a patent, is suitable for boring holes up to 2½in. diameter.

LEICESTER TRAMWAYS REPORT.

(Concluded from page 196.)

Service.—The frequency of service of the cars would, roughly speaking, vary, when worked out, from about one or two minutes in the centre of the town to eight or ten minutes in the suburbs; in fact, in the busy main thoroughfares in the centre of the town there would be at least one car almost always in sight, and available for passengers at any stopping place. The experience of all the towns and cities we visited went to prove that wherever a cheap, rapid, and continuous service was provided the financial results had been the greatest.

General.—The scheme should in every respect be designed and commenced on such a basis as to admit of its being readily and conveniently extended to meet any possible requirements of the borough or the surrounding districts. We were much impressed by the way in which the various tramways run long distances into the country, thus enabling the poorer classes to reside out of the congested portions of the various cities, and consider that in the future it will be well to extend the tramway system of Leicester into the country, with a view of, to some degree, assisting in the solution of the problem of the housing of the working classes. The lines, power station, car depôts, etc., would be designed and carried out by the borough surveyor, and the permanent-way works and the laying of the rails should be done under his supervision by Corporation workmen. This is the course which has been so successfully adopted at other large towns, including Nottingham, Sheffield, Leeds, and Liverpool. It is important that the borough surveyor should be instructed to expeditiously prepare the detailed surveys of the routes, the parliamentary, general, and working plans, specifications and estimates, for the proposed lines, power station, car-sheds, depôts, equipments, etc., also that the services of an electric traction expert should be engaged to advise and assist, as may be required from time to time, in the capacity of consulting engineer in respect of any matters in connection with the preparation of a scheme, and also to advise upon proposals and tenders submitted by electric traction firms, who should be invited to compete on a specification of our requirements prepared, with his advice, by the borough surveyor.

In the course of our investigations we soon discovered that the only successful aspects of the workings of the various systems of electric traction were chronicled in published reports, and that the particulars relating to failures were only obtainable after making most careful examination and exhaustive enquiry on the spot into the several systems, and by interviews with responsible engineers, managers, and others. Although some mistakes have been made in the construction and equipment of tramways in Great Britain, they have been more numerous on the Continent from the very fact that electric traction largely originated there, and has been longer in operation and much more extensively developed. This long practical experience has taught them what to avoid in their later schemes, and what is most desirable to adopt in future. In all cases, whether in Great Britain or on the Continent, the knowledge and experience gained in carrying out and working the different schemes and systems were very freely placed at our disposal, but, for obvious reasons, we were unable, even if it were desirable, to name the towns and cities in which mistakes and failures have occurred. The requirements in growth of traffic have in some cases been so altogether under-estimated that in less than two years the power stations, etc., have had to be remodelled and the system vastly extended and rearranged. Engines, boilers, and dynamos have become insufficient in capacity, and provision in land space for extensions of generating plant, car-sheds, etc., altogether inadequate in consequence of the great popularity of electric trams, which, after conversion from horse traction, has invariably enormously increased, and in many cases multiplied the traffic two or three times. In some of these cases, buildings have had to be partly demolished and machinery pulled out and replaced at much inconvenience and loss. The generation of traction power at several and unsuitable places, instead of at one central station conveniently located and properly designed for traction purposes only, has also in some places been a source of trouble, involving heavy annual charges on construction, feeder cables, equipment, etc., and consequently greater cost of the power supplied and of the distribution works, and also in working expenses. Among other drawbacks to be avoided are the erection of car-sheds too largely in central places instead of providing district sheds where land is cheaper and access more convenient; the complication and cost of the building and equipment of cars to run in connection with two or more systems—viz., overhead and conduit, or overhead and surface contact, also combined with accumulator cars; commencing to run electric cars on light and worn rails originally laid for horse traction instead of at once reconstructing the lines, and the failure financially and inconvenience resulting from being compelled to adopt the conduit and accumulator systems in some thoroughfares for æsthetic or sentimental reasons only. In this matter, involving as it does a large financial outlay, we have pursued what we conceived to be a wise and economical policy by acquiring all the knowledge and information possible before deciding to recommend you to undertake a huge expenditure in effecting such a revolution in the means of transit, even though the change will bring enormous advantages to the inhabitants of this rapidly growing borough. From the evidence contained in our report, and as the result of our thorough investigations of the advantages and disadvantages of the various systems, we are convinced that a most modern and efficient system of electric traction can be installed and worked by the Corporation, which would be not only an immense boon to the public, but also an undoubted financial success. Having devoted our best energies and very much time to the consideration of this

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matter, we now beg to submit, with full confidence, the following recommendations.

RECOMMENDATIONS.

That the necessary steps be taken to purchase and work the tramways undertaking by the Corporation.

That the overhead trolley system of electric traction be adopted.

That parliamentary powers be sought:

To reconstruct and equip the existing tramlines.

To construct and equip extensions of the existing lines, and also to construct and equip new lines, all within the municipal borough, as set out and described in the following schedule, and shown on the annexed map, and on the cartoon prepared.

This work to be carried out in such sections, and at such times, as may afterwards be deemed advisable by the committee and the Council.

EXISTING LINES PROPOSED TO BE RECONSTRUCTED.

Belgrave-gate Route.—The line from the clock tower along Belgrave gate and road and Loughborough-road as far as the present terminus at Belgrave ..... 1·78 miles.

London-road Route.—The line from the clock tower, along Gallowtree-gate, Granby-street, and London-road, to the present terminus near Knighton-road ..... 2·02 miles.

Humberstone-gate Route.—The line from the clock tower, along Humberstone gate and road and Uppingham-road, to the present terminus near the Great Northern Station ..... 1·61 miles.

Aylestone Route.—The line from Granby-street, along Horsefair-street, Pocklington's-walk, Welford-road, and Aylestone-road, to the present terminus at Grace-road ..... 1·94 miles.

Church-gate Route.—The line from the clock tower, along Church-gate, Sanvey-gate, North-gate, and Wood-gate, to the present terminus near Fosse-road ..... 1·05 miles.

Total length of existing routes, 8·38 miles.

PROPOSED EXTENSION OF EXISTING LINES.

Belgrave Route.—An extension from the present terminus at Belgrave along Loughborough-road to the municipal borough boundary, near the entrance to the Great Central passenger station at Birstall-hill ..... ·75 mile.

London-road Extension.—An extension from the present terminus near Knighton-road along London-road to the municipal borough boundary, near the entrance to the Oadby racecourse ..... ·57 mile.

Humberstone-gate Route.—An extension from the present terminus near the Great Northern station along the Uppingham-road to the municipal borough boundary at Humberstone-lane end ..... ·48 mile.

Aylestone Route.—An extension from the present terminus at Grace-road, along Aylestone-road, to a point just beyond the Wigston-lane. A single line from Horsefair-street along Bowling Green-street, Belvoir-street, to Welford-place ..... ·72 mile.

Church-gate Route.—An extension from the present terminus near the Fosse-road, along Groby-road, to the municipal borough boundary, near the isolation hospital and new cemetery sites ..... ·47 mile.

Total length of extensions, 2·99 miles.

PROPOSED NEW LINES.

Narborough-road Route.—A new line from the clock tower along High-street, St. Nicholas-street, Applegate-street, over the West Bridge, and along Dun's-lane, Braunstone-gate, and Narborough-road, to a point where the municipal boundary meets the boundary of the parish of Braunstone, about one-third of a mile beyond the Burton branch railway bridge ..... 1·68 miles.

Hinckley-road Route.—A new line from Braunston-gate, along Hinckley-road to a point at the main entrance to the Western Park ..... 1·10 miles.

Fosse-road Route—A new line along Fosse-road from Hinckley-road to Woodgate ..... ·87 mile.

Great Central-street Route.—A new line along Great Central-street from St. Nicholas-street to the existing line in Northgate street ..... ·32 mile.

Melton-road Route.—A new line from the Melton Turn, along Melton-road to the municipal borough boundary at the northern extremity of the Belgrave sewage farm ..... 1·13 miles.

St. Peter's-road, etc., Route.—A new line from London-road, along Saxe Cobourg-street, Sparkenhoe-street, St. Peter's-road, East Park-road, St. Barnabas-road, to the Uppingham-road line, and also a connecting line from St. Peter's-road along Highfield-street to London-road ..... 1·65 miles.

Melbourne-road, etc., Route.—A new line from the corner of St. Peter's-road and St. Stephen's-road, along Melbourne-road and Nedham-street to the Humberstone-road line ..... ·77 mile.

Welford-road Route.—A new line from the junction of the Welford and Aylestone roads, along Welford-road to the municipal borough boundary at the brook beyond Knighton-lane ..... 1·78 miles.

Total length of new lines, 9·30 miles.

That parliamentary powers be sought: To construct and equip a central electric traction power station on the land adjoining the refuse-destructor buildings at the "Lero," Belgrave-gate, and to utilise the 5,500 yards of spare land, now belonging to the Corporation, for that purpose; to purchase from the Leicester Navigation Company for tramway purposes, such as car-sheds, workshops, etc., 4,366 square yards, or thereabout, of land, part of the public wharf adjoining the above-mentioned land, having a frontage of 504ft. to the public wharf canal basin, at 24s. per yard, including an easement over a width of 15ft. of the waterway, which is not charged for at per yard, but is covered by the price for the land. That the continuous direct-current system of generating plant be adopted, and that designs and tenders, when required, be obtained from electric traction firms for boilers, engines, and generators, switchboard, and all other necessary mechanical and electrical appliances and equipment, on a specification of our requirements prepared with the advice of the consulting engineer. That, when required, designs be invited for overhead construction and equipment, feeder cables, etc., upon a specification prepared with the advice of the consulting engineer.

That parliamentary powers be sought also: To construct a car-shed depôt, with repairing sheds, workshops, etc., on part of the back land belonging to the Corporation, adjoining the canal, off the Abbey Park-road, and having an entrance thereto at the canal bridge near Lero, sufficient land being set apart to admit of extensions to provide for making our own cars eventually, if found advisable; to acquire sites for and to construct and equip such district car-sheds and depôts as may be determined upon in the preparation and adoption of a traction scheme; to alter and adapt for electric traction purposes, as far as may be deemed advisable, the buildings to be acquired from the Leicester Tramways Company, and to obtain such other powers as may be required in connection with the proposed tramways undertakings. That, to enable the Tramways Committee to give effect to the foregoing recommendations, or such other recommendations as may be hereafter adopted, the borough surveyor be instructed to make the necessary surveys and sections of the routes, prepare the parliamentary and general and working plans, specifications, and estimates for the proposed tramway lines, power station, car-sheds, depôts, and equipments; also for the adaptation of buildings to be taken over, and to do such other work as may be required. That the borough surveyor be provided with the necessary additional staff assistance. That the services of an expert of considerable experience in electric traction be engaged by the Tramways Committee to advise and assist, as may be required from time to time, in the capacity of consulting engineer in respect of any matters in connection with the preparation of a scheme as broadly outlined in this report, and to advise upon any proposals and tenders submitted by electric traction firms, and also to support a scheme by parliamentary or other evidence.

That parliamentary powers be sought for the carrying out of the above recommendations, and that the committee and the town clerk be instructed to take such steps as are necessary for that purpose as soon as the requisite plans, surveys, and estimates are completed.

THE GENERAL ELECTRIC COMPANY'S DINNER.

The eleventh annual dinner of the General Electric Company, Limited, was held at the Hotel Cecil on Saturday last. The addition during the year of the word "limited" at the end of the name of the company does not in any way apply to the dinner, as, owing to the large increase in the number of those invited, a change had to be made in the place selected for this event. This year, for the first time, it was held in the Hotel Cecil, and the numbers present can be gathered from the fact that the Grand Hall was comfortably filled by the members of the staff of the company and by the visitors invited. One good feature in the programme of the evening was that the long list of toasts which is so intimately associated with other dinners in the Grand Hall of the Hotel Cecil was reduced, in order to make room for the programme of a smoking concert held afterwards. The chair was taken by Mr. Max Byng, who proposed the first toast, that of "The King, Queen, and Royal Family."

Mr. ECKSTEIN, another director of the firm, proposed "The Army, Navy, and Auxiliary Forces." In so doing,

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he alluded to the war in South Africa and the part which the Electrical Engineers Volunteers had played in the same. The great lesson to be learnt from the war was that the British Empire had risen to the occasion and shown what infinite resources it possessed in times of need, both at home and in its Colonies.

Lieut.-Colonel CROMPTON said that the toast of the Imperial forces was the most appropriate at the present time, as it included not only the navy and the army, but also the militia and the volunteers, which latter departments of the Imperial forces had shown what they could do in the present war. The good work done by the militia in guarding communications had, he thought, not been properly recognised. He was pleased to state that practically all the members of the Electrical Engineers Volunteer Corps who had returned from South Africa had now obtained employment, which was a credit to those electrical engineers who had stopped at home.

Captain LLOYD also replied, and gave an example of the far-reaching influence of the General Electric Company. While the speaker was at Plymouth he had the pleasure of meeting Mr. Hirst and of doing business with the firm. When the Electrical Engineers Corps had got to Pretoria, and were commissioned by Lord Roberts to equip the hospitals with electric light, they found on enquiry that there was in Johannesburg a branch of the General Electric Company. He promptly went down to interview the agent in charge, and took over the entire stock. He believed that the goods were delivered with more dispatch in that case than in any other he knew of.

It fell to the lot of Mr. RAYLING to propose the toast of their absent chief, Mr. G. Byng, who was the founder of the firm, and to whose talent for organisation they owed the progress which they had made. He was pleased to hear that an announcement was to be made to the effect that Mr. Byng hoped to be able to preside over the dinner next year. He coupled with the toast the name of Mrs. G. Byng, who was present.

The CHAIRMAN then read a letter he had received from his brother, which he used as a reply to the toast. In this Mr. G. Byng stated that he was making good progress towards recovery, and that he hoped to be able to resume his place at the head of the firm before long. The letter went on to refer to the great commercial fight which was taking place in the country between English and foreign firms, and to the need which existed for every firm like the General Electric Company straining every nerve to keep their various departments well to the front. If the men on the staff determined to excel individually, he had no fear but that they would be able to repel the foreign competition which threatened so many trades in Great Britain.

Mr. H. HIRST proposed the health of the staff in a humorous speech, in which he referred to some remarks of Mr. Raworth last year on the question of the financing of a large firm like theirs. He was pleased to state that the staff had a large hand in the financing of the company, and that since last year the conversion of the company into a limited liability concern had enabled the members of the staff to take a financial interest in the firm. He added that the ordinary shares of the company were also held to a certain extent by the staff, who were thus actually partners interested in the well-being of the firm. He proceeded to humorously review the relative importance in their own estimation of the various members of the staff. Commencing with the office boy, and going up to the directors, he showed how well in their own estimation each man was able to exaggerate the importance of his own work as compared with that which was done by those above them. There was, however, one common interest in the firm, and this he looked to all the members of the staff to maintain. He announced that in order to increase the strength of the directorate they had just arranged to make Mr. Bevis and Mr. T. Hawkins directors, while Mr. Rayling had joined the Board a few weeks ago.

The toast having been replied to, Mr. M. BYNG, the chairman, proposed "The Visitors," coupled with the names of Prof. John Perry and Mr. R. W. Wallace, K.C. He said that should the first-named gentleman happen to meet the President of the Institution of Electrical Engineers on his return home, he hoped that he would take him a good report of the dinner of the General Electric Company.

Dr. JOHN PERRY, in reply, said that distinctions had been drawn between engineers and men of science, but the organisation and control of a firm like the General Electric Company needed men of science in every respect of the word. He thought that the organisation was one which even our Government offices would do well to copy. He quoted the American author who gave the advice that "you should do unto your neighbour as your neighbour would like to do unto you, and do it first," as the principle which had to be followed when fighting foreign competition. The commercial struggle was now between nation and nation, and it could only result in the survival of the fittest.

Mr. R. W. WALLACE, K.C., who also replied, said there was not even any need to get quotations from America. He was glad to see that a suggestion he had made of increasing the financial interest of the firm by allowing outsiders to acquire shares had been followed during the past year.

Mr. DANE SINCLAIR then proposed the health of "The Chairman," which was drunk enthusiastically, and after a short reply an adjournment was made to an adjoining room for the smoking concert. There an excellent programme of songs, humorous sketches, etc., was given under the direction of Mr. H. S. J. Booth, and the visitors and staff split up into groups for conversation.

It is interesting to note that this firm invites every member of their London staff to the dinner. The guests, among whom were representatives of the leading men in every branch of the profession, in many cases brought their wives, which added considerably to the social character of the occasion. Among the guests we noticed Prof. John Perry (president of the Institution of Electrical Engineers), Lieut.-Colonel Crompton, Captain Lloyd, Mr. J. S. Raworth, Mr. Dane Sinclair, Mr. Roger Wallace, K.C., Mr. Musgrave Heaphy, Mr. and Mrs. E. Manville, Mr. A. H. Walton, etc.

THE MAXIMUM PRICE FOR ELECTRICAL ENERGY.

On Wednesday last Sir Courtenay Boyle received at the Board of Trade a deputation on the question of the proposed decrease in the maximum price for electrical energy which up to now has been inserted in the various new provisional orders which are from time to time issued by the Board of Trade. The Institution of Electrical Engineers were represented officially by Lieutenant-Colonel Crompton and by Mr. W. M. Mordey. A large number of gentlemen representing applicants for provisional orders in this session of Parliament were also present, while the London County Council were represented by their solicitor, Mr. Blaxland.

Sir COURTENAY BOYLE, in opening the meeting, said that the Board of Trade had been urged to reduce the maximum price which was inserted in provisional orders, which was 8d. per unit. The London County Council had suggested it should be reduced to 5d. per unit as a maximum. The Institution of Electrical Engineers had written to the Board on the subject, and he would be pleased to hear what the two representatives of the Institution and the other gentlemen present had to say against the proposed reduction.

Lieut.-Colonel CROMPTON said that he had the honour, with Mr. Mordey, to represent the Institution, and he proposed to confine himself to the broad principles involved. The proposed change chiefly affected small towns and country areas with widely-scattered populations which up to the present had not electrical supply. The actual cost of electrical energy was largely a question of the output of the works at which it was generated. The incidental expenses, when commencing a supply in any district, rendered the cost of generation in the first few years quite as high as in the earlier days of electric lighting. Thus the cost of labour had gone up, and also the cost of supervision, and these increases tended to counterbalance any increased efficiency in the plant. If the maximum in future provisional orders was placed at 6d., it would prevent

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a number of districts from ever having electric lighting undertakings. He should be pleased, if necessary, to furnish the Board of Trade with complete sets of figures to show that for electric light stations of under a certain output a supply could not be profitably given at any price below 8d. per unit. He thought, therefore, that the Board of Trade should hesitate before making any such change in the maximum price in view of the competition between oil, gas, and acetylene lighting and the electric light. The reduction in the price of electrical energy had always followed commercial lines, and he thought that the present charges were quite independent of the Board of Trade limit.

Mr. W. M. MORDEY quoted the village of Sidcup as an example of small places which could not be supplied under 8d. Estimates for the electric lighting of this place showed that some £15,000 would have to be spent, and that the working expenses when supplying 40,000 units would be £900 per annum. The interest in sinking fund at 6 per cent. would make another charge of £900 per annum, and at 6d. per unit the undertaking would not pay its way.

Sir COURTENAY BOYLE asked whether this was not an argument that provisional orders should not be granted to and worked in such small areas, but that they should be dealt with under a large power distribution scheme, such as came before Parliament last year for the supply of electricity in bulk to small undertakers.

Mr. MORDEY thought that the option should be given to places like Sidcup either to do the work themselves or to take a supply from a power company. There was not, however, any such company having powers over the Sidcup area.

Mr. SIDNEY MORSE said he represented several companies which were promoting provisional orders this year. In looking through a complete list of the scales of charges for all electrical undertakings in the United Kingdom, he found only 1 or 2 per cent. charged at the maximum rate of 8d. The average price obtained per unit was very much below the maximum, and in London the St. James's and Pall Mall Company only obtained on an average some 4½d. per unit sold. If the maximum price were reduced from 8d. to 6d., it would seriously interfere with a system of charging which was very largely adopted. He referred to the Wright maximum-demand system, by which the high price was charged for the first hour or two's use per day of the maximum output demanded, after which a great reduction was made for all further energy taken. For instance, at the Clerkenwell station of the County of London and Brush Provincial Electric Lighting Company the charge was 7d. for the first period and 3d. per unit afterwards; the average price obtained by the company under this system was 4·71d. Mr. Morse then quoted evidence to show that when the regulations were being discussed in 1882, it was recognised that the price must depend on the consumption. He urged that any attempt to fix a price by law would be a failure, and that the competitive conditions were quite sufficient to cause serviceable reductions. He quoted the following figures to illustrate the influence of the consumption on the profit. The St. James's and Pall Mall Company had an income of 10*s.* per lamp fixed, and were able to pay a 14½ per cent. dividend with the average price mentioned above. The Chelsea Company, on the other hand, although obtaining a higher price per unit, only had a revenue of 4*s.* to 5*s.* per lamp fixed, and paid a dividend of 5½ per cent. With regard to the Power Bills, he thought they should not be considered in this matter, in view of the clauses which were inserted in them before they left the House. The companies owning them were so much in the hands of the municipal authorities that they might not be able to do business at all. He thought that the question of the maximum rates might be solved by introducing clauses like those adopted in the Weybridge order last year. In this a scale of charges was introduced by which 7d. per unit was to be paid for the first 91 hours per quarter and 4d. per unit for all above. In another order in which he was interested a similar sliding scale was introduced for power purposes, with a proviso that if the average cost per unit supplied for power purposes exceeded a certain figure, the scale should be revised. In summing-up his case, Mr. Morse emphasised the fact that there was no storage in electric lighting undertakings, and that in consequence some such differential rate such as he had described was required. The late Dr. John Hopkinson had advocated a system of making an annual charge per lamp fixed, together with a small additional charge for energy supplied.

Mr. A. H. DYKES described the conditions which existed at Hindhead, where a company was putting down works. From the houses which had had to be supplied, scattered over a considerable area, and the limited time in each year during which these houses were occupied, 8d per unit would have to be charged to certain consumers to keep the undertaking going. He also added that the inhabitants were quite prepared to pay this charge.

Mr. PERCY SELLON, representing the Electrical Section of the London Chamber of Commerce, endorsed what the previous speakers had said. He presented a letter from the section, which letter had been passed by the council of the whole chamber. It suggested that any reduction in the maximum price would be fatal to the maximum-demand system of charges, and that clauses should be inserted in future provisional orders of the general type used in the Wellingborough order last year. The clause should have the effect of reducing the scale of charges if the average price obtained for light and for power exceeded the predetermined limits.

Sir COURTENAY BOYLE said that no doubt large consumers were able to protect themselves, but that it was the small consumers who needed the protection of the Board.

A GENTLEMAN representing Falkirk, which Scottish town is applying for an order this year, said that they objected to a decrease in the maximum rate of charge because it would affect the borrowing power, or rather the rate of interest at which money could be borrowed. In Scotland they were not allowed to make a profit, but had to supply at the bare cost. The bigger the margin there was, therefore, between the price charged and the maximum the easier could money be raised.

Mr. BLAXLAND, on behalf of the London County Council, put in a list which had been prepared by the Council of the prices charged by the various companies and the municipal authorities in their area. While the Council wished to keep down the charges for electrical energy, they did not wish to press for clauses which would prevent the maximum system of charges being adopted.

Sir COURTENAY BOYLE said he was much obliged to the gentlemen who had come there that day, and he was particularly pleased to find in all the remarks an acknowledgment that the Board of Trade was anxious to do what was best for all concerned. They were particularly desirous of avoiding any new departure which would tend to discourage the development of electrical science, or the extension of electrical distribution. The Board had therefore decided at present not to make any hard-and-fast rule. At the same time they felt that the maximum price of 8d. per unit was too high. Therefore, without giving any definite maximum limit for this year's orders, reductions would be made, and the onus would lie on the promoters of provisional orders for small places to show reason why a maximum of 8d. per unit should be adopted. The Board of Trade approved of the maximum-demand system of charging, and thought it was one which ought to be encouraged. On the whole, he thought that the large consumer was able to take care of himself, and that the maximum price chiefly affected the small consumer. They could rely on each case being considered by itself, but the 8d. maximum would only be given in certain cases.

In answer to one or two questions asked afterwards, it was to be gathered that the usual maximum would be 7d. per unit, with 8d. for very small places, and perhaps 6d. in the case of very large undertakings. In either case the promoters would have to show cause why they should be allowed a 7d. or an 8d. maximum. The conference closed with an expression of thanks to Sir Courtenay Boyle for the kind hearing he had given those present.

Merthyr Tydvil.—The Merthyr Electric Traction Company are prepared to supply current for the lighting of the town hall.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

357. Can any reader recommend a thoroughly reliable feed-water filter which will take out all oil from surface condensed water? The condensed water as it leaves the air-pump has a very milky appearance, the oil being very intimately mixed with it. The oil is a mineral oil drawn up the low-pressure piston rods by the vacuum.—C. S. M.

358. In power transmission work is there any advantage in generating two-phase currents and transforming them up to three-phase for transmission? Also again transforming down and to two-phase current for distribution? Give a diagram of the transformer connections.—J. A.

ANSWERS.

Question No. 351.—In running alternators in parallel it is possible to obtain two kinds of motor current between them, one caused by any irregularity in the turning moment of the engines, and which is shown by a violent swinging of the ammeter needles, and the other due to the strengths of the alternator fields being in the wrong proportion. This results in a current passing between the machines which is quite steady, and has the appearance of an increased load. The writer has run two machines in parallel, one of which would not maintain full voltage on full load when running alone, but in parallel would give its full amperage, the other machine maintaining the voltage on the 'bus bar at full pressure. Can any reader explain this apparent boosting up of the volts, and if it is an armature reaction, how it is the field is not weakened instead of strengthened?

Best Answer to No. 351 (*awarded* 10s.).—In order to explain the effects described in the question, it will be as well first to state the causes of the two types of idle current a little more fully. The current which causes the ammeter needles to swing violently is an intermittent alternating one—*i.e.*, it alternates with a periodicity approximately equal to the periodicity of the alternators, and at the same time its value rises and falls with quite a different (usually slower) periodicity depending on the relative irregularity of the turning moments of the two engines. The latter variation can hardly be called periodic, as the spacing of the different maxima and minima might be most irregular, especially if the engines were of different types and ran at different numbers of revolutions per minute. Fig. 1 shows the approximate result of running

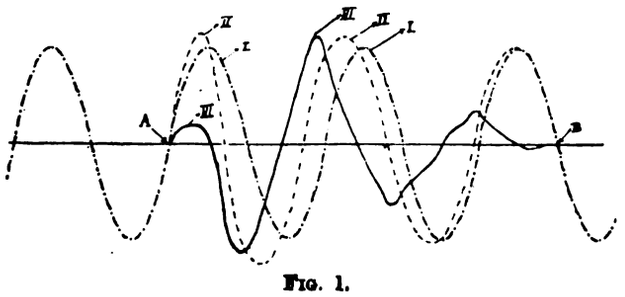

FIG. 1.

two alternators in parallel—one being assumed to run at a perfectly uniform speed and give the voltage curve marked I., whilst the second has an exaggerated unevenness of speed lasting over about 2½ periods at a time and reaching a maximum deviation of about 40deg. of phase from the uniform. (In practice alternators will not run satisfactorily in parallel if this deviation exceeds 5deg. or 4deg. of phase.) Curve III. gives the difference in the ordinates of Curves I. and II. at each point. It will be seen that this difference (which is the voltage tending to pass current round the two alternator armatures in series) starts at zero at A, reaches a maximum amplitude, and then falls again to zero at B during the period of time represented by the curve. In practice, if the engines were of the same type and ran at the same number of revolutions per minute, the time elapsing between A and B would be about equal to the time taken by the alternator to cover $\frac{1}{2 \times \text{number of cranks}}$ of a revolution. If the alternators were running at light or no load, there would be an actual alternating current passing between them at the moments at which a difference voltage (Curve III.) existed; if fully loaded, there would probably only be periodical variations in the relative amounts of current supplied to the external circuit by the two machines. In any case, however, the ammeter between them would vibrate violently.

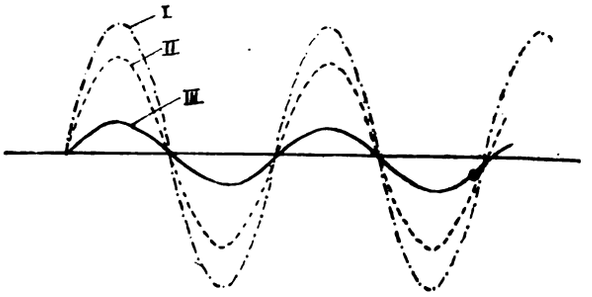

FIG. 2.

Turning next to the effect of under-excitation of one of the machines. This case is represented in Fig. 2, on the assumption that the two alternators are in phase, and have exactly similar turning moments. Curve I. is the voltage curve of alternator No. 1, and Curve II. is that of alternator No. 2, whilst Curve III. is the difference between the two, and is in phase with both. Suppose alternator No. 1 at work and alternator No. 2 put into parallel with it. The immediate result of the voltage represented by Curve III. will be a large current through the two armatures in series. Being practically in phase with the voltage of alternator No. 2 this will act as a strong *motoring* current, and will therefore increase the speed of No. 2 slightly, and shift its voltage slightly ahead in phase of that of No. 1 and of the current in the circuit which depends on the difference between the voltages of 1 and 2. This is equivalent to making the current a maximum at the moment when the armature coils of alternator No. 2, instead of being situated as in Fig. 3—*i.e.*, each side of a coil

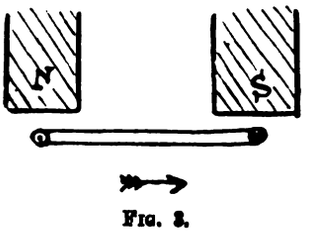

FIG. 3.

centrally under a pole—in which position the magnets are neither strengthened nor weakened by the armature current, are as in Fig. 4, with the result that

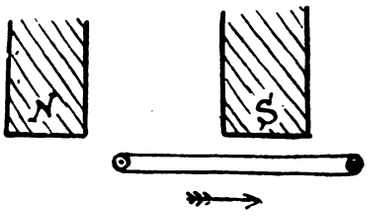

FIG. 4.

the magnets are distinctly *strengthened*. This can be seen from the direction of currents in the coil O (signifying an up-coming current) and × (a down-going one). This is in accordance with the rule that an alternator armature carrying a leading current, or a synchronous motor arma-

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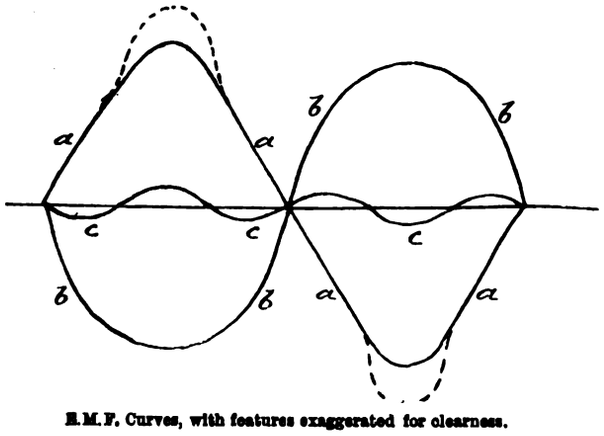
ture carrying a current lagging behind the back E.M.F., strengthens its magnets. It is for this same reason that an *over-excited* synchronous motor can be used in place of a condenser for producing leading currents. As soon as the voltage of alternator No. 2 has been increased sufficiently by this armature reaction (due to a definite armature current passing, the amount of which depends on the type of alternator, whether the air-gap is small or large, whether the armature has many or few ampere-turns per mile of periphery, and on the amount of the under-excitation) a balance is reached, and the machines then continue to run steadily. The ammeter between them would read the motoring current, which, as stated in the question, would be indistinguishable from an ordinary load current, except that alternator No. 1 would be found to be supplying considerably more current than is required in the external circuit.

The above explanation also accounts for the case mentioned of an alternator giving a higher voltage when running in parallel than when alone; but, of course, this means of raising the voltage is valueless, as any current passing through the under-excited alternator is a motoring current.—Q.

Answer to No. 351 (*awarded* 5*s.*).—The cause of the rise of voltage in the first alternator when put in parallel with another may, I think, be due to a difference in the wave-form of the two machines. That the voltage falls below normal at full load is, of course, in part due to ohmic loss and in part to armature reaction, the latter preponderating.



E.M.F. Curves, with features exaggerated for clearness.

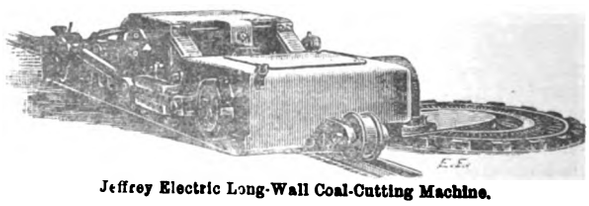
The drop due to armature reaction, moreover, increases with the lag of current behind E.M.F. in a generator. In a motor the case is reversed; armature reaction strengthens the field, increasing the back E.M.F., and this effect is greater with a lagging current. Now, for two alternators in parallel to act as generators at all phases of their cycle it is obvious that the E.M.F. of each must be identical at every instant, or, in other words, their E.M.F. wave-forms must be exactly similar. For if at any instant the voltage of one is never so slightly less than that of the other, the current in it must be reversed, and for that instant it must run as a motor. If, now, the first machine have its E.M.F. wave of some such form as *a a*, and the other have it of the form *b b*, the E.M.F. driving a current in series through the two machines is the resultant, *c c*, of the two curves plotted in opposition, as shown. Where this resultant curve is on the reverse side of the axis relatively to a machine's E.M.F., it shows that machine to be absorbing a motor current supplied by the other over and above that going out to the external circuit.

Leaving out of consideration, for the present, any effect produced in armature reaction, this would have the effect of bringing the ammeter reading for the machine permanently lower than before the other machine was paralleled. There would be no perceptible swinging, as the inertia of the instrument would prevent variations of such frequency being recorded separately. It appears possible that with a machine absorbing current at the beginning and end of a cycle, the field may be thereby so strengthened by the armature reaction of this motor current as to raise the E.M.F. curve in the middle region to a more peaky form, and that this may occur to a sufficiently great extent to bring the E.M.F. and current values up to normal average value for the whole cycle. With regard to this, it is to be remembered that the effective values given by the instruments are the square roots of the mean squares, so that a peaky curve raises the readings rapidly.—ZIPHERN.

Question No. 352.—What advantages are obtained by the adoption of electrical coal-cutting machinery? Describe shortly, with the aid of sketches, what you consider to be the best types of electrical coal-cutters.

Best Answer to No. 352 (*awarded* 10*s.*).—The advantages of cutting coal electrically in mining operations may be briefly summarised as follows: (1) Reduction in number of men actually engaged in coal getting, and consequent reduction in wages bill. One of the best electric coal-cutters, taking two men to work it, will hole as much as from 20 to 30 hewers. (2) Increased amount of coal cut per diem. A satisfactory estimate of the full working capacity of an electric coal-cutter cannot be arrived at, as it is impossible to get the coal away quickly enough to keep pace with the machine. (3) Reduction in cost of upkeep of tools, owing to fitter instruments for the purpose being used. Picks, gads, shovels, etc., are not "lost." (4) Increased comfort to the miners, and therefore easier management of the men. (5) Not so much small coal obtained as by the older method. The cutters make clean cuts around large masses of coal, which are broken into large lumps. (6) Extreme flexibility of system. Cables can be laid along any passage, however low, and provided that a track of light rails can be laid, the cutters can reach portions inaccessible to a man. (7) It is possible to make the roof, floor, and sides of a level more regular than can be effected by hand boring. (8) The rate of driving levels or sinking shafts is two to four times greater than is practicable by hand boring.

Electric coal-cutters have been manufactured capable of working on one of the following principles: (*a*) bar cutters; (*b*) rotary wheel or disc cutters; (*c*) drills. Of these sections the first is the most important at present, being represented by such machines as the Goolden-Atkinson cutter, the Jeffrey coal-cutter, the General Electric Company's cutter, etc. The second class is not so forward, the principal developments being the Snell-Waterhouse cutter used at the Glass Houghton collieries—a rapidly rotating wheel of large diameter undercutting into the coal seam—and the Thomson-Houston "mowing-machine" coal-cutter, which is a modification of the wheel cutter, being a cutter chain turning over a wheel at its front and back ends, and cutting, of course, while passing over the front wheel. In the third class is the Van Depoele electric percussive drill, whose motion is derived from the action of fluctuating currents produced by the interaction of solenoids carrying direct and alternating currents (both obtained from the same direct-current dynamo by means of a special arrangement of brushes). A coal-cutter really consisting of a multiple drilling machine driven by means of a two-phase asynchronous motor, is used in the mines of Pittsburg, Pennsylvania. The advantage of the last system is that the energy is transmitted, without undue waste, a long distance, and, as there are no commutators or collector rings, no sparking can occur. The disadvantage is that fairly high-tension current is used, which is not convenient in a mine.



Jeffrey Electric Long-Wall Coal-Cutting Machine.

The two most useful machines now on the British market appear to be the Goolden-Atkinson cutter (of British manufacture) and the Jeffrey cutter (an American article). Though both bar cutters, their methods of operation are dissimilar. The Goolden bar cuts its way at right angles to the face of the level, being drawn along the level by means of a winch applied to the truck on which it is fixed. The Jeffrey cutter is parallel to the face of the level, and starting at the face cuts its way back to a distance of 5ft. or 7ft. behind the face. The truck is then

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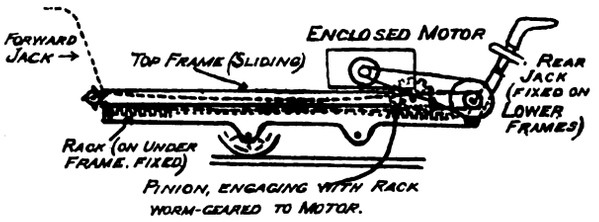
moved along to a new position, clamped on the rail, and jacked against the sides and roof of the level, and the process repeated. A detailed drawing cannot, of course, be given of the machine. The sketch, however, shows the salient features. It consists of a movable frame or bed-plate carrying the cutter bar at the front end, the motor near the rear, and the necessary driving, speed-reducing, and reversing gear both for the turning of the cutter and the travel of the cutter bar forwards. This base slides along a fixed frame mounted on truck wheels and carrying a pair of jacks, one at the front and one at the back. It carries also a straight rack, in which a pinion on the sliding frame engages, which pinion is turned by the motor through reducing gear so as to give a low feed forward. The cutter bar, revolving at about 200 revolutions per minute, is driven by an endless steel or bronze chain from driving shaft. The cutter bar is 36in. wide and its travel 7ft. A 15-e.h.p. motor is required, running at 1,000 revolutions per minute, to drive it, and power is usually supplied at 220 volts. The motor is series-wound to give a good starting torque—sufficient to start the cutter against the friction of *débris*.

Referring again to the Goolden bar cutter, this essentially consists of a direct-current enclosed motor whose spindle is horizontal and geared to the cutter bar by a pair of cast-steel double helical wheels running in oil. This motor, gear, and cutter bar are pivoted on a vertical pin, round which the frame carrying these parts is rotated by means of a worm and worm-wheel, the pin being part of an iron truck which travels along the rails of the level. There is another truck on which a winch is mounted, and which can be clamped and jacked rigid in the tunnel, so that by winding the winch the first-mentioned truck, carrying the

cutter bar, can be drawn along. As this bar is about 4ft. long and rotates at 400 to 500 revolutions per minute, it follows that if the whole length of the bar is at work a cut is made 4ft. deep in the wall, of length corresponding to the travel of the cutter track. In order to start the cut, the bar is slewed round until its top touches the face of the level where it is required to cut. It is then rotated, and the cutter truck being kept at the same place, the bar is slewed round until it is at right angles to the face of the level, and is then cutting throughout its whole working length. The winch is then worked and the cut made. The form of bar usually used is as shown. It is taper, and has holes drilled in spirally to receive cutters, this spiral form facilitating the removal of the *débris*. Both machines take about the same power and do the same work in equal times as far as can be judged. There is no real rivalry between them because their purposes are rather different. The Jeffrey cutter is good for driving headings, and for any work where a deep cut is required. As a rule, however, in English mines such deep cuts are not wanted, in addition to which the level must be 7ft. wide to admit the cutter. The Goolden cutter is excellent for long wall work, as it only needs about 4ft. width of level.—J. A. S.

Answer to No. 352 (*awarded* 5*s.*).—It would be difficult to draw any definite conclusion as to the best type of electric coal-cutter, as the type and also the motive power best suited depends in every case upon the conditions of working, the nature of the coal and the price paid for getting by hand, and the nature of the workings in the mine generally, and upon the commercial value of the coal when brought to the surface. Coal-cutting by electricity is now coming more to the front on account of the previous difficulties having been removed by the increased power given to the motors. One form of machine which is now on the market is constructed with two motors, one at each end of the frame, each gearing into the wheel or disc, upon the periphery of which are fitted the cutters, the motors being either of the continuous or polyphase type. The advantage of the latter is the absence of sparking both at starting and running, thus fitting them for working in the majority of mines in the United Kingdom, as very few mines are free from gas at all times; also it requires no starting resistance "as with the continuous-current motors." The starting switches in both cases, "together with starting resistance for continuous-current motors," are contained in a gastight iron box, the handles of the switch passing through a stuffing box. With the polyphase type the motors are started with the cutters off the coal. Then when the motor has attained its speed the cutter disc is allowed to work its way in the coal.



This form of coal-cutter is shown in the illustration, the makers of which are Messrs. John Davis and Son, of Derby, who also supply machines which consists of cutters fitted into an endless chain, the whole frame of which can be jacked up in any position to suit the seam, and is used for shearing in headings, rooms, or entries. The machine is first placed in position and raised to the top of the seam at which the first cut is made, after which it is lowered to a fresh position. Thus complete shearing from top to bottom, about 7ft. deep and 4in. wide, can be done in about 25 minutes. Another type of machine is the bar coal-cutter manufactured by Mavor and Coulson, Glasgow, and it is claimed that less power is required by this than by the disc type on account of the small leverage at the point at which the power is spent. In the machine, as the name implies, there is a steel bar which stands out at right angles to the machine. This bar, along which the cutters are arranged, revolves and cuts its way in the coal to a depth of from 3ft. 6in. to 5ft. 6in.

The advantages of these machines may be set down as follows: (1) great increase in output, about 80 per cent.; (2) a higher price can be realised for the product, in the way of round coal; (3) in the case of bad roofs, the advantage is that the machine travels quicker, thus fresh roof is opened, and packs and props are got up quicker and not so much timber is required; (4) in the case of thin seams where the getting price is high.

Almost in every form of coal-cutter the machine as a whole is hauled forward by means of haulage ropes, which are coiled on a drum, which can be revolved by the motor at a speed determined by the man in charge.

A polyphase installation can be seen at Park Colliery, Garswood, Lancashire.—K.

CATALOGUES.

The Electrical Company, Limited, have forwarded to us the 1901 editions of their lampholder and measuring instrument lists. The list of lampholders covers a very great range of design, as in it are included all types that are made in Germany, and also those which have been standardised from time to time by English manufacturers. One feature in the list which we do not remember to have seen before is a lampholder specially designed for damp positions, and which can also be used under water. In this holder a complete porcelain covering is provided, which renders the live metal absolutely secure against moisture. Another feature of the list is the lampholders used for stage-lighting. Three types of these are illustrated, in which the holder is mounted on a porcelain base through which the main conductors can be passed. In this way each holder in the footlight acts as a guide to the conductors, isolating them one from the other. On the last page of the list will be found the adjusted lampholders with standard Edison screw sockets, which are devised with the object of preventing lamps of a higher candle-power than arranged for being inserted. These holders are, of course, only required where the light is given on a flat rate of so much per 16-c.p. lamp per annum. In the list of measuring instruments sent us by the same firm, we find included the various ampere-meters and voltmeters which have for so many years been the standard types of the Electrical Company. Following on to these is a complete series of instruments, in which the induced eddy currents in a light pivoted disc and in a metal

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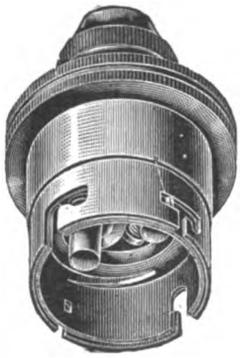
screen are so made to interact as to give the readings required. These instruments are wonderfully dead-beat, and the list is devoted to instruments for special purposes for use in workshops and laboratories. It is quite worth while for every electrical engineer to have this list by him when he is working out any new testing apparatus.

We have received from the General Electric Company, Limited, a copy of their March "Progress" sheet, in connection with which special attention is drawn to their new high-voltage wall socket with "lined chamber" fuse; their "quick-break" tumbler switch, with protecting wall of porcelain; and their new "anti-vibration" holder, for use on traction systems and in theatres, etc. With regard to the last-mentioned speciality, it will be seen from the accompanying illustration



that the holder is similar to the firm's usual bayonet-cap type, except that it is provided with an additional interior ring having a small projection engaging in a bayonet catch. The lamp is inserted in the usual way, and is automatically locked by the inner ring. This holder is strongly recommended for car, street, train, ship, and mill lighting, colliery installations, or any position where the lamps are subjected to vibration. Moreover, the anti-vibration holders enable the lamps to be cleaned without fear of their falling out, and are, therefore, eminently adapted for service in footlights and battens of theatres especially. In view of the rapid growth of electric traction in this country this type of lampholder should prove of considerable value.

Messrs. Geipel and Lange have taken up the sole agency in this country for the Ward-Leonard rheostats and circuit breakers, and have recently issued a complete trade list of the same. In looking through this, one is struck by the great diversity of pipes which the firm are now stocking as standard types, and which are applicable to every conceivable requirement in motor control. It is impossible in the space at our disposal to deal with these types individually, and we therefore propose to indicate certain features which are found in almost all of them. One of these features is that the circuit of the motor is never broken on the regulating contacts. Instead of this, a subsidiary contact is provided, at which any slight arcing there may be takes place. This subsidiary contact is also operated in the event of the current in the circuit exceeding the predetermined limit. In a number of these circuit breakers the starting arm is held in the "full-on" position by an electromagnet in the shunt field circuit of the motor. In the event, then, of the supply being discontinued, this lever is released, and springs back into its original position. Of course, in doing so it has not to interrupt any current. The circuit is thus broken by an independent arm in the event of over load, which combination prevents any damage being done to either the motor or starter. The Ward-Leonard rheostats now being supplied by Messrs. Geipel and Lange consist of resistance wires secured on to an iron base by means of enamel. The iron base is made with radiating fins in order to get rid of the heat which is generated in the resistance wires, and in this way the makers are enabled to get into a small space the wires required for regulating the motor or dynamo. We gather, however, that the design is not strained, as the radiating surface provided is about 1in. for every 2½ watts lost in the resistances. The enamel protects the resistance wires from oxidation. Of course, the success of this type of rheostat entirely depends on the enamel, which must allow of the expansion of the resistance wires with heat without cracking. It must also be of such a nature that the heat does not make the cover soft enough to deform. In both these qualities the Ward-Leonard rheostat enamel appears to be most successful. Another feature standardised by the firm is the Ward-Leonard resistance units, which consist of wires of high resistance and of low temperature coefficient, which are wound on to porcelain tubes. The wire is then cemented on to the tubes by means of enamel, which prevents oxidation and also prevents the adjacent layers of the spiral coming in contact. The porcelain tubes are open at the ends, which, of course, increases the radiating properties, as it allows a through draught to pass up the centre of the resistance spiral. These units can be obtained for a great variety of currents and with a corresponding variation in resistance. For instance, with a spiral and a porcelain tube 3½in. long and ⅜in. in diameter, the first unit listed is 700 ohms resistance, and will stand a maximum current of about one-third of an ampere. A range of 12 of these resistances ends up with one of only 15 ohms resistance, and through which 2·17 amperes can be passed without damage. A second list of the same size continues the range down as low as 0·15 ohm, with a maximum current of 21·7 amperes. It will be a great convenience to electrical engineers to be able to buy at a uniform rate resistances of such a durable character, from which any combination required can be quickly made up. The list of rheostats and circuit breakers is completed by a number of special starting gears such as are required for driving printing machinery and other special applications of electric motors.

From the Dermatine Company, Limited, 95, Neate-street, London, S.E., we have received a copy of the Dermatine price-list for 1901, which contains a considerable amount of information about the goods manufactured from the material in question, including belting, driving bands, air-pump valves, joints, washers, hydraulic cup rings, hose, etc. Dermatine, we are told, consists of a combination of gums and chemicals treated specially and vulcanised much in the same way as indiarubber. It is stated to have been tested all over the world for many purposes against indiarubber, and, particularly in hot climates, found greatly superior, especially in regard to its lasting qualities. But the special feature of the catalogue consists, perhaps, in the maps which it includes to show the districts throughout the world where raw rubber is collected.

LEGAL INTELLIGENCE.

WIRING CONTRACTORS' RESPONSIBILITY.

In the City of London Court on Friday last, before the deputy-judge and a jury, an action of much importance and interest to the electrical trade was disposed of, it having been remitted from the High Court. The claim was made by the Electrical and General Engineering Company, 17, Gracechurch-street, E.C., to recover the sum of £111 1s from Mr. Albert J. Aitkens, Fernwood, Camden Wood, Chislehurst, for work and labour done in installing the electric light at his house.

Mr. Turner, counsel for the plaintiffs, said that the defendant had paid £95 of the sum claimed, but now that the action had come into court the defendant not only refused to pay the balance, but had set up a counterclaim, in which he asked to be awarded £100 for defective workmanship of the plaintiffs'. The defendant was the brother-in-law of an architect named Knight, for whom the plaintiffs had done work on several occasions, and in that way he was introduced to the plaintiffs, because he wanted to have the electric light installed into his house at Chislehurst. The order was given, and a specification was supplied for installation in September, 1899. The plaintiffs suggested that the wires should be carried in enamelled steel tubes, as by using them there would be greater protection from injury. An increase in the price of 25 per cent. was made for that. The work was commenced in October, but it was not completed until early in January because of building alterations which were going on in the defendant's house. At last the electric light was duly installed, and when it was finished the plaintiffs in March sent in their account. Then the defendant commenced to make a long list of excuses why he should not pay their bill. He complained that there was a leakage of the current, but that was due to the dampness of the house. The main was put into the cellar, which was very damp, indeed, and, in fact, the house reeked with dampness during the whole of the time that the plaintiffs were fitting up the light. The condition of the switches alone showed that there was a leakage of current through the dampness. The defendant complained that he could not turn out the light in the hall, and that it had to burn night and day. Afterwards, he complained that he could not get the hall light to burn, and that the billiard-room was in darkness. The plaintiffs' men went down and they found a considerable quantity of surface leakage, but it was all caused by the dampness. They found that the tubes had been damaged by the defendant's builders, and in the vestibule they took out a wire which had been injured while some floors were being put down. Fresh pipes were put in, and the work was left in a thoroughly complete state. There was no cause for the defendant's complaints, and they ought not to have been made.

Mr. J. A. Bower, who said he was one of the plaintiffs, stated that all the work sued for had been carried out under his personal supervision. He was not at Chislehurst the whole time that the work was being done, because he had to go into the country on other business. Their contract required that they should instal the light to the approval of the electric lighting supply company at Chislehurst, as well as the fire insurance companies. Both of those bodies had approved of his work, and the light was supplied after the approval so given. In cross-examination, he said he did not know that the electric current had been escaping all over the defendant's house, to put it generally. He was surprised that the defendant could not use the water in the lavatory because of the electric shock which anyone received upon putting their hands into the water. If there was such a shock, it would not be dangerous. The defendant told them about it, and they immediately sent to rectify it. It was not true that the work

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was done inefficiently, or in an unworkmanlike manner. They had not infringed the rules of the supply company by leaving wires which were uncovered. If the supply company said the installation was at the present time dangerous to their own mains as well as to the lives of the people in the house, it would not be true. The house had been sweating in a marvellous manner, and when he was down there on Monday last the place absolutely tasted of dampness, and the walls were wet. They did not use brazed tubes, but tubes with open joints. The damp could not be excluded from the tubes containing the wires, because it was necessary to leave open spaces. He did not know that they had neglected to put any insulation between the main switchboard and the wall. When he entered into the contract he had no idea the place was so wet. On the previous Monday, when he tested the electric light, he found it was quite satisfactory. The house had had a chance to dry lately, and the lights all over the house were satisfactory, except that the basement was wet. They could have supplied moisture-proof tubing instead of the enamel steel tubing, but the difference in price would have increased the expenses by 50 per cent. If the fire insurance companies had anything to complain of in the defendant's house, it would only have been fair to have given them a chance of remedying any defects, if they existed. The tubing which he used was of the best kind, and of the sort which was generally found in houses. There was a better class of tubing, which had no joints in it and which was lined with insulation, and it would cost three times more than the kind used. The defendant could have had this insulated steel tubing, but that was a fad more than anything else. Their work was delayed to some extent, but that was because the defendant's building operations were interfered with.

Mr. L. Schram was also called to speak to the work being carried out properly. The cause of the leakage was excessive wet and moisture. The test which he made quite recently was satisfactory. There was no ground for suggesting that naked wires were put under the drawing-room floor. The electric light had been in use for 18 months now. The reason he did not use tubing with brazed joints to exclude the moisture was because it was not specified for. He did not know that the rubber round the wires had in some instances burned away in consequence of the electric current escaping. They did not take any exceptional precautions to provide against dampness.

Mr. Frederick J. Bewer was also called, and he said he had had 10 years' experience as an electrician. The work was carried out under his supervision, and wherever it was unsatisfactory it was on account of dampness. The wire which was used was insulated with vulcanised rubber.

Mr. Henry C. Hall, A.I.E.E., arbitrator to the London Chamber of Arbitration, said he acted for the City of London Electric Lighting Company and other large concerns as an expert. He had spent five years in the manufacture of rubber, and he was of opinion that the rubber covering on the wire used by the plaintiffs in the defendant's house was of the highest class used for house purposes. There was no remedy for the leakage which had been complained of. It was impossible to prevent it. If the plaintiffs had contracted to fix up an impossibility, that was no affair of his. The only way to get rid of the condensation was to dry the place, and then it would disappear. The best materials were used in fitting up the electric light at the defendant's house.

For the defence, **Mr. Colam** said the complaint which the defendant made was a very serious one, indeed. The inconvenience to which he had been put was also very great. The defendant had had to pay for a vast amount of electric current which had been wasted in consequence of the very defective way in which the plaintiffs had installed the light into his house. No one would ever be able to tell the extent of the defendant's loss, because the electric current had been escaping all over the house. The defendant had never had given to him the supply that the plaintiffs had contracted to put in. At the present time the defendant had only a partial supply. The supply company would not run the risk of allowing the defendant to leave on the current during the night, and he was compelled to shut it off during the greater part of the day. It was only in the evening that the defendant was allowed to use the light at all, and then only for limited hours. The great charm of electric light was the convenience of it. People did not have it entirely because it was much a more brilliant light, so much as for its convenience in being able to switch it on and off at a moment's notice. The defendant had been deprived of that convenience simply because of the plaintiffs' gross neglect. Furthermore, the defendant was still uninsured because of the possibilities of fire, because the installation of electric light had been carried out so badly that the fire insurance companies thought the risk too great to accept. The defendant now counterclaimed for damages for the plaintiffs' bad workmanship, and he asked the court to give him something to cover his risk of non-insurance. It was very likely that difficulties would still arise, and all in consequence of the careless way in which the plaintiffs had done their work.

The **Jury** here intimated that they only wanted evidence about the plaintiffs having failed to comply with the supply company's requirements and the fire insurance company's stipulations.

Mr. Fricker, of the firm of Fricker, Miller, and Co., said he was a member of the Institution of Electrical Engineers, and adviser to the London, Liverpool, and Globe Insurance Company. He was requested by the insurance company to inspect the defendant's premises on Jan. 30 with a view to insuring them against fire. Their rules had not been complied with, and he could not advise the company to accept the risk. Directly the main switch was on there was a dead earth. That was very serious, and it might be dangerous to life or cause a fire. In his view it was not all due to dampness, as suggested, but because of the imperfect material which the plaintiffs had used. Open-jointed pipes had been laid in plaster work, and that was an improper thing to do. He did not notice that the house was particularly damp, as had been alleged, and, in fact, the cellar seemed rather dry. The insulation had not been properly fixed, and the work was by no means high class. The wire was not the best that could be furnished. Wire enclosed in damp plaster ought to be put in hermetically-sealed conduits.

Mr. F. S. Hanning, an electrical engineer of the supply company, said he inspected the work in question. They had supplied the electric current to the defendant's house, but their requirements had not been complied with by the plaintiff company. There was considerable danger attaching to the way in which the plaintiffs had done their work, and the defendant only had a limited use of the light. They could not tell when a short-circuit might take place. There had been short-circuits.

The **Jury**, in giving their verdict, said they were of opinion that the plaintiffs were not entitled to any more than £95 which had been paid them on their claim, and on the defendant's counterclaim they awarded him £25 damages, and judgment was entered accordingly.

FORTHCOMING EVENTS.

FRIDAY, MARCH 8.

Physical Society.—At 5 p.m., meeting at Burlington House. Papers: "A Theory of Colloidal Solutions," by Dr. F. G. Donnan; Exhibition of Apparatus, by Mr. R. Appleyard; "On the Production of a Bright Line Spectrum by Anomalous Dispersion and its Application the 'Flash Spectrum,'" by Prof. R. W. Wood. Council meeting at 4 p.m.

Royal Institution.—At 9 p.m., discourse on "Vitrified Quartz," by Mr. W. A. Shenstone.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Sewage Treatment," by Mr. Chas. Johnston.

British Insulated Wire Company.—At 6.30 for 7 p.m., annual dinner, Adelphi Hotel, Liverpool.

SATURDAY, MARCH 9.

Royal Institution.—At 3 p.m., "Sound and Vibrations," by the Right Hon. Lord Rayleigh (Lecture III.).

Institution of Junior Engineers.—At 3 p.m., visit to the Southall station of the Brentford Gas Company to inspect the carburetted gas plant, etc.

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "The Progress of Electricity Supply," by Mr. J. G. Scott.

MONDAY, MARCH 11.

Society of Arts.—At 8 p.m. "Electric Railways," by Major P. Cardew (Lecture I.).

Institution of Electrical Engineers (Newcastle-on-Tyne Section).—Ordinary meeting.

Sanitary Institute.—At 7 p.m., lecture on "Ventilation, Warming, and Lighting," by Prof. T. Roger Smith.

TUESDAY, MARCH 12.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "The Æsthetic Treatment of Bridge Structures," by Mr. Jos. Husband.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. "The Adaptation of the Steam-Engine to the Generation of Electrical Energy," by Mr. J. S. Raworth.

Board of Trade.—Adjourned enquiry into the application of the Electric Lighting Companies to increase the standard pressure of supply.

WEDNESDAY, MARCH 13.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., extra meeting. Paper: "Distribution of Energy in Coal Mines," by Mr. F. E. Pring.—Glasgow Section: At 8 p.m., ordinary meeting.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the Millbank-street pumping station of the London Hydraulic Power Company.

Society of Arts.—At 8 p.m., ordinary meeting. "The Proposed Electrical 'Monorail' between Liverpool and Manchester."

Parochial Institute.—Mr. C. N. Russell will read a paper on "Refuse Destructors."

THURSDAY, MARCH 14.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. If the discussion on Mr. O'Gorman's paper is concluded the following paper will be read: "Some Notes on Polyphase Sub-station Machinery," by Mr. A. C. Eborall.—Students' Section: Visit to the works of the Incandescent Lamp Company announced for this date will not take place.

FRIDAY, MARCH 15.

Institution of Mechanical Engineers.—At 8 p.m. ordinary meeting. Paper on "Combined Trolley and Conduit Tramway Systems," by Mr. A. N. Connett.

SATURDAY, MARCH 16.

Royal Institution.—At 3 p.m., the Right Hon. Lord Rayleigh on "Sound and Vibrations" (Lecture IV.).

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ELECTRIC POWER FOR WEST AFRICA.

Such is the title of an article in the *Financier and Bullionist* of Tuesday last, suggesting a power transmission scheme for the economical working of the gold mines on this coast. That electrical transmission has a great future in Africa there is no doubt, but the promise is only first rate when water power is available. We are not going to criticise too closely the statements and figures of the article, though it will be necessary to indicate that the true conditions of the case are not considered, and the estimates are a little rosy. The writer correctly states that "electric power can now be generated and economically transmitted one hundred miles," and then points out the advantages as regards transport and labour that would arise with a generating station at the coast. A weak point comes in when it is assumed that "the power would be reliable and continuous, breakdowns would practically become things of the past." Aluminium conductors, instead of copper, are suggested, and the distance of transmission fifty miles from the coast. If the conductors were overhead, maintenance would be very difficult for many reasons, not the least of which would be the tendency of the natives to get at the metal. The author evidently intends the cables to be overhead, because he states that the lighter aluminium will require less poles. It is certain that some deaths would occur with a pressure of ten thousand volts and pilfering natives; this might frighten the latter. On the other hand, it might exasperate and greatly affect the political situation. We doubt, indeed, if the politicians would in the present state of affairs permit of overhead transmission, and underground transmission is probably impracticable. A more important point, however, in considering the suggestion is, assuming the success of mines only fifty miles from the coast, whether it would not lead to the early construction of a railway to the scene of operations. If so, would it not be much better to erect a central station on the field and distribute around. At the present moment the contour of the district is not before us, so that the cost of a railway cannot be estimated; we assume its practicability. With a railway—and it might be an electric railway—the transport difficulties would be solved, and it would be easier to guard the conductor of an electric railway than the conductor through a virgin country. The question of labour also would present fewer difficulties, in that the coast would be easy of access. The estimated cost of erecting and equipping a station to supply 1,500 h.p. at the point of consumption, together with working capital to run for a year, is £110,000 + £35,000 = £145,000. The working costs are estimated at £34,250, hence the above allowance of £35,000. Allowing for a working year of 3,500 hours, 1·56d. is the estimated cost "per horse-power hour for energy given off at the mines," and if sold at 3d. per horse-power the profit would be over £31,000 a year. This, of course, would be an excellent scheme if the conditions were altogether favourable, but, as previously indicated, they are somewhat doubtful. A mere transmission

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plant would not help the transport of machinery or supplies; and if success comes, these must be considered. If "Jungles" turn out another Rand scene of operations, a railway will become a necessity; hence we suggest caution.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE LONDON COUNTY COUNCIL TRAMWAYS.

SIR,—Your correspondent, "Pro Bono Publico," quotes the first half of a certain paragraph, and in it puts italics which are his. Allow me to quote the second half of the same paragraph, and to use italics which are mine:

"... *it is doubtful if there will really be much saving, for the extended yoke need not be rectangular (as shown in Fig. 7), but can be of the more commonly employed triangular shape (as in Fig. 9), which is an illustration of one of the New York tracks.*"

"Pro Bono Publico" says he quoted the paragraph to show that there are other considerations besides those of ingenious design and elaborate machinery. His meaning is not clear, unless he means that the London County Council conduit has the one advantage of small size. In other words, the advantage would be in the small amount of road excavation necessary for the laying of that conduit, but I had shown the advantage of a system which required *few* repairs.

More than all the excavation saved in the beginning with the London County Council conduit will be made afterwards in repairs. There are 13 years of experience with conduits which prove this. It is not less than amazing that such a question should be raised at this date. Men have not made conduit yokes heavy for any reason more subtle than this: that the lighter forms of yokes proved unworkable.

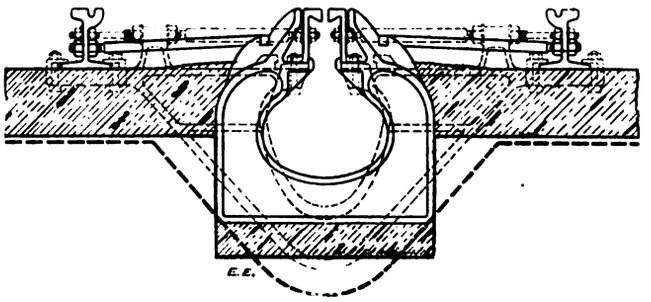
And it is not alone the lightness of the London County Council conduit to which experienced men will object; it is to the bad design throughout. First of all, it is bad engineering to lay the rails independently of the slot-rail yokes. The inadequate stay-bolts in the London County Council track can be of no avail, and of what advantage is it that less excavation be made in the beginning, if afterwards the slot closes up tight on the contact plough, and the passengers have to walk? The slot does close up. At 6,000lb. per square inch the London County Council slot closes an eighth of an inch. It ought to resist 20,000lb.

If engineers form themselves into national cliques so that, for example, a Bulgarian will never use a certain cylinder oil because it is Roumanian, we shall soon have more than enough nationality and too little progress. This is happening, not in the Balkans, but in England, and all over this miserable affair of a conduit. Is it worth her while to fight over such a matter? I mean, is it worth a little corner of her pride to fight against the *via trita* of successful experience?

Someone in the *Electrical Review* of Feb. 22 has been making a skirmish of that kind. He would defend the conduit of the London County Council by asking much begged questions which he himself decimates. But after all he fails to champion that which he damns by the inevitable faintness of his praise. It would be an injustice to the designer of the London County Council conduit to suppose that his high reputation depends upon the worth of that device. And no one need champion him by the defence of other numbers of his works than those which have added undoubted elements to the industrial progress of Great Britain.

At all costs the electric tramways must work without a hitch. A failure in the beginning will do more harm than a thousand excessive excavations which might for some weeks annoy the gentle omnibus driver. But no one proposes such excavations.

An actual discussion of the comparative amounts of excavation has not been entered upon because that question stands far to the side of the *sine qua non* in London traction. However, for the benefit of the few who cannot help seeing a paramount importance in a tertiary consideration—viz, excavation—I give a drawing which shows the facts.



The full lines show the London County Council yokes and conduit. The dotted lines show one of the many conduits which have worked with perfect success. One may compare the excavations and the concrete.—Yours, etc.,

M. B.

P.S.—"Pro Bono Publico" loves chaff. Tell him that I shall try to feel the flattery which he intimates when I note the charming attention symbolised by the use of granite in England. He bids me consider the motto, *Via trita, via tuta.* My Latin, as one says, is not what it used to be. But it can stand the strain of *tritus* and *tutus.* Am I to read, "*The beaten path is the safe path*"? Impossible! "Pro Bono Publico" is but turning humour on himself. Surely the grey matter is on the wrong side of his venerable skull. It is the *via trita* I have recommended; the beaten track, the tried thing; not the new conduit. When in the wet spring of 1893 I sailed for the last time out of the Bay of New York, the sound of the exploding conduits brought tears to my eyes. I would ask "Pro Bono Publico" to leave me this memory of my race, and to bring it not too prominently into the glare of a great public controversy.

THE LATE PROF. G. F. FITZGERALD, F.R.S.

We regret that pressure on our columns prevents us giving a detailed obituary notice of the late scientist, who was president of the Dublin Section of the Institution of Electrical Engineers, but no remarks from us could better express our sense of loss than the following references made at the parent Institution last week. Thus before the commencement of the ordinary business of the meeting, Dr. Perry called on Prof. Ayrton.

Before the commencement of the ordinary business of the meeting of the Institution of Electrical Engineers on Thursday week some sympathetic references were made to the recent death of Prof. G. F. Fitzgerald, late chairman of the Dublin Section of the Institution.

Prof. W. E. AYRTON said he rose to propose no ordinary vote of condolence, for in expressing in conventional form the sincere regret that this Institution felt at the death of the chairman of its Dublin Section, he desired rather to give voice to their deep grief and sorrow at the loss of the dear friend of many and the willing helper of them all. To some of them, perhaps, Fitzgerald was but a name—and why? Because his life's work was that of inspiration—inspiring others. He gave them his ideas; aye, he even explained to them the real meaning of their own. Science to Fitzgerald was what religion is to the highest type of priest—not a thing to be used to increase the status or the wealth of its exponent, but a great good to be poured forth without reference to reward or even to remuneration, for the benefit of man and of the world. Singularly free from human importance, singularly fertile in suggestion on all subjects, was their dead comrade. He knew his worth, but never claimed it. He knew his power; but whenever he used it was for them, for him, for science, to secure intellectual liberty, but never to secure position for Fitzgerald. And yet for him abstruse mathematics had no difficulty, complex physical processes no obscurity. He seemed to be able to follow the interaction of physical molecules more than they could grasp

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the working of visible machines. Only that day he (Prof. Ayrton) was looking at two letters from Fitzgerald—one which reached him on the very day that Duddell read his paper in that room in December, and the other a few days later. Every line breathed suggestion, encouragement, criticism, modification. These two letters were little treatises of the theory and possibilities of Duddell's device. Single-minded, simple-hearted, he died as he had lived, respected, honoured, beloved.

Major-General WEBBER also paid a high tribute to the memory of Prof. Fitzgerald. He could trace his descent back to the time of the Normans, and there was no doubt that the brain tissue was strengthened and brought down to him through generations of strong and powerful men. Not only was Fitzgerald strong, but he was entitled to be called gentle.

Prof. S. P. THOMPSON wished to add his voice in expressing their condolence at the loss of one who was so dear to them, and so helpful to every worker in science who had the fortune to come across him. In Germany they deplored the fact that there was not more combination in the efforts of scientific men such as was the custom in England. If there was one man who was more helpful than another in that work, it was Fitzgerald. They ought not to forget what a very important part Fitzgerald's ideas played in the discovery of the propagation of electric waves. Fitzgerald had read papers before the British Association, and predicted the properties of these waves on the lines of Maxwell before even the researches of scientists had resulted in the experimental methods of exploring electric waves. One of the suggestions for a coherer for detecting waves was made by Fitzgerald himself. In thousands of ways he helped others to carry out ideas which he himself could not possibly develop for want of time, and so gave them to the scientific world. Even in the work of examining candidates for their degree in physics at the University of London, he was as kindly and helpful and as fertile in ideas as any man could be. There were few in any walk of life that could claim the ability which Fitzgerald had, and there were none who surpassed him in kindly help to others.

The PRESIDENT said that at the inaugural meeting of the Birmingham Local Section the night before he had said what he had to say on this subject. He had attended the funeral of the late Prof. Fitzgerald as representing the Institution.

The following resolution was then passed in silence, each member standing in his place: "That the Institution of Electrical Engineers in full meeting desires to express its profound sorrow at the death of Prof. George Francis Fitzgerald, and to place on record the high appreciation of his brilliant qualities as a man, as an investigator, and as a leader of scientific thought; and to express to Mrs. Fitzgerald and his family its heartfelt sympathy in the calamity which has fallen on them and on science."

ELECTRIC LIGHTING ENQUIRY.

Question of Increased Pressure.

At the Westminster Town Hall on Friday last, Sir Courtenay Boyle, permanent secretary to the Board of Trade, opened an enquiry into the application of the electric lighting undertakers in general that the proviso to Clause 6, Section B, of the regulations made by the Board of Trade on March 4, 1896, might be so altered as to take away the right of consumers to object to an increase of the standard pressure of supply.

The counsel engaged in the enquiry were: Mr. Balfour Browne, K.C., Mr. Roger Wallace, K.C., and Mr. D. Warnington, for the Westminster Electric Supply Corporation; Mr. Moon, for the Chelsea Electric and the Metropolitan Electric Companies; Mr. Roskill and Mr. A. B. Cane, for the City of London Electric Lighting Company; Mr. Littler, K.C., for the Windsor Hotel and the Junior Constitutional Club; Mr. Alfred Lyttleton, K.C., and Mr. Talbot, for the London County Council; Mr. R. C. Glen, for the Paddington Borough Council; and Mr. Danckwerts, K.C., and Mr. A. J. Walter, for the City Corporation. A number of local authorities were represented, Mr. John Bowers, town clerk depute, representing the Glasgow Corporation in support of the application.

The PRESIDENT explained the object of the enquiry to be as stated above.

Mr. BALFOUR BROWNE said he not only appeared for the Westminster Electric Supply Corporation, but also on behalf of several local authorities. He proposed to state the case of the Westminster Corporation first. Under the Electric Lighting Act of 1888 the company applied for a provisional order. The Board of Trade then held an enquiry as to the questions involved, and one of the principles laid down in the report, which had been very often acted upon since, was that competition was in favour of the public, and that the best competition the Board could see its way to sanction was competition between two companies supplying two different kinds of energy—one alternating and one continuous current. An order was granted to the Westminster Company in 1889, and Section 10 provided that energy was to be supplied by means of a system approved by the Board of Trade and subject to such regulations and conditions for securing the safety of the public and ensuring a proper supply of energy that the Board of Trade might from time to time impose. In July, 1890, the company submitted a system to the Board of Trade, which was sanctioned on Sept. 4 the same year. This was a low-pressure continuous-current three-wire system. The same month the Board of Trade published their regulations in accordance with the section to which he had already referred. The most important of these regulations was that with regard to the fixing of the standard pressure of supply by the undertakers, which ran "Such constant pressure shall not be altered, except by permission of the County Council, and upon such terms and conditions as the County Council may impose, and after public notice has been given." Then there was a provision that if the company were not satisfied with the decision of the County Council they might appeal to the Board of Trade, whose decision was to be final. The learned counsel said that, as he understood it, the regulation just referred to was made for the express purpose of guarding the rights of the public. It was a perfectly sufficient protection for the public, but the regulation which afterwards took its place was no protection at all, and allowed one or two consumers to block and interrupt a proper supply of energy to a very large district in London. Regulation 6 provided that the undertakers were to declare the constant pressure at which they proposed to supply energy, which was not to be greater than 115 volts and not less than 45 volts. The seventh regulation provided that the variation of pressure at the consumer's terminals should not exceed 4 per cent. Under these regulations the Westminster Company commenced supplying energy in 1891, and in accordance with Regulation 5 they fixed their standard pressure at 100 volts. By the fourth schedule of the order, Section 1, they were entitled to charge 8d. per unit. The business of the company increased very rapidly. In 1891 they had 763 consumers taking 672,500 units, while to-day they had 5,500 consumers taking 7,000,000 units. Accordingly, they were able to and did reduce the price, until to-day it stood at 6d. per unit for the first 4,000 units, and 4d. for every unit in excess of that figure. This represented an average charge of 4¾d. per unit, which was only 57·4 per cent. of the authorised price. The method of supply to consumers which was chiefly adopted was by means of an agreement terminable on either side by one month's notice. It must not be forgotten that in this district the public were not entirely dependent upon one company, as there was a competitive company to whom they could go if dissatisfied. The Board of Trade had from time to time, said the company's counsel, power to alter and revise their regulations, and in 1895 they exercised this power. One of the chief points to consider was the question of allowing the use of a higher voltage than 100, and in November of that year the Board of Trade held a conference, presided over by Sir Courtenay Boyle. The result was that many of the existing regulations were revised and altered. A question, however, arose as to the definitions of the terms "high pressure" and "low pressure," and when the conference arrived at the consideration of Regulation 6, providing that the undertakers were to declare the constant pressure, the discussion was postponed, the president intimating that it depended upon the true definitions of these terms. Subsequently the Board appointed a committee of experts, consisting of Lord Kelvin, Sir Wm. Preece, and Major Cardew, to consider the question of pressure, and on their recommendation 250 volts was fixed as the highest limit for a low-pressure supply. The following regulation was then made: "No change shall be made in the pressure of the supply to any premises except with the consent of the consumer." It was to this clause that the companies now objected. When the Westminster Company began to supply energy they were advised by exceedingly competent engineers, and they were fully alive to the advantages of a 200-volt pressure, but at that time there was no 200-volt lamp which could be depended upon. The company accordingly adopted the 100-volt pressure. In 1896, however, they were again advised by Prof. Kennedy, and they saw that the time had come to alter the pressure, as being in the interests of the consumers, of the company, and of the local authority. In order that they might increase the pressure, they circularised their consumers, pointing out that they considered the change would be advan-

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tageous, and that the permission of the County Council to the alteration had been obtained. The result was that 5,500 consumers were to-day taking the 200-volt pressure with the exception of eight. In these circumstances they had, under the present regulations, to go on supplying eight customers scattered over a large area with energy at 100 volts, and this cost the company a great sum of money. As they had the right to charge 8d. per unit they had charged these eight consumers the full price, and even then it was at a loss. Instead of going to the other company, they insisted upon still continuing to have their energy from the Westminster Company, and they also insisted that if the change from 100 to 200 volts was to be made, they should dictate what should be done and what should be paid them. The large bulk of the consumers were satisfied with the 200-volt pressure, and the change had been made entirely at the company's expense, having cost them already £45,000 in the houses of the consumers. What some of the opponents seemed to desire was not that the change should be made on fair arbitration terms, which the company were quite willing to accept, but they wanted to dictate what was to be paid them on account of inconvenience caused by the conversion. And the company resisted.

The PRESIDENT: Have the company offered arbitration terms at their expense?

Mr. BALFOUR BROWNE said he was told no such offer had, in fact, been made. The company, however, had been exceedingly fair in the matter. He was prepared at this instance to offer arbitration terms, the arbitrator being appointed by the Board of Trade or the Local Government Board. The proviso the companies proposed in place of the one now existing provided that "no change shall be made in the standard pressure of supply except upon such terms and conditions as may be agreed upon between the undertakers and the consumer, or, failing agreement, as may be settled by an arbitrator to be appointed by the Board of Trade." The first of the objectors was the Junior Constitutional Club in the Mayfair district, of which Mr. V. D. B. Cooper was the electrical adviser. They consumed 89,980 units in 1900. This was the only objector in the Mayfair district. The next was the Dowager Duchess of Sutherland, of Belgrave-square, her case being that she was afraid of getting a shock with the 200-volt current which would not be given by the 100-volt current. It would be explained later in the proceedings that there was no more danger from shock from a 200-volt circuit than from the 100-volt three-wire system. Mr. Todd, of Eaton-square, and Mr. Norman, of Belgrave-mansions, also objected, but gave no reasons. Then in the Westminster district the Hotel Windor objected. Mr. Cooper, again, was not only the electrical adviser, but he had an interest in the hotel as well. They consumed 68,505 units in 1900. Messrs. Sellon and Cooper, of the Broadway, and Prof. Forbes, of Great George-street, also objected. They consumed 70 units and 17 units respectively. The Westminster Company were now supplying seven million units to 5,500 people, and these eight were the only objectors. The advantages of the change from the 100-volt to the 200-volt pressure were these. In the first place, to all those consumers who had taken the 200-volt current a reduction in price of 8 per cent. had been made. Another advantage of the 200-volt pressure was that of economical distribution, and a great saving in the loss in carrying the energy to the consumers. With the 100-volt supply the loss was 12½ per cent., and the consumers had to pay for it. That loss could be reduced to 5 per cent. by the change-over to 200 volts, which would enable the company to supply energy at a cheaper rate. Again, owing to the increased capacity of the mains, there would be less frequent interruption and pulling up of streets. Besides that, there was the steadier and more efficient supply of energy with the 200-volt current. In the first place, the higher pressure would be an advantage to the company, and in 21 years there would be a saving in capital expenditure of £157,000, which they would have had to spend in additional feeders for the 100-volt supply. But, of course, against that must be put the £45,000 which they had already paid for the conversion of the lamps and fittings. There, however, would be a net saving of £112,000 in that period. One great effect of this was that when, at the end of 42 years from the date of the provisional order, the company came to be bought out, the less spent on capital the less the local authorities would have to pay. The loss of 5 per cent. in distributing the current would not go up again to 12½ per cent. until the company was nearly at the end of their tether.

The PRESIDENT asked why the figures had been calculated on a 21 years' basis.

Mr. BALFOUR BROWNE said that at the end of that time the company would have exhausted the capacity of the existing mains. It was thought by some people that by having a greater pressure they would be forced to use more energy in their lamps, but that was not the case. They had examined the accounts of the consumers both under the 100 and 200 volt supply, but no appreciable difference could be ascertained. Under these circumstances what was to be said against the change? Everywhere it was being carried out—St. Pancras, among other places. Bradford was the first town to adopt the 200-volt current with entire satisfaction to the consumers, while in Glasgow the majority of the consumers were being supplied at the increased pressure. Why, asked the learned counsel, should a few consumers have the power to prevent the companies doing this? He appealed to the Board of Trade to say whether it was fair. These eight consumers did not really object to the increased pressure; they were holding out so as to get all they could out of the company because the company would not come to Mr. Cooper's terms. It was a matter of public interest, and he would ask the president to say that the first regulation made in 1890, leaving it for the County Council to decide whether or not the change should be permitted, was a more reasonable one than the last made. The 1890 regulation left the public to be protected by the county councils, and, if necessary, by the Board of Trade, while the latter regulation left the companies at the mercy of the public. In the event of arbitration, he was perfectly willing that the question of the costs should be left in the hands of the arbitrator.

A discussion here followed as to the mode of procedure to be adopted during the enquiry, and it was eventually decided to deal with the general questions affecting the companies as a whole; any special points to be dealt with separately.

Mr. LITTLER, on behalf of some of the objectors, raised the point that, as the Board of Trade had given a vested right to the consumers to have current supplied at a pressure of 100 volts, that right could not now be taken away by the alteration of a regulation which was made with the consent of the company themselves. It was a condition precedent to the regulations being changed, and could not be altered except with the consent of the person directly interested. He must say he had the greatest respect for the Board of Trade, but——

The PRESIDENT: I am very glad to hear you say that, Mr. Littler, in view of some of the letters we have had from your clients. I do not think you would approve of some of the letters we have received from them.

Mr. LITTLER said he was not responsible for the action of his clients.

Mr. DANCKWERTS, for the City Corporation, who are opposing the application, pointed out that the power which the Board of Trade had was to make regulations "for ensuring a proper and sufficient supply of energy." To take away from private people the vested rights which they had, the Board had no power to do. What the companies were seeking to do was not to have an alteration in a regulation, but to take away the condition upon which the Board of Trade altered the regulations. The County Council and the Borough Councils of Lambeth and Paddington were supporting this objection.

Mr. BALFOUR BROWNE, in reply, said a proviso was either a regulation or it was not. If it were not, then the Board of Trade had no power to make it, and it was not binding; if it were, on the other hand, they had power to alter it.

The PRESIDENT ruled that for the purposes of these proceedings the Board of Trade had power to alter the proviso.

Mr. DANCKWERTS then raised the point that the question had been finally decided in 1896, and could not therefore be reviewed. In this case there was an appeal to the Board of Trade, and one of the conditions on which the change of pressure was permitted was the proviso now objected to.

Mr. A. J. WALTER also argued on the same lines on behalf of the City Corporation. If this point were decided in favour of the Corporation, they would retire from the enquiry.

The PRESIDENT said it was true the Board of Trade had given a decision on appeal, but he thought it was so probable that his advice to the Board of Trade would be that they could alter the proviso, and so do away with that particular appeal, that it was very desirable that the City should be represented throughout the enquiry.

Mr. WALLACE, who appeared with Mr. Balfour Browne, then proceeded to call evidence in support of his case.

Prof. A. B. W. KENNEDY, engineer-in-chief to the Westminster Supply Corporation, stated that in 1890 the system employed by the company was the three-wire system, the pressure used being 100 volts. It was in 1895 that it became possible to get lamps which would work at 200 volts, and it was then that he advocated the change in pressure to the Board of directors. He had made several tests with the 200-volt lamp, and he found that it compared quite favourably with the 100-volt lamp. With regard to the suggestion that there was danger from shock with a 200-volt current, which was absent in the 100-volt current, it was a mistaken impression. In the case of lamps at 200 volts used on a three-wire system, the Board of Trade had arranged that the middle wire should be definitely put to earth, so that in any consumer's house there was only a 200-volt pressure for anybody to get a shock from, as was also the case in a three-wire system at 100 volts. In very large premises, where both sides of the 200-volt two-wire system were taken in the wires were kept quite separate, and it was impossible to get a shock unless one went to certain protected places. A 400-volt shock was not par-

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ticularly harmful. He knew of no other alleged danger from the increased voltage. The risk of fire, in his opinion, was not more than with a 100-volt current. On the other hand, there were many advantages to be gained by the increased voltage. In 1896 he knew that the company's distribution losses were about 12½ per cent., and he calculated that with the change of pressure to 200 volts they could go on with the same mains for approximately 21 years before the losses came up to 12½ per cent. again. They would be at once reduced to 4½ or 5 per cent. In 1896 they were spending £7,500 per annum on new feeders, and accordingly he put the saving in feeders alone at £7,500 per annum for 21 years in the case of the Westminster Company. In general, there would be a very considerable capital saving, and he took it that if a company saved capital it was also an advantage to the statutory purchaser when the company's term was up. In the case of the Westminster Company, the consumers benefitted by the advantages gained in that the price of the current was reduced. The company had spent about £38,000 or £40,000 in the consumers' premises in providing new lamps and overhauling wiring and fittings, besides what they had spent in the power station. They had given them new lamps for old, and a reduction of 8 per cent. on the current charges. Taking it generally, the wiring in the consumers' houses had been improved. All over the country the increased pressure had been or was being adopted. There was no supply which had been laid on since 1897 on which lamps of 200 volts pressure or more had not been used. Owing to the opposition of the eight consumers on the wires of the Westminster Company, the shareholders of the company were suffering a distinct loss. Everything was ready to give them a supply at 200 volts pressure if they would only follow the example of the other consumers. The company would have completely changed over the pressure to 200 volts last year but for this opposition. In the event of only one or two consumers holding out great difficulties arose. It was necessary either to lay separate mains or put a rotary transformer at the terminals of the consumer who wished for the 100-volt current. This latter course was a very undesirable thing for a small private consumer, but comparatively simple in the case of a very large consumer. What the Westminster Company had done was to set apart certain of their mains for those consumers who would have the 100-volt supply. It was true that whenever the company made a saving it had shown a tendency to lower the price of the energy, so that the average price now charged those consumers who took the 200-volt supply was 4¾d.

Under cross-examination, Prof. Kennedy repeated that the change in pressure made absolutely no difference to the consumers so far as the light obtained for a given quantity of energy was concerned. The whole cost of the change was borne by the company. On paper the increased pressure would quadruple the capacity of the mains, but not in reality. He could not agree that a 200-volt lamp gave 33 per cent. less light than a 100-volt lamp for the same energy, nor was it the fact that the candle-power hours were infinitely less in a 200-volt lamp. An 8-c.p. 200-volt lamp could be set to run for 1,000 hours as specified by him, or else it would not be accepted, and if it consumed from 3½ to 4¼ watts per candle he considered it satisfactory. He knew of no disadvantages attaching to the 200-volt supply. Since it was possible to get a 200-volt lamp he had carried out the change for a large number of municipalities—Edinburgh and Oldham, amongst others. In these cases the fittings of all consumers were overhauled and replaced where necessary. In some cases it was true that the insulation used for the lower voltage had proved insufficient for a 200-volt supply. This should have been seen to, and also, he should think, a careful examination of the mains laid for 100 volts was necessary before the change was made.

The PRESIDENT asked whether there was not more risk of corrosion in insulating materials in a consumer's premises with the 200-volt current than with the lower voltage—whether with the 200-volt pressure there was not more risk of the wearing away of the insulating materials.

Prof. KENNEDY thought not. If the wiring had been put in for 100 volts and the insulation were really efficient, then the increase of voltage made no material difference. In answer to further questions put by Mr. Danckwerts, the witness agreed that it was as important to the supplier of energy as to the consumer that the fittings on the consumers' premises should be overhauled. The lampholders were just as safe with 200 volts as with 100. In answer to the question what advantage did the consumer get from the higher voltage, Prof. Kennedy said that, *per se*, he did not think the consumer got a direct advantage, but in the case where the consumer had been changed over from one voltage to another, he did get an advantage because the whole of his installation had to be overhauled and he was presented with new fittings and lamps. In the case of the Westminster Company he also got a reduction in price.

The PRESIDENT: Suppose the consumer deprives himself of having the 200-volt lamp, and continues on with the 100-volt lamp, what advantage does he gain?

Prof. KENNEDY did not think he got any advantage at all. With the 200-volt current the main advantages he got were new fittings and the reduction in price.

Mr. LITTLER here said he had already intimated his desire to come to some sort of settlement with the Westminster Company, although he could not compromise his clients by saying that they were in any way to blame. He had been discussing the question with his learned friend, Mr. Balfour Browne, and he thought it would be best if he postponed his cross-examination of Prof. Kennedy in the hope that some sort of settlement might be arrived at.

The PRESIDENT consented.

The WITNESS was then further cross-examined by Mr. Talbot for the London County Council, and Mr. Glen for the Paddington Borough Council. Prof. Kennedy, in answer to questions, said that if the Westminster Company had been able to reap the full benefit of the change to the 200-volt pressure, they would not have had to lay any more feeders for 21 years. The consumption of electric energy by a 200-volt lamp was no more than by a 100-volt lamp. He was aware that there was a difference of opinion on this matter. A single 5-c.p. lamp could be used with a 200-volt current, but he could not say as regarded a 3-c.p. lamp. It was the custom with these smaller candle-power lamps to run a number of them in series, in which case lamps of 100 volts could be used, or even less. This was largely done on the Westminster circuits. There was no difficulty in obtaining good and efficient lamps of 8 c.p. for the 200-volt circuits.

In answer to Mr. Roskill, for the City of London Electric Lighting Company, Prof. Kennedy could not say that the light given by a 200-volt lamp was superior to that of the lower-voltage lamp. There was no appreciable difference between the two.

Mr. JAMES HEALD, chairman of the Electricity Committee of the Lancaster Corporation, in reply to Mr. Wallace, said that the standard pressure of current in that town was 100 volts, but they now wished to increase the voltage to 200. The number of consumers was about 800, and these were spread over a fairly large area. He quite agreed with Prof. Kennedy as to the advantages of the 200-volt current over the lower voltage.

Mr. W. A. CHAMEN, electrical engineer to the Glasgow Corporation, was the next witness. Examined by Mr. Wallace, he stated that the area taking the Corporation's supply was about 28 square miles. The system adopted was the three-wire system with 250-volt lamps on the consumers' premises. The horse-power of the generating station in Waterloo-street was 3,300. In 1893 the voltage they commenced with was 100 volts on the three-wire system, making 200 volts altogether. Since then two other generating stations had been put down, and the Corporation had spent altogether over £800,000 on the undertaking. The voltage that was allowed by the regulations at the time the provisional order was granted was 115 volts. In January, 1897, however, the Corporation gave an intimation to the consumers that the standard pressure would in future be 250 volts, permission having been obtained from the Board of Trade to the change. Since then the Corporation had taken over a very large number of the consumers to the 250-volt pressure, and had not yet finished operations in this direction. Only four cases of difficulty had as yet been met with, one of which was absolute refusal to take the increased voltage. The others were cases of extortion. They did not expect any further trouble except from about a dozen consumers. These objectors would either have to be supplied by separate mains, or the pressure would have to be reduced at the consumers' terminals by means of motor-generators. The latter was a most unsatisfactory arrangement as the transformer required daily attention, and this was not a thing that could be put up with. In one particular case of opposition it had cost the Corporation £150. The transformer was attended to every day by the butler of the house, but the Corporation had to send a man once every week to examine it. Up to the present they had spent about £23,000 on the change, in alteration to fittings on the consumers' premises and in new lamps.

In answer to further questions, witness said he decidedly thought it was a fair matter to be left to an arbitrator to decide what money should be paid to the consumer, but he was sure in the majority of cases arbitration would not be necessary. The total consumers on the Corporation's main were 3,500, of which 2,150 were being supplied at a pressure of 250 volts, and the remainder, numbering 1,350, were taking the 115-volt current. However, 460 of these were already prepared for the change, leaving 890 still to be dealt with. As to the advantages of the higher voltage, he quite agreed with what had been said by the previous witnesses. There was no trouble or worry to the consumer in consequence, and as to the pulling up of the street, etc., the higher voltage saved this to a considerable extent.

Under cross-examination, witness admitted that in the case of Glasgow they were able to change the voltage practically without leave, as the Corporation was the local authority. They asked their own permission, in fact. They had a similar proviso in their order as in the case of the Westminster Electric Supply Corporation. The average cost of the change of pressure

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was about £20 a consumer. Last year about 15 per cent. of the energy could not be accounted for. This year the loss in the mains was only 5 per cent. Asked whether when the light was bad in those places where the change had not been made, witness said that where the 250-volt current was used nothing of this sort was experienced. It was impossible to maintain a constant pressure with 100 volts, but easy with 200 volts. One reason for this was that the loss in the 100-volt mains was so much greater than with the higher pressure. A very distinct advantage accrued both to the supplier and the consumer by the use of the increased voltage. The lamps used at Glasgow were of the Robertson, Edison and Swan, and Stern makes. They lasted just as long as the 100-volt lamps with the exception of one particular make. The consumption was about four watts per candle in both cases. In reply to Mr. Roskill, witness agreed that the saving in price and the more uniform supply summed up the advantages of the 250-volt pressure.

At this stage the enquiry was adjourned till yesterday.

This conference was resumed yesterday, when further important evidence was taken, which we propose to give a *résumé* of in our next issue. At the opening of the conference two important announcements were made. The first of these was from Sir Courtenay Boyle to the effect that the Board of Trade had decided, after taking advice, that it had power to alter the regulation of 1896, which required the consent of the consumer to be obtained before making a change to a higher voltage. The other announcement was that no agreement had resulted from the negotiations between the Westminster Electric Supply Company and the eight consumers who were resisting the proposed change.

APPOINTMENTS VACANT.

Assistant Electrical Engineer, Ilford Urban District Council, lighting and tramways department, £120 per annum, March 11.

Engine Driver, Ilford Urban District Council, experience of Willans engines, £2 per week, March 11. Details in our advertisement columns.

Stokers (two), Ilford Urban District Council, 26s. per week, March 11. Details in our advertisement columns.

Assistant Driver, Ilford Urban District Council, 30s. per week, March 11. Details in our advertisement columns.

Switchboard Attendants (two), Ilford Urban District Council, 25s. per week, March 11. Details in our advertisement columns.

Arc Trimmers (two), Ilford Urban District Council, 30s. per week, March 11. Details in our advertisement columns.

Meter Fixer and Inspector, Ilford Urban District Council, 9d. per hour, March 11. Details in our advertisement columns.

Working Foreman, National Electric Supply Company, Preston; must be used to paper-insulated and Callender cables. Details in our advertisement columns.

NEW COMPANIES.

The following companies have been registered since our last issue:

H. Ingram, Limited.—Capital, £2,000. Object: to acquire the business carried on by H. Ingram at 72A, Sankey-street, Warrington, as H. Ingram and Co., and to carry on the business of electricians, electrical engineers, mechanicians, manufacturers of and dealers in electrical plant, etc.

Wolseley Tool and Motorcar Company, Limited.—Capital, £40,000. Object: to carry on the business of omnibus, motorcar, cycle, and vehicle manufacturers, electricians, etc.

Universal Lighting Syndicate, Limited.—Capital, £2,000. Object: to carry on business as ironfounders, engineers, tool manufacturers, die sinkers, wood workers, electricians, etc.

European McGuire Manufacturing Company, Limited.—Capital, £20,000. Object: to acquire under an agreement with F. C. Buxton certain patents relating to inventions for electric motor trucks, sweepers, fenders, stores, life guards, elastic brake hangers, brake handles; and to carry on business as engineers, electricians, electrical equipment manufacturers, electric traction and lighting supply manufacturers; and to act in England for the McGuire Manufacturing Company (Chicago), U.S.A., or any other agency business.

Barcelona.—A circular has been issued by the Municipality stating that they are desirous of changing the public gas-lighting arrangements of the city and suburbs, and adopting the "latest and most perfected styles in the light and its manufacture"; they accordingly invite tenders for the realisation of this end, to be accompanied by plans and projects, to be sent in not later than March 31, 1901. All tenders to be marked "Tender for Gas Supply." The basis of contract can be had on application to the Municipality.

LIGHT RAILWAYS.

The Light Railway Commissioners (Mr. Fitz-Gerald and Colonel Boughey) have held an enquiry at Pwllheli with reference to the application by a syndicate to construct a light railway from Pwllheli to Port Nevin and Port Dinlleyn. In closing the enquiry the president said that, as far as they were concerned, they would grant the order.

The Commissioners have also held an enquiry into the application of the Worcester Tramways Company, Limited, for powers to construct light railways along the Malvern-road to Asylum-lane, Powick, to Astwood Cemetery and Shrub Hill Station, and from the Bull Ring, St. John's, to Henwick Station. The order will be granted.

The Commissioners have held an enquiry at the North Stafford Hotel, Stoke, respecting the proposed extension by the Potteries Electric Traction Company, and will grant the order.

The Commissioners have held an enquiry into the application of the Essington and Ashmore Light Railways Company for the authorisation of an amendment and extension of the Essington and Ashmore Light Railways Order, 1900. The Earl of Jersey said they had to decide whether they would be justified in turning the private agreement into a public railway. They did not think they would be. Mr. Disturnal had abandoned railway No. 1, and proceeded with an alternative proposal, by which, he said, the two collieries and the population of Short Heath district would be served, and to this proposal there was no objection.

The Commissioners have held an enquiry into the application by the Halesowen District Council for an order authorising them to construct light railways within their district, at the close of which they intimated that they would report upon the application at a future date.

The Commissioners have decided to grant the application, made in May last, for a light railway order, in respect to the proposed extension of the Southwold Railway to Kessingland.

The name of the Mid-Anglian light railway project has been altered by permission to the Bury and Diss Light Railway.

The Oswestry Town Council propose to make an additional grant of £2,000 to the Tanat Valley Light Railway Company, £1,000 of which sum was to be in ordinary shares, so as to secure the appointment of a representative director under the order, and the remaining £1,000 as loan.

At a recent meeting of the Electric Lighting and Dinas Dinlle Light Railway Committee it was resolved to arrange for the drawing up of the objection to the granting of the order, also that Mr. Peterson be informed that the resolution passed by the Council supporting his application has been rescinded, and that the Gwyrfai District Council be so informed.

Application has been made to the Commissioners for an order authorising the construction of a light railway from Lyndhurst to the London and South-Western Railway Company's sidings at Lyndhurst-road Station. The proposed light railway will cross the main road in the parish of Colbury, and the Main Roads Committee have the proposals of the promoters under consideration, with a view of securing the due protection of the interests of the county.

The Bridges and Roads Committee of the Merthyr District Council recently reported to that body that they had received a copy of the award of Mr. W. R. Sheldon upon the arbitration between the Council and the British Electric Traction Company in reference to matters connected with the construction of the new electric railway. The London agents of the Council had suggested an appeal, but it was decided that no further action be taken in the matter. The question of costs will be determined by the Board of Trade.

A deputation from the promoters of the proposed light railway from Basingstoke through Kingsclere to the Highclere Station of the Didcot, Newbury, and Southampton Railway, recently waited on the Newbury Corporation to explain its objects. It was stated on behalf of the projectors that they would aim to get into Newbury as quickly as possible, but did not think it could be managed any other way than *vid* Highclere.

At the last meeting of the Quorn Urban District Council it was stated with reference to the Loughborough and District Light Railway that none of the Council's terms had been inserted in the draft order, and that Messrs. Clifford and Perkins had been instructed to lay the Council's objections before the Board of Trade.

The Carnarvon County Council have confirmed the decision of the Light Railways Committee to grant a loan of £7,500 for the purpose of the light railway from Pwllheli to Nevin, subject to the provisions of the Light Railways Act, and to the Cambrian Railway Company giving a binding and sufficient guarantee for the regular and efficient working of the line and the payment of the interest.

There is considerable opposition at Stockton Heath to the Warrington and Northwich light railway scheme.

The Runcorn Rural District Council are opposing the Warrington and Northwich Light Railway.

At a special meeting of the shareholders of the Isle of Axholme Light Railway Company on March 2 it was resolved

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to sell the Isle of Axholme Light Railway to the North-Eastern Railway Company upon terms to be agreed upon. It was stated that the directors were willing to accept £8,000 per mile.

The Montgomery County Council have agreed to make a further advance of £1,250, making a total of £3,750, to the Tanat Valley Railway Company.

The Wiltshire County Council will lodge a protest with the Board of Trade against the issue of an abandonment order with respect to that portion of the Amesbury and Military Camp light railway proposed to be carried beyond Amesbury, on the ground that the proposed railway would be of great value to the County Council for the transport of road materials.

At the meeting of the Armagh County Council on the 13th inst., it will be proposed that the Council petition against the Kingscourt, Keady, and Armagh Railway scheme.

On Thursday Sir Courtenay Boyle, K.C.B., had before him, for approval at the Board of Trade, the Tickhill Light Railway Order, under which it is proposed to construct a line of railway in the West Riding, about 12 miles in length, from Tickhill to Haxey, where it will connect with sidings of the Great Northern Railway and also with other sidings of the Great Eastern and Great Northern joint line. Sir C. Boyle thought that the Great Northern must have a wire clause to guard against falling wires to apply only to the use of electricity for traction.

The Worthing Town Council have decided to apply to the Light Railway Commissioners for a provisional order authorising the construction of light railways in the town.

The preliminaries in connection with the letting of the contract for the construction of the Wick and Lybster Light Railway have now been arranged. The works have been let to Mr. William Kennedy, contractor, Partick, and operations will be commenced without delay.

The Portmadoc Urban District Council are opposing the South Snowdon and Beddgelert Light Railway Bill.

The Commissioners have submitted to the Board of Trade for confirmation an order made by them amending the Isle of Thanet Light Railways.

COMPANIES' MEETINGS AND REPORTS.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.

At a special general meeting on Monday, Mr. W. E Jones in the chair. Bills (1) for conferring further powers upon the Company and authorising agreements with the Brompton and Piccadilly-circus and the Central London Railway Companies; (2) to empower the Company to extend their authorised railways to Highgate and Victoria and for authorising agreements with the Midland, the Central London, the Baker street and Waterloo, the Brighton, and the Victoria and Pimlico Railway Companies, and the South-Eastern and Chatham Railway Companies' Managing Committee; and (3) for incorporating and conferring powers on the Finchley and Hendon Tramways Company were approved.

W. T. HENLEY'S TELEGRAPH WORKS.

The directors' report for the year 1900 states that of the additional capital authorised by the shareholders in August, the directors have issued £25,000 preference shares at par, and £25 000 ordinary shares at 100 per cent. premium, the latter enabling the reserve account to be increased by £25,000. These shares were all issued to the shareholders or their nominees. During the past year a net profit has been made of £62,723 18s. 6d. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, etc, there remains £56,411. 17s. 10d., making, with £18 853 7s 4d. brought forward from last year, a total of £75,265. 5s. 2d. available for distribution. The directors have transferred £1,000 to the debenture redemption sinking fund, and £11,000 to the reserve account (in addition to the £25,000 above mentioned), and they recommend the payment of the following dividends—viz.: on the preference shares at the rate of 4½ per cent. per annum (less income tax); and on the ordinary shares at the rate of 20 per cent. per annum (less income tax), including the interim dividend of 4 per cent. paid on Sept. last. These payments will, together, amount to £50,554. 9s. 2d., leaving £24,710. 16s. to be carried forward. The Earl of Galloway and Sir Henry M. Stanley, G.C.B., retire by rotation in accordance with the provisions of the articles of association, and being eligible offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish, and Co., retire, and being eligible offer themselves for re-election.

NORTHALLERTON ELECTRIC LIGHT AND POWER.

At the annual shareholders' meeting on the 6th inst. (Mr. C. E. L. Ringrose presiding) the directors presented a balance-sheet which showed an adverse balance of £473. 17s. 5d. During the year the current taken by private consumers had very greatly increased, and had been so great as to necessitate a large extension of the works and alterations and additions to the plant. It was estimated that the consumption for private lighting and motors for the next quarter would be over 10,000 units. Unfortunately, the contract with the Urban District Council had proved a heavy loss to the Company, and the directors felt it their duty to give notice to the Council to terminate it in May next. The report and balance sheet were adopted.

CARLISLE TRAMWAYS

The report of the directors of the Carlisle Electric Tramways Company states that owing to the Corporation of Carlisle pressing for the construction of certain additional lengths of lines authorised, but which were not contracted for or intended to be laid, the completion of the tramways and equipment was considerably delayed. The directors are, however, glad to state that they induced the Manchester Traction Company, Limited, to construct these additional lengths, which has now been done, and without any increase on the original contract price. The tramways depôt, etc., were not finally taken over by the Company until Nov. 1, 1900. Meanwhile such lines as were finished were opened for traffic on June 30 last and the remaining lines at later dates, and worked by the Company under an arrangement to pay 40 per cent. of the traffic receipts to the Manchester Traction Company, Limited as shown in the accounts, in consideration of which, under the terms of the contract, the Manchester Traction Company, Limited, paid the 4 per cent. interest on the debenture stock subscribed and paid up, and the 5 per cent. interest upon the ordinary share capital to the date of the taking over the tramways by the Company. The revenue account for the half-year and one day shows a surplus of £1 523. 13s. 8d., and the balance of the profit and loss account, after writing off one-third of preliminary expenses, is £1,669. 4s. 10d., which your directors recommend should be dealt with as follows: to carry to a fund to meet depreciation, £500; to pay dividend for the half-year ended Dec. 31, 1900, at the rate of 3 per cent. per annum, making a total return of 4 per cent. for the year £900; to carry forward £269 4s 10d.—total, £1 669. 4s. 10d. The car miles run in the period have been 116 853 and the number of passengers carried 1,103,941 The results above shown must be regarded as preliminary to the regular working of the tramways, and is considered satisfactory, many initial difficulties having presented themselves and been overcome. The short lengths of the routes render it absolutely necessary to run very frequent services, and as the number of cars contracted to be supplied is found inadequate for the lengthened system, arrangements have been made for the provision of three new cars to be delivered in ample time for the spring and summer traffic. The directors who retire are Mr. R. B. Barningham and Mr. T. D. Lingard, who being eligible, offer themselves for re-election. Messrs. Walter J. Kershaw and Co. the auditors, also retire, and are eligible for re-election.

The revenue account is made up from June 30 to Dec. 31, 1900 (half a year and one day). It shows that the receipts were as follows (omitting shillings and pence): traffic £4,606; advertising, £114; sundry, £17; bank interest, £5—total, £4,742. Expenditure — electrical energy purchased, £884; running expenses, £1,341; maintenance and repairs, £20; administration and general expenses, £482; debenture stock interest, £491; surplus, £1,523.

The traffic receipts per car mile amounted to 9·46d.; total receipts, 9·74d.; total expenses (57·52 per cent. of receipts), 5·60d.

CHELSEA ELECTRICITY SUPPLY.

Directors: J. Irving Courtenay (chairman); Nugent Daniell; G. N. Marten; Major-General Webber, C.B. (retired R.E.). Chief engineer: Percy Still. Secretary: S. J. Cluer.

Report of the directors (with abstract of accounts) for the year ended Dec. 31. 1900:

In October. 1900. an allotment of 14,000 ordinary shares, at a price of £6 per share, was made *pro rata* to the shareholders, and at Dec. 31 allotments of 9,805 shares had been taken up. The balance of premium received in 1900, after deducting cost of issue and certain exceptional expenses, has been carried, as on previous occasions, to the reserve fund. The total of the reserve fund now stands at £56 622 13s. 5d. In order to conform to the Companies' Act, 1900, some alterations in the articles of association of the Company are necessary, and with this object resolutions will be submitted for approval at an extraordinary general meeting which will be held immediately after the ordinary general meeting. In consequence of the high price of coal, there has been a considerable increase in the cost beyond the provision made in 1899 to meet the expected extra outlay. An appreciable diminution in the revenue per unit sold has also been caused by the reduction in the price of the unit to consumers on the 200-volt supply, which it was deemed advisable to make in the latter part of 1899. This reduction has, however, been gradual, as it depended on the change by consumers to the higher pressure; it has resulted in bringing increased custom and inducing a somewhat freer use of the current. The number of lamps connected on Dec. 31, 1900, was 145,277, an addition of £16,410 during the year. The sum of £3,000 has been added to the renewals and depreciation fund out of the net revenue. After deducting this amount and after payment of interest on debenture stock (£6,750), there remains a balance of £11,370. 17s. The directors recommend that this balance shall be applied as under; interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30, 1900 (paid July 1, 1900). £900; interim dividend of 5 per cent. per annum on the old ordinary shares for the half-year to June 30, 1900 (paid July 1, 1900), £4,250; dividend of 6 per cent. per annum on the preference shares for the half-year to Dec 31, 1900, £900; dividend of 6 per cent. per annum on the old ordinary shares for

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the half-year to Dec. 31, 1900, making a total dividend of 5½ per cent. for the year, £5,100; dividend of 5½ per cent. per annum on the 9,805 new ordinary shares from the due dates of the instalments to Dec. 31, 1900, £99; amount carried forward to next account, £121. 17s. The retiring directors, Mr. Nugent Daniell and Mr. George N. Marten, are eligible for re election. The auditors, Messrs. Cooper Bros. and Co., offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£5,269	9	7			
Oil, water, and engine room stores	704	13	6			
Wages—engineers' salaries	1,670	12	9			
Repairs, maintenance, and renewals of buildings, £167; engines and boilers, £887. 3s. 8d; dynamos, £204. 9s. 7d.; instruments, tools, and sundries, £159. 18s. 3d.	1,418	11	6			
Sundry costs not included in the above	220	8	8			
				9,283	16	0
Distribution of Electricity.						
Wages at out-stations, etc.	1.169	7	1			
Stores used at out-stations	128	14	0			
Repairs, maintenance, and renewals of mains, £267; accumulators and other apparatus, £536 12s. 3d; meters, £207. 8s. 2d.	1 011	0	5			
				2,309	1	6
Rent, Rates, and Taxes.						
Rents payable	604	0	0			
Rates and taxes	1,453	5	9			
				2,057	5	9
Management Expenses.						
Directors' remuneration	1 000	0	0			
Salaries of staff	1.000	19	8			
Salary or commission of collector	150	0	0			
Stationery and printing	91	3	8			
General establishment charges	330	11	7			
Auditors of Company	52	10	0			
				2,625	4	11
Law expenses				24	9	0
Special Charges.						
Insurance	289	7	10			
Wayleaves	7	0	0			
				296	7	10
Balance carried to net revenue account				21,666	3	3
				£38,262	8	3

Dr.	£	s.	d.
Sale of current (less allowances made)	36 225	0	8
Rental of meters	1 702	17	9
Transfer fees	20	0	0
Discounts and sundry small accounts	314	9	10
	£38 262	8	3

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
Capital account—amount received	370,645	0	0
Sundry creditors for plant and buildings	2,405	13	5
Sundry creditors on open accounts	3,557	1	1
Debenture stockholders for interest accrued	3 206	5	0
Reserve fund	56,622	13	5
Balance at credit of net revenue account	6 220	17	0
	£442,657	9	11
Cr.	£	s.	d.
Capital account—amount expended, £425,545. 7s. 10d.; less renewals and depreciation fund account, £11,570	413,975	7	10
Stores on hand: coal, £541. 1s.; general stores, £7,710. 3s.	8,251	4	0
Sundry debtors for current supplied	13,464	5	1
Sundry debtors on other accounts	903	10	0
Cash at bankers and in hand	6 063	3	0
	£442,657	9	11

The annual meeting of the shareholders was held at the Chelsea Town Hall on Wednesday, Mr. J. L. Courtenay presiding.

The **Chairman**, in moving the adoption of the report said three causes had operated in lowering the dividend by ½ per cent.—namely, the increase in the price of coal, the diminution in the amount of revenue per unit sold resulting from the reduction in price to consumers who took the supply at 200 volts (a decrease amounting to ½d. per unit on the whole supply, or close upon £3,000), and the unusually light weather in the first and last quarters of the year 1900, which the directors estimated had diminished the revenue by much more than £1,000. The Company's plant had given very little trouble, and had been maintained in a high state of efficiency. Several important extensions of the mains had been carried out, and the Company was in a position to supply electricity at short notice to premises situated in any part of the area of supply. They would have to invest a substantial sum before the end of the year in acquiring certain properties, which it was estimated would give them sufficient space for all buildings necessary for the supply of current to the whole of Chelsea. In conclusion, the Chairman said he thought the Company had done a very great deal towards educating the residents in that important West-end district on the advantages derived from the use of the electric light for domestic purposes, and from this point of view the directors looked forward with every confidence to the future success of the Company.

Major General Webber, C.B., seconded the motion, which was approved.

NEWCASTLE ELECTRIC SUPPLY.

The annual meeting of this Company was held at the offices of the Company.

Mr. T. G. Gibson (chairman) presided, and in moving the adoption of the report and accounts said that out of capital account they had expended during the year on Pandon Dene £15,997. That represented a considerable expense in the building of further plant, and they had also had to increase the condensing plant. The sum included also a cooling tower, which had been found necessary in order to minimise the steam arising from the condensing plant. This cooling tower was now in operation and giving good results. They had added to the Pandon Dene plant two continuous current 500 kw. machines. The greatly increasing demand for power in the town could not be supplied from the alternating plant that they started with. They had laid during the past year five miles of mains, and they had now about 31 miles of mains in the town. The capacity of their plant was equal to supplying 90,000 8 c.p. lamps, and they were supplying at the present time 75,000 8 c.p. lamps, divided over about 1,160 customers. The power station at Wallsend had cost them £74 696. That had been taken over pursuant to a resolution approved at the September meeting of the Company. They had there a very large station, which would enable them to supply the wants of the Wallsend and Walker Union Gas Company's district, and gave them power also to supply their own extended wants at Gosforth, Willington Quay, and all about there—districts which they got power to supply by Act of Parliament last year. With a view to the further extension of works, and having regard to the powers which they obtained in the Act of Parliament last session, the directors had thought it wise and prudent to secure a site at Carville, by the side of the River Tyne. That site comprised 11 acres, and it was proposed to erect further works upon it. The site cost them £22,000, but they had not paid for it in cash, the vendor taking shares at £1 premium. The Company would require further capital to develop the works at Carville, and that would be raised partly by the issue of further shares, and by calling up money that had not yet been paid for shares that had been issued. That would carry them on for some time, but they thought it desirable that they should borrow some money, and the directors proposed to issue debentures at not more than 4 per cent., to the amount of half of the paid-up capital of the Company at any one time.

Dr. J. T. Mers seconded the motion, and the dividends recommended were declared.

METROPOLITAN ELECTRIC SUPPLY.

Report of directors (with abstract of accounts) for year ended Dec. 31, 1900:

The capital expenditure, which at the end of 1899 amounted to £1,244,254. 1s 6d, has now reached a total of £1,417.805. 8s. 11d., being an increase during the year of £173,551. 7s. 5d. The principal items of expenditure were for the works at Willesden, and for the extension of the low-tension system. During the past year the capital has been increased by the issue of £125,000, being the balance of the 3½ per cent. mortgage debenture stock; and also by the issue of 15,000 ordinary shares of £10 each to the shareholders at par, being the balance of the Company's authorised share capital. The gross revenue for the year amounted to £209,420. 6s. 1d., as compared with £179,190. 1s. 10d. in 1899, being an increase of £30 230. 4s. 3d. The cost of generation, which in 1899 was £90 419. 7s. 1d., amounted in 1900 to £106,009. 4s. 9d., or an increase of £15,589 17s. 8d. To meet the rapidly increasing demands for current, a fourth steam generator of 1,500 kw. capacity is in course of erection at the Willesden works, and a fifth machine of similar size has been ordered, and will be erected in the course of the summer. During the year negotiations took place with the St. Marylebone Vestry for the sale to them of the Company's West London (Marylebone) undertaking. A provisional agreement, subject to the approval of the Vestry and the shareholders respectively, was entered into on terms which, in the opinion of the Board, were fair and reasonable. The agreement was approved by the Vestry on Aug. 3, but at a subsequent meeting held on Oct 16 the Vestry decided that the resolution approving the agreement should not be confirmed. The balance at the credit of the revenue account, before providing for depreciation, is £78,500. 10s. 5d. The directors have set aside £14,000 as an addition to the depreciation and reserve fund, which now amounts to £78 422. 5s. 10d., carrying to the credit of the net revenue account the sum of £64,500. 10s. 5d. which, with the balance brought forward from last account and other receipts, makes a total of £71,840. 18s. 9d. After deducting debenture and share interest and other charges, there remains a balance of £27,841. 1s. 3d. An interim dividend of 6s. per share on the ordinary share capital was paid on Aug. 11, 1900, amounting to £25,500, and the directors recommend that a further dividend of 6s. per share on such shares be now paid, making a total distribution of 12s. per share for the year, being at the rate of 6 per cent., together with the proportionate payment of 9d. per share on the new shares. This will absorb a further sum of £26,016. 6s. 9d.,

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and leave a balance of £1,824. 14s. 6d. to be carried forward to the next account. The directors consider that this result is satisfactory, having regard to the high price of coal generally, especially during the last three months of the year. The number of 8-c.p. lamps supplied by the Company increased during the year from 500,000 to 570,000. The present number of lamps connected is 578,000, and the applications show no signs of decrease. In accordance with the articles of association, the following directors – viz., the Hon. J. B. Lubbock, Sir James Pender, Bart., and J. Carr Saunders, Esq.—retire from the Board, and are eligible and offer themselves for re election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and are eligible and offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£69,065	4	6			
Oil, waste, water, and stores	6,172	0	10			
Salaries of engineers, etc.	3,387	10	2			
Wages and allowances	11,887	9	6			
Repairs and maintenance: buildings, £2,348. 3s. 11d.; engines and boilers, £10,031. 11s.; dynamos and exciters, transformers, motors, etc., £1,239. 4s. 7d.; other machinery, instruments and tools, £1,364. 4s. 3d; accumulators and accessories, £488. 16s.	15,471	19	9			
Purchase of current	25	0	0			
				106,009	4	9
Distribution of Electricity.						
Repairs, maintenance, etc., mains	384	6	1			
Repairs, etc, of transformers, etc.	1,073	17	0			
Maintenance of distributing stations	65	9	0			
				1,523	12	1
Rents, Rates, and Taxes.						
Rents payable	1,777	3	5			
Rates and taxes	3,604	18	3			
				5,382	1	8
Management Expenses.						
Directors' and trustees' remuneration	3 650	0	0			
Salaries of management	8,001	16	11			
Wages of meter readers and wiring inspectors	491	0	9			
Stationery and printing	901	3	1			
General establishment charges	3,128	14	6			
Auditors: Board of Trade, £85; Company's auditors, £157. 10s.	242	10	0			
				16,415	5	3
Law and Parliamentary Charges.						
Law expenses	162	9	4			
Parliamentary charges	12	2	0			
				174	11	4
Insurances				1,415	0	7
Depreciation—buildings, plant, machinery, etc.				14,000	0	0
Total expenditure				144,919	15	8
Balance carried to net revenue account				64,500	10	5
				£209,420	6	1

Cr.	£	s.	d.
Sale of current (9,855,175 B.T. units) after making provision for bad and doubtful debts	202,826	16	0
Rental of meters	6,143	15	5
	208,970	11	5
Rents receivable	407	6	7
Work done and goods supplied	42	8	1
	£209,420	6	1

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	1,419,055	14	5
Sundry tradesmen and others	57,575	12	5
Sundry creditors on open accounts	10,502	0	9
Depreciation and reserve fund	78 422	5	10
Balance at credit of net revenue account	27,841	1	3
	£1,593,396	14	8

Cr.	£	s.	d.
Capital account—amount expended for works	1,417,805	8	11
Stores on hand: coal, £2,764. 11s. 3d.; oils, waste, etc., £485. 16s. 6d.; general, £10,602. 7s.	13,852	14	9
Sundry debtors for amounts paid on account	283	9	4
Sundry debtors for current supplied	82,467	3	9
Other debtors	1,209	4	3
Suspense accounts waiting adjustment	1,027	3	11
Deposits (provisional orders, vestries, etc.)	675	0	0
Investments at cost	64,190	19	7
Cash at bankers on current account	11,885	10	2
	£1,593,396	14	8

The ordinary meeting of the proprietors of this Company took place on Tuesday at Winchester House.

Mr. W. H. Cripps said the number of lamps added during the year was 70,000. This large rate of increase was a very gratifying feature when considering their future, and was far in excess of the estimate they formed when they first considered the advisability of erecting the works at Willesden. The Board therefore felt that the shareholders would agree that the Company was fully justified in the step they took when the Willesden works were decided on, for this large yearly increase could never have been properly met in any other manner. As it was, with ample space at their disposal it was comparatively easy for them to cope with any demands that might be made on them, and already two new machines had been ordered, and would be in readiness for next winter's supply. This would bring up the total capacity of the plant to 12 500 h.p., equal to the supply of nearly 500,000 lamps connected. Referring to the negotiations carried on last year with the St. Marylebone Vestry for the sale to them of the West London portion of their undertaking, he said their successors, the Borough Council, had not reopened negotiations, but decided to proceed with the application to Parliament for a right to give a competing supply. That Bill would come before Parliament this session. The directors having done their best to work amicably with the local authority, and having offered to sell the undertaking to the vestry on what, he was sure, would be considered the most reasonable terms, were determined to offer the most strenuous opposition to the Bill. Entirely apart from whether municipalities, backed by the rates, should compete with private traders, it could never have been contemplated in the original Electric Supply Acts that the local authorities should become trade rivals to the companies. Parliament had given the local authorities extensive powers of supervision over the Company, powers which could be only fairly used by an entirely disinterested authority. These powers, combined with those obtained under an agreement, were freely used by the Borough Council. To be given over, bound hand and foot, to a jealous trade rival clothed with such powers as the Borough Council possessed was not competition, but rather unjust confiscation. He never could believe that a parliamentary committee would sanction such a scheme, inflicting as it would a blow on free and independent trading, the life and soul of commercial enterprise in this country. The directors were glad to be able to state that by far the greater portion of the Company's mid-London area had now been changed to a low-pressure continuous-current supply, and the economy obtained from the results of that change had abundantly justified them in the policy which they had been pursuing for the last few years. Portions of the Company's St. Marylebone and Paddington district had been similarly dealt with, except that the supply remained alternating. The directors were engaged in treating the southern half of St. Marylebone in the same manner as they had treated the mid-London area—viz., by changing the present high-tension supply to the continuous-current one; and the laying of the mains for the purpose was already in progress. He feared they would not be able to complete much before the beginning of next year. He moved the adoption of the report.

Sir James Pender seconded, and the motion was unanimously agreed to.

W. T. HENLEY'S TELEGRAPH WORKS.

The ordinary general meeting of the shareholders of this Company was held on the 6th inst. at the Cannon-street Hotel, Mr. Sydney Gedge presiding.

The Chairman, in moving the adoption of the report, congratulated them on its very satisfactory nature, and stated that, comparing the accounts this year with those of last year, an improvement was shown in every particular. The dividend of 15 per cent. last year required £16,500, and this year the 20 cent. they proposed would require £25,467; while among the preference shareholders the amount divided would be £3,712, as compared with £2,086. He then compared the position of the Company in the past five years, and pointed out that the progress made had been steady, the rate of dividends having been 10 per cent., 12 per cent., 14 per cent., 15 per cent., and 20 per cent. They could not have presented these agreeable results had it not been for the unremitting attention of Mr. Sutton (managing director), Mr. Hatton, and the staff.

The Earl of Galloway seconded the motion, which was carried unanimously; and resolutions were afterwards passed, declaring the dividends mentioned and reappointing the Earl of Galloway and Sir Henry M. Stanley as directors.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

Directors: Henry Ramié Beeton (chairman); William Reginald Davies; Robert Arthur Germaine; William Francis Leese; William Page. Manager: Henry W. Bowden. Secretary: Thos. J. Owens.

Abstract of directors' report and accounts for the year ended Dec. 31, 1900:

The revenue account shows a credit balance of £21,324. 3s. 7d., which, with the balance of £229. 4s. brought forward, and £282. 13s. 5d. balance of interest received makes a total of £21,836. 1s. After deducting £2,250 for interest on debenture stock paid and accrued, £2,100 for interim dividend paid on the 7 per cent. cumulative preference shares, and £2,457. 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30, 1900 on the ordinary shares, the directors recommend that the sum remaining—viz., £15,028. 8s. 6d.—be dealt with as follows: to credit of depreciation account, £6,000; in reduction of renewals suspense account, £3,000; to payment of the remainder of dividend to Dec. 31, 1900, on the 7 per cent. cumulative preference shares, £2,100; to payment of a dividend on the ordinary shares for the half-year to Dec. 31, 1900, at 7 per cent. per annum, making 6 per cent. for the year, £3,440. 13s. 6d.; and that the balance of £487. 15s. be carried forward to the next account. The increase in the number of lamps connected during 1900 was

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equivalent to 13,675 35-watt (8-c.p.) lamps. In accordance with the special resolution passed Jan. 10, 1901, the nominal capital of the Company is now £300 000, divided into 20,000 preference shares of £5 each and 40,000 ordinary shares of £5 each. The directors now propose to issue 8,000 preference shares and 339 ordinary shares, bringing the ordinary and preference capital up to £100,000 each, and to redeem the existing debenture stock. The renewal of antiquated plant has been completed during the year at a further cost of £2,992. 16s. 10d., and after appropriating £3,000 from the income of the year, the renewals suspense account stands at £14,194. 16s. 10d. Mr. W. R. Davies and Mr. W. F. Leese retire from the Board by rotation, and being eligible, offer themselves for re election. Messrs. Miall, Wilkins, Randall, and Co., the auditors of the Company, offer themselves for re-election.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£5,138 15 4	
Oil, waste, water, and stores	449 11 0	
Proportion of salaries	1,119 2 1	
Wages and gratuities	1,938 16 7	
Repairs and maintenance: buildings, £39. 9s. 6d.; engines and boilers, £393. 4s. 10d.; dynamos, exciters, motors, etc., 14s. 2d.; other machinery, instruments, and tools, £187. 8s. 2d.	620 16 8	
Cartage of ashes	37 2 0	
		9 304 3 8
Distribution of Electricity.		
Proportion of salaries	225 0 0	
Wages	261 18 3	
Repairs and maintenance of mains	38 14 1	
Repairs, etc., of transformers, etc.	35 17 11	
		561 10 3
Rents, Rates, and Taxes.		
Rents payable	529 10 6	
Rates and taxes	1,303 17 11	
		1,833 8 5
Management Expenses.		
Directors' remuneration, less amount waived	1,200 0 0	
Salaries of secretary and clerks	726 1 8	
Salaries of collectors	165 17 6	
Stationery and printing	163 6 2	
General establishment charges	327 13 6	
Auditors of Company	42 0 0	
Auditors of the Board of Trade	45 0 0	
		2,669 18 10
Law and parliamentary charges		65 0 4
Special charges—insurances		263 9 7
Sundries.		
Remuneration to trustees, and other charges		103 9 9
		14,801 0 10
Balance carried to net revenue account		21,324 3 7
		£36,125 4 5

Cr.	£ s. d.
Sale of electricity per meter (less rebates)	34,457 10 8
Rental of meters on consumers' premises	1,658 18 9
Transfer fees	8 15 0
	£36,125 4 5

Dr. GENERAL BALANCE-SHEET.	£ s. d.
Capital account—amount received	208,305 0 0
Sundry creditors	7,800 12 8
Depreciation account	17 500 0 0
Balance at credit of net revenue account	6,028 8 6
	£239,634 1 2

Cr.	£ s. d.
Capital account—amount expended for works	207,700 14 8
Renewals suspense account	14,194 16 10
Stores on hand: coal, £878; oil, waste, etc., £206. 6s. 3d.; general, £20	1,104 6 3
Sundry debtors for electricity supplied	13,475 16 11
Other debtors and prepaid and suspense charges	600 9 1
Cash at bankers—Parr's Bank, Limited	2,521 5 3
Cash at office	36 12 2
	£239,634 1 2

At the ordinary general meeting of the proprietors held at Winchester House, Old Broad-street, E.C., **Mr. H. R. Beeton** (chairman) said that but for the increase in the price of fuel the works cost would be the lowest they had yet achieved. During the past year they had completed the renovation of their station by disposing of the last instalment of the antiquated plant. To accomplish this they had had to write off the capital account from first to last nearly £27,000, but they had now practically a brand new engine-house equipped with the most modern type of plant, the fruit of which they were reaping, and would continue to reap, in economy of production for many years to come. By substituting vertical for horizontal plant they had added so much to the floor space of the engine-room as to postpone the necessity for building a new station for a long time to come. They had laid the foundations of lasting and growing prosperity, so that the directors would be very disappointed if in their next report they were unable to recommend an increased distribution of profit. From the circular sent out it would be seen that the directors contemplated an issue of further capital whereby their ordinary and preference capital would be raised to £100,000 each. The object of that issue was not merely to provide for the immediate capital requirements, but to redeem the debenture stock. He moved the adoption of the report and accounts, and that the dividends recommended therein be approved.

Mr. Wm. Page seconded.

On the question of coal, the **Chairman** said they had about two months' stock under their present contract, and there was nothing fixed beyond that, so that they could avail themselves of the present price.

The motion was then put and carried unanimously. Mr. W. R. Davies and Mr. W. F. Leese were re-elected directors, and a vote of thanks to the chairman concluded the proceedings.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

Directors: William Francis Fladgate, Esq., Craig's-court, S.W. (chairman); G. H. Brougham Glasier, Esq., St. James's-street, S.W. (vice-chairman); Stefano Gatti, Esq. (A. and S. Gatti), Strand, W.C. (managing director); John M. Gatti, Esq. (A. and S. Gatti), Strand, W.C.; Richard Chadwick, Esq., St. Martin's-lane, W.C. Secretary: Edwd. Wilmot Seale, Esq. Engineer-in-chief: W. H. Patchell, M.I.C.E., etc.

The report of the directors (with abstract of accounts) for the year ended Dec. 31, 1900, states that the directors are glad to be able to put before the shareholders a satisfactory report of the working of the Company. The building extensions at the Lambeth station have been completed, and the entire site is occupied by the generating station, which is now fully equipped. The sub-station buildings at Short's-gardens have also been completed and partially equipped. One thousand five hundred kilowatts in motor-generators and 400 kw. in batteries have been installed. The plant and machinery at these stations and at the Maiden-lane station have been maintained in a high state of efficiency. The increase in the Corporation's business has necessitated the erection of a further sub-station to supplement the existing stations in use for the West-end areas, and a site has been acquired in St. Martin's-lane, in the rear part of which a sub-station is being erected, while in the front offices are being built to accommodate the staff necessary to carry on the general business of the Corporation. An Act empowering the Corporation to acquire land and erect generating stations at Marsh Gate-lane, Bow, was passed in the session of 1900. The Act also empowered the Corporation, upon terms to be approved by the Board of Trade, to supply electric energy in bulk to certain local authorities in the East-end. The site acquired under this Act consists of 7½ acres of freehold land, on part of which the generating station is being erected for the City order. Sites for sub-stations have been secured at Fenchurch-street and Ludgate-hill. Building operations are in progress on these sites, and negotiations are proceeding for other necessary sites. Motor-generators and batteries are being installed at Ludgate-hill sub-station, and supply is already given from that station to part of the City area. The growth of the Corporation's business in all its areas has been satisfactory. The equivalent of 39,431 additional 8-c.p lamps (36,004 in the western areas, 3,427 in the City area) have been connected to the mains of the Corporation, making a total of 222,120 lamps now connected, while negotiations are proceeding in the several areas for a supply to nearly 50,000 additional 8-c.p. lamps, of which a large proportion are in the City area. There have been 22 miles added to the mains in the West-end area, and 27 miles in the City area, making the total mains laid 174 miles. The units sold during the year 1900 show an increase of 995,132 over those sold during 1899 The increase of gross revenue from sales of current in 1900 over 1899 was £15 962, as compared with an increase of £10,715 in 1899 over 1898—*i.e.*, an increase of nearly 50 per cent. The directors have reason to congratulate the shareholders on the satisfactory results of the year's trading, which would have been even more satisfactory but for the price of coal (entailing an increased expenditure of nearly 30 per cent. over the price paid in 1899); the serious loss of income due to the fire at Maiden-lane Station in March last, and the further consequent heavy distribution losses pending the reinstatement of damaged plant and machinery. The fire loss on capital account is being written off share premium account. In accordance with the arrangements authorised at the extraordinary meeting of the Company held on May 17, 1900, the sum of £73,670. 16s. 10d. has been lent to the Charing Cross and City Electric Company on account of £200,000 authorised. The net earnings, as shown in the revenue account, have amounted to £29,517. 1s. 3d. A sum of £2,182. 2s. 9d. has been paid in respect of interest on debentures and temporary loans up to Dec. 31, 1900, and £10,625 was distributed as interim dividend at the rate of 8½ per cent. per annum for the half-year ended June 30, 1900. There remains a sum of £16,709. 18s. 6d., which, added to the undivided profit of £4,541. 13s. 10d. from the preceding year's account, and £1,161. 4s. 7d. received for interest on advances, makes £22,412. 16s. 11d., which the directors propose to deal with as follows: to provide for dividend on 4½ per cent. preference shares, £7,052. 1s.; to pay a dividend at the rate of £9½ per cent. for the half-year ended Dec. 31, 1900, on the ordinary shares (making with the interim dividend paid in August, 1900, £9 per cent. for the whole year), £11,875; and to carry forward £3,485. 15s. 11d. Mr. W. F. Fladgate and Mr. R. Chadwick are the directors who retire by rotation, and being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire, and offer themselves for re-election.

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REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal or other fuel, including carriage	£25,718	4	9			
Oil, etc., and engine-room stores ...	1,553	7	8			
Proportion of salaries	900	3	4			
Wages and gratuities	5,026	16	10			
				33,198	12	7
Repairs and maintenance—buildings	268	7	11			
Engines, boilers, dynamos, etc.....	3,506	5	9			
Accumulators and accessories.....	244	1	3			
				4,018	14	11
				37,217	7	6
Distribution of Electricity.						
Proportion of salaries	955	6	1			
Wages and gratuities	190	1	1			
Repairs, testing, maintenance, and renewals of mains	1,424	6	6			
Repairs, maintenance, and renewals of meters, switches, etc.	558	3	0			
Wayleaves and licenses	844	11	6			
				3,972	8	2
Public lighting maintenance				306	2	9
Rents, rates, taxes, and insurances				3,365	15	7
Management Expenses.						
Directors' remuneration	1,050	0	0			
Salaries of secretary, etc.	2,494	19	10			
Stationery and printing	242	18	7			
General establishment charges	474	3	10			
Auditors of Company	75	0	0			
				4 337	2	3
Law expenses.....				277	1	0
Accident compensation claims				25	19	6
Auditor				80	0	0
Depreciation in respect of buildings, plant, machinery, etc.				8,000	0	0
				57,581	16	9
Rents, repairs, rates, and taxes payable in respect of property not in occupation.....				130	0	0
Total expenditure.....				57,711	16	9
Balance carried to net revenue				29,517	1	3
				£87,228	18	0

Cr.	£	s.	d.
Sales of current, less rebates and allowances for bad debts.....	84,199	19	9
Public lighting	1,463	17	10
Rental of meters, etc., on consumers' premises ...	1,259	11	3
Transfer fees and sundry receipts	43	17	6
	86,967	6	4
Rents receivable in respect of property not in occupation	261	11	8
	£87,228	18	0

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	510,700	0	0
Sundry creditors for preference dividend, £4,052. 9s. 3d.; various credits £2,939. 10s. 1d.; sundry tradesmen and others. £50,409. 9s. 9d.	57 401	9	1
At credit of net revenue account, £33 037 16s. 11d.; less preference dividend, £7 052. 1s.; and less interim dividend paid, £10.625	15,360	15	11
Depreciation fund account. £36,000; leaseholds depreciation fund account, £10.000; share premium account, £63 667. 8s. 11d.; reserve fund capital account, £30,000	139,667	8	11
	£723,129	13	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	609,830	0	0
Freehold premises sub let	3 550	11	6
Leasehold premises sub let	400	0	0
Charing Cross and City Electric Co. for advances..	73,670	16	10
City of London provisional order	1,852	4	6
Stores on hand at Dec. 31 1900.....	6,597	5	10
Sundry debits on account of contracts	2,235	1	6
Sundry debtors for current.....	21,623	10	0
Other debtors:.....	1,549	2	9
Cash at bankers and in hand	1,821	1	0
	£723,129	13	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units.....		6,572,739
Quantity sold { Public lamps ..... 139 921 / Private consumers by meter..... 4,857 260 }		4 997,181
Quantity used on works		1,564 582
Total quantity accounted for		6,561,763
Quantity not accounted for.....		10,976
Number of public lamps		113
Total maximum supply demanded (kilowatts)		3,049

At the annual meeting of this Company held at St. Martin's Town Hall, Mr. J. M. Gaster, who presided spoke of the position of the Company as satisfactory in every way. During last year they had added nearly 14,000 lamps in St. Martin's district, 15,100 in the Strand district, and 7,000 in Holborn. A new demand for electricity was arising for motor and heating purposes; last year the Company had doubled their supply under that head. The gross revenue was also in a satisfactory state, the increase being £15 962. That being the case, he could understand shareholders enquiring how it was that the Board proposed to pay only the same dividend as last year, and that in order to do even that they had to fall back on some of the carry forward of the previous year. There were two causes for this—the increased price of coal and the expensive mode of working during several months as the result of the fire last March at their Maiden-lane station. The Corporation was now supplying electric light in 166 streets in its western area and 55 streets in the City.

Mr. G. H. B. Glasier seconded the motion, which was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Stockton.—Tenders will be advertised shortly for one 300-kw. engine.

Sutton Coldfield.—The Corporation invite tenders for house wiring. Tenders by March 11. Details in our advertisement columns.

Shereditch.—The Council invite tenders for their annual contracts. Tenders by March 12. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for indiarubber-covered cables, etc. Tenders by March 29. Details in our advertisement columns.

Wallasey.—The Urban District Council invite tenders for the supply and delivery of electrically-worked tramcars. Tenders by March 14. Details in our advertisement columns.

Ploesti (Roumania).—The Municipality invite tenders for the laying down and working of electric tramways for 30 years. The provisional deposit is £2,000. Tenders by April 3.

Colwyn Bay.—The Urban District Council invite tenders for the supply of one 120-kw. steam dynamo and switchboard extensions. Tenders by March 22. Details in our advertisement columns.

Buxton.—The Urban District Council invite tenders for a 250 kw. steam dynamo and a Belliss engine coupled to two 43-kw. dynamos. Tenders by March 12. Details in our advertisement columns.

Shipley.—The Urban District Council invite tenders for the supply of house terminal boxes and switch gear, motors, wiring installations, &c. Tenders by March 19. Details in our advertisement columns.

Cheltenham.—Tenders are invited for the electric lighting of St. John's Church, Cheltenham. Specifications, etc., can be had from Mr. Weaver, Carlton-place, Hewlett-street, Cheltenham. Tenders by March 25.

Southampton.—The Corporation invite tenders for insulated electric cables, frames, and covers, including excavation and reinstating of roadways. Tenders by March 11. Details in our advertisement columns.

Warrington.—Tenders are invited for electrical light installation for the new police buildings. Specification, etc., can be obtained from the architects, Messrs. Cackett and Burns Dick, 24, Grainger-street West, Newcastle on-Tyne.

Darwen.—The Corporation invite tenders for the supply and delivery of feeder cables pillars, and overhead electrical equipment in connection with the electric tramways. Tenders by March 25. Details in our advertisement columns.

Manchester.—The Tramway Committee invite tenders for the supply of permanent-way materials, tools, and plant. Particulars may be obtained from Mr. J. M. McElroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by March 9.

Aberdeen.—The Electric Lighting Committee invite tenders for supply of fuel economiser and additional Babcock and Wilcox boilers. Specification, etc., may be obtained from Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen. Tenders by March 15

Cardiff.—The Corporation invite tenders for steam-pipes, exhaust pipes, injection and overflow pipes, feed pipes, drain pipes, engine-house flooring, and switchboard gallery and central service gangway. Tenders by March 18. Details in our advertisement columns.

Dagenham (Essex).—The West Ham Town Council invite tenders for the erection of a dynamo house at their small-pox hospital, Dagenham Essex. Specification, etc., may be obtained at the Borough Engineer's Office, Town Hall, West Ham. Tenders by March 12

Wolverhampton.—The Tramways Committee invite tenders for the complete overhead equipment of about five miles of tramway route, and the supplying and laying of feeders, conduits, and switch pillars for the same. Tenders by March 22. Details in our advertisement columns.

Vercelli (Italy).—The Municipality will shortly advertise for tenders for an electric installation for public and private lighting. The former will consist of 76 arc lamps of 800 c.p. and eight amperes each, and the latter of 1,700 16-c.p. lamps. Work must be commenced within six months.

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Burnley.—The Tramways Committee invite tenders for the supply of the necessary materials for the overhead equipment in connection with the trunk line. Specification, etc., may be obtained from Mr. R. Birkett, borough electrical engineer, Aqueduct-street, Burnley. Tenders by March 23.

Hammersmith.—The Borough Council invite tenders for supply of electrical stores for 12 months ending March 31, 1902. Specification, etc., may be seen and any further information obtained of Mr. G. Gilbert Bell, resident engineer at the electricity works, 57, Fulham Palace-road, Hammersmith. Tenders by 13th inst.

Wimbledon.—The Urban District Council invite tenders for cables, joint-boxes and jointing material, transformers, meters and demand indicators, lubricating oils, and Welsh steam coal, for the year ending March 31, 1902. Specification, etc , may be obtained on application at the Electric Lighting Works, Durnsford-road, Wimbledon. Tenders by March 15.

Bristol.—The Electrical Committee invite tenders for the erection of the superstructure of the Avonbank electricity works, Feeder-road, Bristol. The work comprises a large amount of steelwork, as well as brickwork and concrete work. Specification, etc., can be obtained at the office of Henry Williams, Esq., architect, 24, Clare-street, Bristol. Tenders by March 12.

Warrington.—The Corporation invite tenders for (Section 1) supply, delivery, and laying of steel rails, paving, etc., forming permanent way; (2) supply, delivery, and erection of steel poles, brackets, trolley wire, insulators, etc., forming a complete overhead equipment; (3) electric tramcars. Specifications, etc.. can be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Tenders by March 27.

Bray (Ireland).—The Urban District Council invite tenders for the supply and erection of: (Section A) boiler-house plant—one Lancashire boiler and accessories; (Section B) engine-house plant—(1) one 150-kw. high-speed steam alternator, and (2) one 25-kw. rope-driven alternator and accessories, for the municipal electricity works. Specification, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, M.I.C.E., the consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by March 14.

Newport (Mon.)—The Corporation invite tenders for the supply and erection of: (Section 4) constructional steelwork, bunkers, etc.; (5) steel flue; (6) coal and ash conveyor; (8) overhead travelling crane; (9) steam-boilers; (10) mechanical stokers; (11) fuel economiser; (12) water-storage tanks; (13) compound condensing vertical engines; (14) electric generators; (15) condensing plant with cooling towers; (16) feed pumps. Specifications, etc., may be obtained from Mr. H. F. Parshall, 8, Princes-street, Bank, London, E.C. Tenders by March 25.

London, W.C.—The British Electric Traction Company, Limited, on behalf of the Gravesend and Northfleet Electric Tramways Company, invite tenders for the construction of new tramways in Gravesend and Northfleet, and the reconstruction of the existing tramways in Gravesend; for the supply and construction of the necessary electrical equipment for working the overhead system. Copies of the specifications and schedules can be obtained on payment of £10, returnable upon receipt of a bona fide tender, from the secretary, Mr. Charles Dade, Donington House, Norfolk street, Strand, London, W.C. Tenders by 25th inst.

RESULTS OF TENDERS

Bradford.—Messrs. D. Bruce Peebles and Co. have secured the contract for two 200-kw. tramway generators for the Corporation.

Cregdon.—Messrs. Callender have obtained the contract to supply cables and undertake works of mainlaying, etc., during the current year.

Mortlake.—The Barnes Urban District Council have accepted the tender of Messrs. Johnson and Fitzer, St. John's-road, Richmond, at £89. 6s., for wiring their electricity works at Mortlake.

Halifax.—The Tramways Committee have accepted the tender of the Brush Electrical Engineering Company, Limited, for the supply of 12 tramcar bodies at the price of £238 5s. each, and for the supply of 36 trucks for tramcars at £55 each.

Islington.—The Borough Council have accepted the following tenders for the supply of electrical stores: Sloan Electrical Company, 15, Fore street, Avenue, E.C., and Mackey's Electric Lamp Company, Limited, Tulip-place, New Church-street, Bermondsey.

Worthing.—The Electric Lighting Committee have received tenders for the fitting up of premises with the electric light from Messrs. Bostel Bros., Brighton; Messrs. Page and Miles, Limited, Brighton; and Messrs. Whittaker Bros., Limited, Dudley.

Ballinasloe (Ireland).—The tender of the Ampère Electrical Company, Mill Abbey street, Dublin, at £1,205, has been accepted for supplying and erecting the necessary plant and fittings for an electric light installation in the new hospital block of the district lunatic asylum, Ballinasloe.

Aberdeen.—The Tramways Committee have accepted the offer of the British Insulated Wire Company, Limited, amounting to £1,601. 2s. 7d., to furnish the electrical equipment of the tramway to the bathing station. The Gas and Electric Lighting Committee have accepted the tender of Messrs. Alley, M'Lellan, and Co., Glasgow, for condensers for the new Dee Village electric lighting station, at £1,697.

Huelva.—The tender of Don Julio Saranana, at 7,400 pesetas per year, has been accepted for the lighting concession of the town for 20 years. In connection with these Spanish contracts, it is interesting to note that the successful tenderer, who will transfer his concession to the Electro Ayamontina Company, was the only tenderer, and that he obtained the same at 100 pesetas per annum less than the official estimate.

Wolverhampton.—Tenders have been received for the construction works for the new electrical tramways and the erection of the buildings. They include the supply of about 1,500 tons of steel rails for 7½ miles of the track. The tender of Mr. H. Holloway, of Wolverhampton, at £50,000, for making the line from the boundary on the Bilston side through Wolverhampton to Tettenhall, has been accepted. The time fixed for this work is 11 months.

London School Board.—The School Board have received the following tenders for wiring, etc., for electric lighting Offord-road School:

G. Weston and Co.	£379	0	0
Drake and Gorham	365	5	0
Peto and Radford, Limited	331	0	0
Comyn Ching and Co.*	324	0	0

* Recommended for acceptance.

Hendon.—The following tenders are recommended for acceptance in connection with the electric lighting:

Section A.—Holdsworth and Sons	£3,838	0	0
Section B.—Mather and Platt, Limited	5,876	0	0
Section D.—J. Spencer and Co.	330	0	0
Section E.—B. Thomas	1,221	16	0
Section F.—Electrical Power Storage Company, Limited	2,103	7	6
Section G.—Western Electric Company	12,318	11	9
Section H.—British Thomson-Houston Company, Limited	347	15	0
Section I.—Puck and Hickman	255	4	9

Section C not yet tendered for.

Southwark.—The Electric Lighting Committee have received the following tenders for the second extension of electric lighting station:

Section A.—400-kw. steam generator with foundations, steam connections, etc., and a spare armature for same.

C. A. Parsons and Co.	£3,520	0	0
Bergtheil and Young	£3,827, £3,897, £3 987, 4 627	0	0
British Schuckert Company, Limited	£4,000. £4,303, 5,882	0	0
British Westinghouse Company, Limited,	£4,064, £4,220, £4,254, £4,268, 4,884	0	0
Willans and Robinson, Limited,	£4,070, £4,409. £4 579, £4 878, 5,142	0	0
Siemens Bros. and Co.	£4 226 *£4,310, £4,313, 4,995	0	0
Mather and Platt, Limited	£4,180, £4 24), 4 300	0	0
Smith, McMillan, and Co.	£4 379, 4 969	15	0
Electric Construction Company	£4,390 4,769	0	0
Ashton, Frost, and Co., Limited	4,328	0	0
S. Z. de Ferranti, Limited	£4,610. 15s., £4,717. 15s., 5,190	15	0
General Electric Company	4,813	10	0
Johnson and Phillips	4 350	0	0
Crompton and Co., Limited	£5,034, 5,017	0	0
Brush Electric Engineering Company, Limited	5,270	0	0
Bow, McLachlan, and Co., Limited	£5,500, 5,582	0	0

Section B.—For the provision of a further pair of water-tube boilers with steam connections, mechanical stokers, and extensions to coal-conveyor gear.

Babcock and Wilcox, Limited	†3 230	0	0
D. Smith, McMillan, and Co.	3 300	0	0
Stirling Boiler Company	3,460	0	0
Hornsby and Sons, Limited	3 709	0	0
J. Thompson	3 900	0	0

* Recommended for acceptance. † Recommended for acceptance, subject to the price of their chain grate stokers and Vicars's stokers being included in the schedule annexed to their contract, and the Council reserving the right to determine which stoker is to be installed within three months from the execution of the contract. Switches, ammeters, and instruments required for regulating the East-street feeder are to be fitted to the switchboard panels in the station by the General Electric Company, at a cost of £117. 10s.

BUSINESS NOTES

TRACTION.

Carlisle.—Steps are being taken to safeguard the public as far as possible from the risks attending the falling of electric wires.

Ayr.—Mr. Frederick Coutts, of Dundee, has been appointed manager of the electric tramways at a salary of £200 per annum.

West Cumberland Tramways.—On Monday the West Cumberland Electric Tramways Bill was read a first time in the House of Commons.

Barnes.—A ratepayers' meeting has unanimously approved the action of the District Council in opposing the London United Tramways Bill.

Power Bills.—The Brighouse Town Council and the Mexborough Urban District Council intend to petition against the two Yorkshire Electric Power Bills.

Merthyr Tydvil.—At the meeting of the Bridges and Roads Committee on Monday, it was stated that the electric traction company's authorised lines were nearly completed.

Darlington.—At a meeting of the General Purposes Committee on Wednesday it was resolved to recommend the Corporation to conclude the purchase of the tramway company's undertaking for £7,590.

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North Shields.—It was fully expected that the new electric tramways would have been in operation on Saturday, but for some reason the cars were not running, and much disappointment was expressed.

Warrington.—On the recommendation of Mr. Preece, the consulting electrical engineer, estimates of the cost of additional plant in view of the early introduction of electric tramways are being prepared.

Leamington.—All that is now needed before the work of laying the new line for the electric trams for Warwick and Leamington can be commenced is the formal parliamentary ratification of the provisional order.

Stourbridge.—At a special meeting of the Urban District Council on Tuesday it was stated that the Railway Committee had now agreed to allow the tramway company to use span wires and ornamental poles to carry them.

Bilston.—The District Council have given their consent to the transfer of the old Wolverhampton Tramway Company's undertaking in Bilston to the Wolverhampton District Electric Tramway, Limited, at the price of £9,582.

Gateshead.—The system to be adopted on the tramways for the protection of the public against falling wires is to consist of earthed guard wires over the trolley wire at such points where the trolley wire is crossed by telegraph or telephone wires.

Chester.—With reference to our note in last week's issue, we now learn that at a special meeting of the Town Council last week it was decided to abandon the proposed extensions of the tramways to Hoole and Liverpool-road, and to Stonebridge, Saltney.

Ipswich.—The Corporation have notified the tramways company that they have obtained the approval of the Board of Trade to their purchasing the company's undertaking. An extraordinary meeting of the company has resolved to sell to the Corporation by agreement.

Swansea.—The official notice of approval of the tramways extension shows that the maximum charges are to be 1d. per mile, and the Corporation have power to borrow up to £100,000, and are given leave to lease the undertaking to the tramway company on terms already arranged.

Leicester.—Mr. E. George Mawbey, M.I.C.E., the borough engineer, is particularly interested in the proposed tramways, having, in conjunction with the Tramways Sub-Committee, prepared the scheme. As reported in last week's issue, Mr. E. Manville has been appointed consulting engineer.

Pembroke (Ireland).—The Urban District Council have received a deputation from the railway company in reference to the proposed Scalp and Enniskerry tramway. It is contended that the statutory requirements have not been complied with, and the matter is postponed to enable the Council to obtain advice on the point.

Shoreham.—Representatives of the Brighton and District Tramway Company have had an interview with the Urban District Council's Works Committee relative to running their cars by electricity instead of by horses, and respresentatives of all interested authorities are to be invited to meet and talk the matter over.

Gosport.—A ratepayers' meeting has unanimously agreed to the proposal of the District Council to apply the rates under their control to the payment of the expenses attending the opposition to the Bill now being promoted by the Portsmouth Street Tramways Company to construct further tramways in the urban district of Gosport and Alverstoke.

Croydon.—The County Council have decided that on the conversion of the tramways to electric traction the cars shall stop only at certain fixed points along the route. A start was made on Wednesday with the work of erecting the poles for the overhead system, the contract for which is in the hands of the British Thomson-Houston Company.

Scarborough.—With regard to the offer of the tramways company to hand over their Bill to the Corporation on payment by the latter of £1,600 (expenses in connection therewith), the Streets and Buildings Committee have decided not to close with this offer, but to continue to oppose the Bill of the company pending any arrangement which might be come to.

Crewe.—At a meeting of the Town Council on Wednesday the chairman of the Tramways Committee stated that the Light Railways Commissioners had refused to give the Council an order for the construction of electric tramways within the borough. The scheme although blocked would only be delayed, and he thought it would be carried out in a few years' time.

Burnley.—The price to be paid by the Corporation for the undertaking of the Burnley and District Tramway Company has been fixed at £53,000. The Corporation took possession on March 1, and are now carrying on the system. Already it has been decided to abolish the existing steam trams, and to spend £120,000 forthwith in equipping the line for electric traction.

Sunderland. — The overhead equipment of the new electric tramways on the Southwick, Tatham street, and Hylton-road routes was inspected on Tuesday on behalf of the Board of Trade by Mr. A. P. Trotter. He expressed himself satisfied, and then proceeded to the electric power station in Dunning-street, which he inspected and approved. Major Druitt, R.E., inspected the permanent way of the new routes the following day.

Manchester.—The General Purposes Committee have resolved that a statement be inserted in the petition of the Corporation against the Lancashire and Yorkshire Railway Bill that the angle of the proposed new road at its junction with St. Mary's-road would be unsuitable for the electric tramways, and suggesting that the company should make such alterations as might meet the views of the Corporation and the safety and convenience of the public.

Motor Union.—At the annual meeting of the Automobile Club it was decided to form a motor union, open to all motorists, ladies or gentlemen, without reference to social position, by which all automobilists shall be embodied under one banner for the purpose of furthering the motor movement. Members of the union will have the privilege of claiming from the union financial and legal assistance in respect of proceedings or actions-at-law, either civil or criminal, in connection with their motor vehicles.

Proposed Railway under the Solent.—In the case of the South-Western and Isle of Wight Junction Railway Bill, under which powers are sought to connect the Isle of Wight with the mainland by a railway under the Solent, the Examiners of Petitions for Private Bills have decided that the Standing Orders of the House of Lords have not been complied with, inasmuch as no proof has been given in connection with that part of the Bill empowering the London and South-Western Company to subscribe to the undertaking.

Dundee.—Work upon the eastern tramway route is now practically completed. As all opposition to the Constitution-road scheme has been withdrawn, it is expected that the Municipality will be vested with authority to construct the proposed tramway in that part of the town. A start with the work will be made about the end of April. Plans are also being prepared for the conversion of the system in Victoria-road. The Board of Trade inspection of the electric overhead equipment of the East End tramway system was announced for Wednesday last.

Proposed Russian Electric Railway.—The Berlin correspondent of the *Standard* states that an English company proposes to build an electric circular railway, with several branch lines and a central station, in St. Petersburg. It promises to provide the Russian capital with a service of trains running every two minutes. In the city the line would run overhead on iron pillars, and in the suburbs on an embankment. It would be about 60 miles in length, and would cross the Neva and canals on 11 bridges. It is reported that the Russian Government has appointed a committee to examine the project.

Cardiff.—At the adjourned meeting of the General Purposes Committee on Monday it was resolved that the Tramways Committee be requested to discuss with the tramways company the suggestions contained in the letter of Mr. John Glenn, the essential parts of which are: that the existing lines be measured up by the engineer of the company with the borough engineer; that the value of the lines as the result of the measurement be agreed; that the company reconstruct the lines for electric traction by Jan. 1, 1902; and that the work done for this purpose be carried out by the company at the cost of the Corporation.

Aberdeen.—On the report of the electrical engineer in reference to the equipment of the bathing-station route of the tramways, the Tramways Committee have recommended the grouping of the telephone and telegraph wires at as few points as possible, and the erection of efficient guard wires. At a meeting of the Tramways Committee on Saturday, it was stated that instead of there being a deficiency of £1,100 on the horse tramcar service for the last 35 weeks as previously reported, there was, in fact, a surplus of between £300 and £400, and, in consequence, the present service will be continued. The mistake was due to a miscalculation of the mileage.

Liverpool.—The subject of the proposed Manchester and Liverpool electric express railway was before the council of the Chamber of Commerce on Monday. The Chamber had previously resolved to petition in favour of the new railway. Considerable diversity of opinion seems to exist in Liverpool as to the desirability of the scheme. The Parliamentary Committee have recommended the City Council to petition against the Bill authorising the construction of the proposed railway, and on Wednesday the Council adopted the recommendation on the ground that the railway would be a source of danger on account of the excessive speed proposed—viz., 110 miles an hour.

Dudley.—The Tramway and Electric Lighting Committee are recommending the retention, so long as he is professionally engaged in the district of Mr. R. Wilson as chief engineer at the electric generating station at a salary of £500, on condition that he engages and pays two assistants, one to Mr. Marsh, the present engineer. At a meeting of the Town Council on Tuesday considerable discussion took place respecting the new tramway regulations, by which cars to and from Cradley Heath were not allowed to run through the town, an alteration which, it was contended, had given great dissatisfaction to the travelling public. It was stated that the tramway officials proposed to lay a new scheme with regard to the matter before the committee.

Barrow.—Up to the present the Corporation and the British Electric Traction Company have been unable to come to terms in regard to the purchase of the steam tramways. The Board of Trade are granting the company licenses for short periods, and as the permanent way is being repaired, a full service of cars is still maintained. The Corporation have intimated to the company that with regard to an extended tenure and the conversion of the present lines to electric traction, they are prepared to receive in writing and discuss the length of term, value of present lines, cost of conversion, electric current, improvements in lines and rolling-stock, etc. The Independent Labour Party have appointed a committee to urge the Corporation to municipalise the tramways.

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Traction Equipment.—We are informed that Messrs. Robert W. Blackwell and Co., Limited, have lately secured the following contracts: Bradford Corporation, overhead electrical equipment of the Idle and Thackley, Clayton and Queensbury, and Farsley sections of the tramways; Southampton Corporation, overhead electrical equipment of the Canute-road, Dock Station to Avenue, and St. Mary-street sections of the tramways; Brighton Corporation, supply of their traction switchboard and for the overhead electrical equipment of their tramways system; Southport Corporation, supply of all the poles and brackets required for the extensions of the tramways; Manchester Corporation, the material required for the overhead equipment of their new car-shed, and for tower wagons, reel wagons, and all the necessary tools required by the tramways department for carrying out extensions of their line.

Hampstead.—With a view to securing the withdrawal of the opposition of the Borough Council to the Hampstead, Euston, and Charing Cross Railway Bill, the promoters offer to give way in every important particular to which those interested in the preservation of the Heath have objected. They promise not to erect a station on the summit of the Heath, or at North-end, and not to tunnel under any portion of the Heath if the Borough Council will undertake not to oppose the Bill for the construction of the extension of the line from Holly-hill, Hampstead, to Golder's green, Hendon. The Borough Council has appointed a committee to meet a deputation representing the promoters and discuss the details with a view to a settlement being arrived at. The General Purposes Committee of the Borough Council have agreed to confer with the London County Council's Highways Committee on the proposal for the construction of a new tramway line from the Marble Arch along Edgware-road to the county boundary at Cricklewood.

London County Council Tramways.—The parts of the London County Council (Tramways and Street Widenings) Bills which have been struck out in consequence of the opposition of road authorities related to tramways in Stoke Newington and Hackney; Hampstead-road, Marylebone, and Tottenham Court-road; Cambridge-circus and the parish of St. George-the Martyr, Holborn; from Cheyne-walk to Blackfriars Bridge along the Victoria embankment; Chelsea and Hanover-square; Vauxhall and Grosvenor-road, and the parish of St. John's, Westminster, and Vauxhall Bridge, Putney, and Battersea Bridge; Hammersmith and Fulham, King-street, Hammersmith, and the Broadway, from Uxbridge-road to Netherwood-road, from Netherwood-road to Shepherd's Bush-road, etc. Consents to the Battersea parts of the Bill were given, as also were those to the parts affecting Lambeth, Southwark, Bermondsey, Wandsworth, Camberwell, and Newington. Tramway No. 6, it is understood, will run along the boundary line between Finsbury and Holborn, and that while Finsbury consents Holborn in part refuses consent. A special report will in this case be submitted to the Standing Orders Committee.

Leeds.—The Tramways Committee have approved of the electrical engineer's recommendation in favour of the furnishing of every electric car with an earth switch, which will practically divert the electricity from a fallen wire or wires to the rails; and also of his proposed arrangement of telephone boxes, and the suggested connection of the underground telephone system with the fire brigade station. At the same meeting a discussion took place relative to the present management of the tramways. The Chairman admitted that the system he had favoured two years ago of having two managers had absolutely broken down, and that he was now in favour of the proposal advocated by the Liberal party in the Council at that time. The chief point in the discussion was whether a general manager could be appointed with full control over the entire staff. No decision was arrived at. The Tramways Committee recommend that the salary of the tramway electrical engineer be increased by £200, and that of the superintendent of street-lighting by £25. An effort is being made to have the Beeston-hill electric tramcars running at the beginning of next week. The equipment of the line is almost complete, and workmen are now devoting their attention to the Elland-road section.

London's Underground Railways.—A Select Committee of the House of Lords is to be appointed to join with a committee of the House of Commons to consider and report whether the lines of route for the proposed underground railways in and near London are best calculated to afford facilities for present and probable future traffic, and, if not, what modifications of those lines of route are desirable; what special provisions, if any, should be made for the protection of owners, lessees, and occupiers of property adjacent to underground railways from possible damage and annoyance, what special terms and conditions as to construction and working should be imposed on the promoters; and whether any of the schemes should be sanctioned in the present session. In the House of Commons last Friday the President of the Board of Trade, in answer to Mr. Compton Rickett, stated that an expert committee was sitting to enquire into the subject of vibration on the Central London Railway, and until it had reported he was not in a position to express any opinion. Among a number of Bills which received second readings in the House of Lords on Tuesday were those of the Central London, City and Brixton, and the City and South London Railway Companies. Yesterday the Chairman of Ways and Means in the Commons, in accordance with a message from the Lords, moved a resolution corresponding with that passed in the Lords as to the appointment of a joint committee of both Houses to consider the question of underground railways in London. Notice of opposition has been given in the House of Lords by the trustees of the Cavalry Club against the Charing Cross, Hammersmith and District Electric Railway Bill; by the Westminster Corporation against the King's-road Railway Bill; and by the Westminster Corporation against the Piccadilly and City Railway Bill.

LIGHTING AND GENERAL.

Hastings.—The Town Council have resolved to purchase electric light plant at a cost of £9,500.

Wath.—The Urban District Council will not at present oppose the South Yorkshire Electric Power Bill.

Durham.—The County Council will probably petition in favour of the Cleveland and Durham Electric Power Bill.

Share Market.—A steady business was done during the week in electric shares, although prices did not alter much.

Lynton.—The agreement between the Council and the electric light company for lighting the town hall has been sealed.

Eastbourne.—We understand that Mr. Bennett is being consulted with regard to the proposed municipal telephones.

British Insulated Wire Co.—The annual staff dinner of this Company takes place to-day at the Adelphi Hotel, Liverpool.

Neyland.—The Urban District Council are making enquiries into the cost of obtaining an electric lighting provisional order.

Calverley.—The District Council have obtained a report by the committee appointed to obtain information with respect to proposed electrical supply.

Not Made in America.—Messrs. Escher, Wyss, and Co., of Zurich, have just received from Niagara an order for six electric turbines, each of 5,500 h.p.

Todmorden.—The Town Council have decided to oppose the Bills of the Electric Power (Yorkshire) Company and of the South Yorkshire Electric Power Company.

Manchester.—Mr. S. D. Pearce (now chief engineer at Shepherd's Bush generating station) has been appointed deputy chief electrical engineer, at a salary of £500 per annum.

Cable Depot.—Messrs. Johnson and Phillips, Electric Cable Works, Old Charlton, have opened a West-end depôt for their cables at 37, King-street, Covent Garden, W.C.

City of London Electric Co.—The directors announce a dividend of 6s. per share on the preference shares for the six months ended Dec. 31, £11,350 being carried forward.

York.—The Local Government Board have sanctioned the borrowing of the sum of £20 000 by the Corporation for electric lighting purposes, the time allowed for repayment being 25 years.

Morley.—Sanction has been received to the reborrowing of £21,247 for electric lighting works. Application is to be made for sanction to borrow £7,050 to carry out electric cable extensions.

Ilford.—Mr. Arthur Shaw and the accountant are about to visit Brighton with a view to making themselves acquainted with the system of keeping the electricity accounts as in use at that town.

Coventry.—The Council have confirmed the resolution previously noted by us to borrow £23,200 as follows: electric works extensions, £14 891; distribution £3 300; expenditure already incurred, £5,009.

Middlesbrough.—The Town Council on Wednesday decided to apply for sanction to borrow £21,000 for additional generating plant and extensions to the Park-road, Linthorpe, and Newport districts.

Penzance.—The Town Council have adopted the engineer's report on electric lighting, and will discuss the same at a future meeting. It is probable that the scheme will be handed over to a company.

Hull Telephones.—The Hull Guardian Society at their annual meeting last week passed a resolution urging the City Council to immediately apply to the Postmaster-General for a license for municipal telephones.

Bridlington.—The Electric Lighting Committee having considered the Bridlington Electric Lighting Order, 1900, are now asking certain syndicates upon what terms they would be prepared to carry out the order.

London Gazette.—The day fixed for public examination *re* the Gutta Percha Corporation, Limited, Throgmorton House, Copthall-avenue, E.C., is March 11 (at 11 a.m) at Bankruptcy-buildings, Carey-street, Lincoln's-inn, W.C.

Arbroath.—The Arbroath Town Council have resolved to apply to the Secretary for Scotland for a provisional order conferring powers upon the Council to borrow a sum not exceeding £40,000 for the purpose of electric lighting.

St. Pancras.—The Borough Council have adopted an extensive scheme of arc lighting prepared by Mr. Baynes, chief electrical engineer, for various parts of the borough. The necessary feeders are to be laid down at an estimated cost of £69,112.

Southwark.—Application is to be made to the London County Council for a loan of £15,000 for electric lighting extensions, repayable in 42 years, the first instalment being made payable at the end of the third year from the date of the loan.

West Hartlepool.—The Town Council intend to oppose the Bill of the Cleveland and Durham Electric Power Bill, the promoters having declined to insert a clause which had been approved at the joint meeting of Corporation representatives at Stockton.

Worcester.—We note that Mr. C. J. Sutherland resumed his duties on Jan. 1 last, and that the City Council at their last meeting apppointed Mr. Hoadley (who carried out Mr. Sutherland's

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duties during his absence) as chief assistant at a salary of £250 per annum.

Beckenham.—The National Telephone Company are asking the Urban District Council for permission to lay a cable through the Croydon road recreation ground, as they have been refused seven important wayleaves. The matter is before the Works Committee and the surveyor for report.

Aron Electricity Meter Co.—We are informed that, owing to disputes as to the management of this Company, Dr. Julius Juttke has resigned his seat on the Board as well as his position as managing director of Aron Electricity Meter, Limited, after having been connected with the Aron Meter for the last 11 years.

Tredegar.—At the last meeting of the Bedwelty District Council at Pengam it was decided that an expert from Cardiff be engaged to report upon the cost of an electric light scheme for the whole of the Rhymney Valley area of the Council's district. It is suggested that the generating machinery be placed at Pengam.

City of London.—The Court of Common Council have received formal notice from the Charing Cross and Strand Electricity Supply Corporation of their intention to open all the principal streets in the eastern part of the City for the purpose of laying cables. The notice has been referred to the Streets Committee.

Barrow.—The Corporation intend to apply for sanction to borrow £12,000 for electric lighting in connection with the new town of Vickerstown on Walney Island, Barrow, which is being built by Messrs. Vickers, Sons, and Maxim and where over 1,000 houses are being erected for the workmen employed at the shipyard.

Wimbledon.—At the last meeting of the Urban District Council it was stated that Mr. Barnes Spencer had yielded to the Electric Lighting Committee's wish that he should remain with the Council. His salary is to be raised by £100 a year as from April 1 for a period of two years, at the end of which time the matter will be reconsidered.

Newport.—It is reported that there has been a mistake in the estimate of expense in putting up and equipping the new power station to the amount of something like £70,000. The estimate at first was about £130,000; now it is about £200,000. The foundations alone will involve a much greater expenditure than was at first thought.

Gravesend.—Application is shortly to be made for sanction to a loan to cover the cost of the proposed installation of the electric light system, including a supply of energy to the tramway company and others, with the addition of a dust destructor. The committee are about to view proposed sites for the works in company with Mr. Trentham.

Eastbourne Telephones.—The borough accountant is preparing a map showing the premises of those who have agreed to become subscribers to the municipal exchange, and the Town Council have notified the National Telephone Company that they are prepared to negotiate with them for the acquisition of the company's Eastbourne undertaking.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Cape Electric Tramways £400 000 shares of £1 each, fully paid, Nos. 1 to 400 000; Electric Lighting and Traction Company of Australia 20 000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 1 to 20,000.

Newport (Fife).—At the last meeting of the Town Council a discussion arose on a motion that the Council consider the advisableness of applying for a provisional order for electric lighting. It appears that the community of Newport are strongly of opinion that the quality of the gas is so bad that they would rather have electric light. The question was remitted to a committee.

Worksop.—An interview with the solicitors to the promoters of the Notts and Derbyshire Electric Power Company's Bill having proved futile, so far as securing the insertion of a clause to safeguard the interests of the Council is concerned, the latter have decided to oppose the Bill in Parliament. The Council are now spending £15,000 on electric lighting works within their district.

Southport.—At the meeting of the Chamber of Commerce last Friday a letter was read from the town clerk, stating that the Corporation were considering the desirability of establishing a municipal telephone exchange, and until a decision had been come to on that matter they could not consider any application from the Telephone Company for permission to lay down any underground wires.

Sales of Plant.—The Electric Lighting Committee of the Hull Corporation are about to sell four Willans Siemens direct coupled steam dynamos, together with spare armatures and other parts, switchboards, and accessories; and the Dudley Electrical Committee have for sale generators, belt-tightening gear, Westinghouse engine, wrought-iron stack, etc. Full particulars appear in our advertisement columns.

West Bromwich.—The Mayor has consented to open the works at Black Lake as soon as everything is ready for the generation of electricity. Several demands for power having been made, the Electric Lighting Committee have decided to carry a main down Swan-lane and Phœnix-street; a distributing main will also be laid along the latter street. It is also recommended that the Farley clock tower be lighted by electricity.

Monmouth.—The report of the Drainage Committee, adopted on Monday, stated that Messrs. Siemens Bros. had accepted the conditions offered by the Council, the Council agreeing to pay them £4,753. 4s. 5d. in settlement of the electric machinery, etc., supplied, including the extra dynamo now on order—£757. 4s. 5d. to be paid now, the balance, £3.996, with interest, to be paid by quarterly instalments extending over five years.

Twickenham.—The Council have consented, under the usual conditions, to an application from the General Post Office, in connection with the proposed new Post Office telephone service, to lay distributing pipes from time to time in order to reach the premises of the subscribers, and asking that the Council would give their general permission for the laying of such distributing pipes under the footways and streets within the district.

Dudley.—It is proposed that the scheme for the free wiring of the premises of intending users of the electric light be abandoned on account of the opposition of the Local Government Board. The price for current recommended is 5d. per unit throughout or 6d. per unit for two hours per day (the hours to be determined by the Corporation or their engineer from time to time) and 1½d. per unit for the remaining 22 hours, no rental to be charged for meters.

High-Voltage Switch.—The Electrical Trades Supply, Limited, of Birmingham, have forwarded to us one of their circular sheets, illustrating the high-voltage tumbler switch manufactured by them. The chief advantages claimed for this switch are a long break between the lever and contacts, wide space between the terminals, and improved leverage, while it is asserted that no leakage is possible. These high-voltage switches are made in three sizes, of 5, 10, and 20 amperes respectively.

Aberdeen.—The Council on the 4th inst. decided to borrow a further sum of £81 000 with the view of meeting the additional expenditure on machinery, buildings, etc., in connection with the electric light undertaking. It was remitted to a special committee to report as to the propriety of the Corporation obtaining a license from the Postmaster-General to provide a system of public telephonic communication for the city and district adjoining under the powers conferred by the Telegraph Act, 1899.

Pacific Cable.—Reuter wires that a resolution authorising Canada's share of five-eighteenths of £2,000,000—the cost of the Pacific cable—was adopted in the Dominion House of Commons on the 5th inst. Mr. Mulock, the Postmaster-General, said that as to the concession granted by New South Wales it was too late now for Canada to recede, as the contract was signed and the cable under construction. He denied the report that any pooling arrangement existed with the Eastern Extension.

Heathman's New Factories.—We have been asked by Mr. Heathman to mention that he will be pleased to show anyone over Messrs. Heathman and Co.'s new works at Rectory-road, Parson's Green, when in his direction. The various workrooms have been designed specially for the services they are to render. We note that the company's west central stock and showrooms, 37, Hadell-street, Covent Garden, and the Islington depôt at 7, Pentonville-road, will still be retained for the convenience of customers.

Bath.—The resignation of Mr. G. F. Metzger, the city electrical engineer, who has been appointed engineer to the Manchester Corporation, has now been accepted. Fifty applications were received for the post, and of these the committee selected three to appear before them—Messrs. Teague (Paisley), Sayer (Hampstead), and Pullen (Ealing). At a special meeting of the Electric Light Committee on Tuesday it was decided to recommend the appointment of Mr. Teague, at a salary of £350 per annum.

Accrington.—On Monday afternoon last, the Accrington Corporation new electricity works were formally opened by Councillor Jas. Cunliffe, chairman of the Electricity Committee. The Mayor (Mr. D. L. Sprake) subsequently spoke in highly appreciative terms of the work done by Councillor Cunliffe for the benefit of the ratepayers in connection with the undertaking. We hope to give illustrations and full particulars in an early issue. The electrical engineer's report for January states that there were 61 consumers connected with the mains. The average units generated had been 2 270, the average units delivered to the town 1,884 per week. The average fuel used per week was 7·5 tons, or 7·45lb. per unit generated. The appointment of Mr. Harold Gray as borough engineer, to take effect from Jan. 1, has been confirmed. The electrical engineer and surveyor are conferring with a view for temporarily heating the assembly-room in the town hall by electricity.

Leith.—A sub-committee has been appointed to consider the terms and conditions on which electricity was supplied to consumers, and also the practicability of free wiring and of hiring out motors. The provision of further generating plant at the power station, and a reduction in the charges for both light and power, will shortly be considered by the Council. The accounts of the electricity department show that the capital expenditure to date has been £44 014. 4s. 10d. Of that sum £35,000 has been borrowed for 30 years at 2¾ per cent., and £9,000 for five years at 3¼ per cent. It had been a hard year for the scheme owing to the high price of coal, of which 2,945 tons were consumed, costing £1 795. 8s. 11d., an average of about 12s. 2¼d. per ton. If coal could have been bought at 6s. 8d. a ton the price of the previous year, the revenue would have shown a surplus of £435 4s. 9d., instead of a deficit of £378. 10s. 10d. The income was: from private lighting £3,041; from motive power, £1 247; from public lighting £2 160; miscellaneous receipts £15—total, £6 385. The cost of generation and distribution was £4 743, leaving a profit of £1 641. This added to the credit balance brought forward, gave a total of £2,370 to meet payment of interest, £1,602, and repayment of capital, £1,298. On the whole, the accounts were very satisfactory. Attention was drawn to the fact that the amount of electricity sold compared with the amount generated showed a deficiency of 54,564 units, about 10 per cent. of the total production.

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North Shields.—The electric light supplied by the Tynemouth Corporation has been tested on several occasions during the past week, and has proved in every way satisfactory. A number of large arc lamps in the principal thoroughfares have been tried and found to give an excellent light. A number of places of business, the North Shields police station, and the Presbyterian church in Northumberland-square have also been lighted with the new illuminant, and the results produced have come up to the most sanguine anticipations.

Burnley.—The deputation appointed by the meeting of consumers of electricity waited upon the Corporation Electricity Sub-Committee on Thursday last week with respect to the method of charging for electricity supplied for lighting purposes. The deputation requested the sub-committee to institute a uniform system of charging, and that the price per unit be 3½d. The sub committee, after fully considering the present system, decided to abolish the maximum-demand principle of charging, and to charge 4d. per unit for all electricity supplied for lighting purposes.

Glasgow Technical College Scientific Society.—The eighth annual dinner of this society was held in the Bath Hotel on Saturday night, Mr. D. Home Morton, M.I.C.E. and M.I.M.E., occupying the chair. There was a large attendance. Mr. Andrew Stewart, A.I.E.E., who had officiated as honorary secretary to the society for the past three years, and had lately departed from Glasgow to fill the important position of manager and engineer to the Durham Power Distributing Company, Limited, was presented with an illuminated address and various other tokens of esteem.

Hendon.—At the last meeting of the Urban District Council a letter was received from Mr. G. D. Perks intimating that the approximate price at which his company could furnish current for electric lighting would be 3d. per Board of Trade unit. A communication was received from the borough of Hampstead intimating that the price for electricity in bulk would not be less than 5d. per Board of Trade unit. The Council decided to abandon the idea of taking a supply of electricity in bulk from an outside source and to proceed with the execution of their own electric lighting order.

Stockton.—At a meeting of the Town Council on Tuesday the electric works manager submitted an estimate, amounting to £21,000, for additional machinery required and the necessary cables in connection with the proposed extensions of the electric lighting system in the town. The manager was instructed to prepare plans and estimates of the future requirements for electric lighting, and it was decided to advertise in the meantime for tenders for a 300-kw. engine. The Rural District Council have decided to formally petition against the Cleveland and Durham Electric Power Bill, but it appears that the feeling is in favour of the Bill, provided that the Council's interests are properly protected.

Exeter.—Plans for the new electricity works at the Basin have been approved, and tenders for building and equipping the station are to be invited. The Council will consider any alternative complete proposals on the alternating system of equal efficiency, under guarantee, for the construction and equipment of the electric station, such proposals to be accompanied by estimates. Additional plans and specifications are to be prepared for dynamos, etc., for supplying electric current on the direct system for motor purposes, with a view of inviting tenders for the supply of such power in conjunction with the construction and equipment of the new station. The salaries of various members of the engineering staff have been increased.

Rochdale.—At a meeting of the Gas and Electricity Committee last week a resolution was received from the Rochdale Merchants' and Tradesmen's Association urging that it would be to the general benefit to have one uniform charge for electricity. The committee, however, could not see their way to any alteration in the present system of charges until the present method has had a full three months' trial. A discussion arose as to the decision of the joint conference on the utilisation of refuse for the generation of electricity. The committee resolved to be in readiness to supply electric power for the tramways when it is called for, and to recommend the Council to give orders for necessary additional plant to generate the power so required.

Salford.—The severe weather of the past month has caused some delay with regard to the outdoor work at the new electrical station at Strawberry-road, but (according to the *Salford Chronicle*) satisfactory progress is being made. The walls of the fine generating station are completed, and half the roof principals have been erected. Eight of the large Lancashire boilers are already in position, and a ninth will be delivered this week end. The erection of the two fine stone and brick chimney stacks is proceeding apace. These are to be 200ft. high, and the one nearest the roadway has already attained the height of 185ft. Plant and machinery are daily being delivered, and great efforts are being put forth to be prepared to supply the great demand for the electric current when any of the tramway routes are ready for it.

Presentation.—On the occasion of Mr. Cross, the present works engineer of the electricity department, leaving Aberdeen to fill the position of borough electrical engineer for Rotherham, he was entertained in the Bon Accord Hotel, Market street, by the staff of the department and presented with a case of drawing instruments, a collection of books on electrical and allied sciences, and a photograph of the present staff as a token of their esteem and good wishes. The city electrical engineer (Mr. J. Alexander Bell) presided, and referred to the excellence of the work carried through by Mr. Cross during the 2½ years he had been connected with the department. He said Mr. Cross was the first Aberdeen assistant who had been appointed a chief electrical engineer, which showed that Aberdeen was growing in standing and importance in electrical distribution in comparison with other towns.

Shipley.—At the last meeting of the District Council a statement was referred to which had appeared in the *Bradford Observer* to the effect that the Shipley District Council in their Bill were applying for powers to supply electricity to other districts. This was stated to be a misrepresentation. The Council were not making any such application, therefore it could not be necessary for the Shipley Bill to be opposed on that ground. It was also stated that it might be necessary for Bradford, as they were making an application for Baildon to be included in their area, to free Baildon from the necessity to take its gas from the Shipley Council. Provision was made in the Shipley Bill under which Bradford, for Heaton, or Baildon, for itself, might at any time, by giving six months' notice, obtain the right to supply its own district. It could not be contended that the powers of the Shipley Council should be voluntarily surrendered, or that Bradford or Baildon would attempt to compel Shipley to part with legitimately-acquired rights without proper consideration.

Croydon.—The borough electrical engineer's report, which was adopted at the last meeting of the Town Council, stated that the extra high-pressure main to Upper Norwood, laid in the autumn of 1898, specified to work at a pressure of 5,000 volts, and to stand a test pressure of 10,000 volts, notwithstanding its having successfully withstood this test at the works, does not now, as laid, meet the requirements of the specification, the failure not being due to deterioration, but to the fact that such a long length of cable requires larger margins of insulation to withstand the current produced by the machines than the makers have given it. The borough electrical engineer further reported that he had been in communication with the contractors with regard to the cable not meeting the requirements of the specification, and that the contractors had now expressed their willingness to lay a new cable, in accordance with the specification, from the central station to Upper Norwood, *viâ* Thornton Heath, free of cost, the Corporation to pay for the excavation only, the old cable being left in the ground, the property of the Corporation. The committee recommended that this offer of the contractors be accepted, and that the corporate seal be affixed to a contract embodying this arrangement.

Edwards Air-Pump Syndicate, Limited.—The third annual report of the directors, with revenue account and balance-sheet at Dec. 31, 1900, has just been issued. The royalties booked during the 12 months show an increase of over 32 per cent. on the previous year. The revenue for 1899 amounted to £3,219, while that for 1900 is £4,266. We quote from the report as follows: "In addition to the important contracts formerly booked for the London County Council, the Mersey Dock and Harbour Board, and the Corporations of Glasgow, Manchester, Liverpool, Salford, Bradford, Portsmouth, Halifax, Swansea, Newport (Mon.), etc., the Edwards pump was specified during the past year for the following installations: the Midland Electric Corporation for Power Distribution, Limited, the Metropolitan Electric Supply Company, Limited, South London Electricity Supply Corporation, Limited, Merthyr Tydfil Electric Traction Company, Limited, Melbourne Electric Lighting Company, and Calcutta Tramways Company; Leeds, Bristol, Burton-on-Trent, Torquay, Aberdeen, Wrexham, Accrington, Barrow-in-Furness, Derby, Southport, Warrington, Wolstanton, and Alloa Corporations; Wimbledon and Dartford Urban District Councils; Shoreditch, Hackney, Plumstead, and Wandsworth Borough Councils. More than 1,000 pumps are now at work or in course of construction."

Walker.—At a meeting of the District Council on Tuesday the Surveyor reported to the Electric Lighting Committee that electric mains were being laid from the Walker and Wallsend Gas Company's generating station at Wallsend along the riverside railway into Walker, and preparations were being made for the erection of a sub-station between the railway and Fisher-street, but no plan had been deposited for the Council's approval. The gas company were running the overhead cables from their station at Wallsend through Messrs. W. Richardson's boiler works in Walker, and were continuing them through the shipyard. It was recommended that counsel's opinion be taken. A resolution was proposed to reconsider the question of the destructor, as the estimates were higher than anticipated, and the usefulness of the destructor had been curtailed. It was stated that at the beginning it was estimated that the cost of the destructor, erecting an electric station, and providing plant would be £30,000. Already they had spent £13,000 for the destructor and £16,000 for the mains, leaving only £1,000 for the station. The Chairman said the destructor would save £500 a year to the ratepayers, and the sanitary conditions would be greatly improved. The entire expenditure would come out of the pockets of the electric supply company under an agreement already come to. The motion was lost by a large majority.

Basingstoke.—Mr. Reginald P. Wilson, electrical engineer, of 66, Victoria-street, S.W., has submitted to the Town Council a report on the proposal to introduce a scheme of electric lighting for the borough. The following estimates are appended to the report: Capital expenditure—engine-room and boiler-house, engine and boiler foundations, chimney, £4,750; boilers and mechanical stokers, feed pumps, pipe work, etc., £2,500; two 100 kw. and one 50-kw. sets, switchboard, balancers, traveller, etc., £4,050; cables, including all roadway work, arc lamps posts, switch pillars, meters, and house connections, say, £4,650; legal and engineering charges, etc, £1,250—total expenditure at end of third year, £17,200; probable cost of destructors, £750. Financial results: Revenue—private lighting (84,000 units at 5d.), £1,750; public lighting (including repairs, interest, etc.) (10,652 units at 2¾d.), £120; power supply (104,000 units at 2d.), £866;

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pumping water (218,400 units at ¾d.), £682; pumping sewage (155,520 units at ¾d.), £486; meter rents, £75—total units, 572,545; total receipts, £3 979. Expenditure—total works cost (198,625 units at 1·5d.), £1,237; total works cost (373,920 units at 0·6d.), £935; interest and sinking fund at 6½ per cent. on £17,200, £1,120—£3,292; balance being profit, £687—total, £3,979. The interest and sinking fund on the sewage and water pumps are not included in this figure because they will be borne by the committees responsible for sewage and water works respectively.

Bury St. Edmunds.—On Thursday week the Mayor and Mayoress (Mr. and Mrs. Shillitoe), accompanied by Mr. A. H. Roe (borough electrical engineer), and Mr. C. Oliver (former chairman of the Electric Supply Committee), assisted in the inauguration of the public lighting. The Mayoress switched on the current. There was no speechmaking. There are eight arc lamps, of the open, double-carbon, change-over type, and are capable of burning for 32 hours without re-carboning, serving to light 24 ends of streets or turnings of streets. The current for the arcs is taken from the private lighting mains, and the lamps are controlled by means of time switches. The arc lamps will burn from sunset until 11 o'clock, at which hour the incandescent lamps, fixed about half-way up the pillars, will be switched on, and will continue to burn for the remainder of the night. Each arc lamp is equal to about 2,000 c.p., thus giving a total of 16,000 c.p. Measuring from the centre of the globe, the height at which they are suspended is 22ft. from the ground. The small incandescent lamps are 12ft. Mr. A. H. Roe, the borough electrical engineer, is responsible for the design of the installation, and the work has been entirely carried through by the staff at Bury St. Edmunds electricity works. The three-core steel-armoured cable has been supplied by Messrs. Callendar and Co.; the pillars by Messrs. Macfarlane and Co., of Glasgow; the lamps by Messrs. Crompton and Co., of Chelmsford.

WORCESTER ELECTRIC LIGHTING ACCOUNTS.

The accounts of the electricity department of the Worcester Corporation for the year ended Dec. 31, 1900, have just been published, from which we give an extract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. An abstract of the report of Mr. C. J. Sutherland, city electrical engineer, to the Electricity Committee on the work of the department during the year is also appended:

Dr.	Revenue Account.	£	s.	d.
Coals		2,677	12	1
Oil, waste, and engine-room stores		217	11	3
Wages at generating station		1,037	0	7
Repairs to building, plant, and machinery		507	18	5
Wages of linesmen, fitters, and labourers		2	14	11
Repairs and maintenance and renewal of mains		16	2	7
Repairs and maintenance of transformers, meters, etc.		68	13	3
Attending and maintenance of public lamps		333	2	3
Rents		33	12	9
Rates and taxes		49	0	0
Salaries—engineer's department		481	10	1
Stationery and printing		63	13	10
General establishment charges		22	13	2
Law expenses		31	8	9
Compensation *re* accident		75	0	0
Insurances		52	7	4
Free Wiring Company		57	8	2
Lamps		266	16	2
		5,999	5	7
Balance carried to net revenue account		3,669	13	5
		£9,668	19	0

Cr.	£	s.	d.
Sale of current per meter, £8,152. 5s. 8d.; less discounts and allowances, £217. 3s. 4d.	7 935	2	4
Public lighting	1,378	12	2
Rental of meters, etc., on consumers' premises	219	18	1
Repairs, testing fees, carbons, etc.	5	10	0
Rent of water-mill at Powick, etc.	50	0	0
Rent of cottages	28	10	3
Sale of old iron, casks, etc.	33	15	1
Damage to electric lamp pillar	0	9	0
Employés' share of premium *re* insurance against accidents	1	16	7
On account of amount due *re* action Rucker *v.* London Electric Supply Corporation, Limited	15	5	6
	£9,668	19	0

General Balance-Sheet.

Liabilities.	£	s.	d.
Capital account—amount received	68,217	17	3
Sundry creditors	1,839	18	9
Balance at credit of net revenue account	93	19	10
Sinking fund account	9,908	8	2
Treasurer	16,227	12	0
	£96,287	16	0

Assets.	£	s.	d.
Capital account—amount expended for works	82,629	14	5
Stores on hand	498	18	4
Sundry debtors for current supplied	2,805	5	1
Public lamps	366	16	9
Other debtors	78	13	3
Sinking fund account	9,908	8	2
	£96,287	16	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units		842,132
Quantity sold { Public lamps 106,049 / Private consumers by meter.. 519,690 }		625,739
Quantity used in works		8,605
Total quantity accounted for		634,344
Quantity not accounted for		207,788
Total maximum supply demanded (kilowatts)		510

Number of public lamps: 57 arc lamps of 500 watts each, three incandescent lamps of 600 watts each, 13 of 60 watts each.

Mr. Sutherland's Report.

I have the honour to submit to you the following report on the results of the sixth year of working of the electricity department. I have followed the usual precedent, and included the result of previous years in order that they may be compared with those obtained in 1900. I think it is a matter for congratulation that the financial result shows a small profit, in spite of the large increase in the cost of coal. It will be noticed that the coal bill has increased by a sum of £1,051. 8s., and this is almost entirely due to the high price, and not, as might be supposed, to a largely increased consumption. As a matter of fact, the consumption for 1899 was 2,068 tons, and for 1900 was 2,157 tons. If this is reduced to pounds of coal per steam unit it will be seen that though the cost of coal per unit has increased from ·707d. to 1·027d., the weight of coal used has only increased from 11·19lb. per steam unit to 11·27lb. per steam unit. This small increase is accounted for by the fact that we were using a different class of coal during 1900. The item of oil, waste, etc., shows a small increase of ·015d., chiefly owing to the additional quantity of oil required by the Ferranti plant. The cost per unit of salaries and wages at works has again fallen, and has shown a steady diminution since the commencement of the supply, and the figure at which it now stands—viz., ·397d.—will be found very low in comparison with the majority of other undertakings. There is a rise of ·029d. per unit in repairs and maintenance to buildings and plant, etc., due to several repairs which had to be undertaken during the past year, and also to the fact that as the engines age they naturally require more repairs than when they are practically new. It will be noticed that the cost of repairs and maintenance of mains, etc., has fallen by ·024d., the reason being that in 1899 the repairs were heavier than usual owing to the breakdown of several transformers. The total works costs show an increase of ·323d., and as coal alone is responsible for ·320d. of this amount, I think the result may be considered satisfactory. Every other cost per unit including salaries, etc., has decreased until insurance is arrived at. This shows a small increase of ·004d., owing to the committee having decided to insure the works more fully against fire and the alternators against self ignition. Our payments to the Free Wiring Company have increased during the past year, but this is due to a larger number of units having been sold to free-wired customers, and is merely a receipt which is passed on to the company. The cost of lamps is, however, included, and though this has risen, it must be borne in mind that it is not a cost in the usual sense of the word, but is merely a discount formerly allowed for prompt payment, and is therefore no more a cost than a cash discount would be. As more units were sold during the first six months of 1900 (the period during which the lamps were allowed) it follows that the cost necessarily increased. Now that the giving of "free lamps" has been abandoned, the item will disappear from the accounts. The total costs have increased ·211d. per unit, and when it is remembered that coal increased ·320d. and lamps ·016d., it will be seen that if it had not been for the higher price of coal a substantial reduction in costs would have been shown and a profit of several hundred pounds would have been made. The units supplied to public lamps are returned as less than in 1899, but this decrease is more apparent than real. It is not possible to measure these units, and they have to be calculated from the hours the lamps are lighted. This year I have adopted a standard for calculation which I consider more accurate than the former method, and the result is that the units appear less; this new method also accounts for a larger percentage of units remaining "unaccounted for." The units sold to private consumers for the year 1900 increased 17·62 per cent., a satisfactory result, but slightly below the previous year, when the increase was 20·73 per cent. The waterworks used 24·22 per cent. more current for their motors, the total units being higher than any previous year. The mean price per unit obtained has risen from 3·638d. to 3·708d., owing to the increase in the price of current, which came into force in the last quarter of the year. It is worthy of note that the average price obtained for private lighting only is 4·48d. per unit, which proves the advantage of the maximum demand system of charging to the consumers, for as a whole they pay rather less than 4½d. per unit for current. The number of new customers connected during 1900 was 69, against 51 in 1899. This is a very good result, especially as the increase in prices mentioned above, which was rendered necessary by the high cost of coal, preventing many customers from coming on. With regard to the water power, I am pleased to say that this was much better than during the previous year, the result being

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that practically half our units were generated by water power—the actual figures are 50·87 per cent. by steam and 49 13 per cent. by water. There were only two floods of long duration, and the wet summer caused the water to hold out better than usual during August, September, and October. One result of the increased water power was that we were able to run both motors at the waterworks more frequently, and consequently the units used for pumping were much higher than usual, as mentioned above. The contract formerly existing between the Free Wiring Company and the Corporation was terminated last June, up to which time they had obtained 44 customers altogether. From June until the end of the year nine customers had availed themselves of the Corporation free wiring scheme, and there seems every probability of its becoming more popular as the advantages are more fully realised by the citizens. The Ferranti plant has run well during the winter load, and is proving very economical in steam—in fact, it is largely due to the use of this plant that our coal consumption increased so little in spite of the increase in units generated. When we have a good head of water the turbines are made to do all the load possible, and the surplus is done by the Ferranti plant, which is a much more economical arrangement than when we were obliged to run several Brush engines. There was an unfortunate breakdown of the Ferranti engine in November, and for some eight weeks it could only be run on the high-pressure side, which caused a large increase in the coal used during these weeks, amounting to some 50 tons. The valve gear on the engine has been remodelled and now runs very smoothly, and is less complicated than the old arrangement; and a new governor has recently been fitted, which is very satisfactory up to the present. It will be remembered that the Ferranti Company agreed during last year to alter the plant from 300 kw. to 400 kw. in lieu of penalties for delay, and though it will do the increased load it is not at present quite satisfactory when running with loads above 325 kw., and the company are giving the matter their attention. We are still in the same position as last year regarding reserve plant, and if the Ferranti set breaks down during the winter it will be a very serious matter, more especially if the accident should happen during a flood, when the water power is not available. The scheme for the new generating station in the town is now under way, but it is doubtful if if the plant will be available for use before the spring of next year.

UNITS GENERATED BY STEAM AND WATER POWER WITH PERCENTAGES FOR 1900

Month.	Total units.	Steam.	Water.	Steam, per cent.	Water, per cent.
January	87 366	56,528	30 838	64·6	35·4
February	70,898	43,698	27,200	61 9	38 1
March	68 966	24,856	44 110	36·0	64 0
April	56,956	10,764	46,192	18 9	81·1
May	50,938	8,922	42 016	17 5	82 5
June	44 580	13 838	30,742	31·0	69 0
July	49,024	31,738	17,286	64·7	35·3
August	55 072	18,669	36 402	33·9	66·1
September	65 056	50,173	14 883	77·1	22·9
October	82,955	62,120	20,835	74·8	22 2
November	101,201	45,237	55,964	44·8	55·2
December	109 120	61,874	47 246	56 7	43·3

Note.—July, September, and October only 36in. wheel for a few hours per day; Oct. 17 to Nov. 3, No. 5 turbine under repair. Floods: (1) Jan. 1 to 10; (2) Feb. 16 to March 14; (3) Dec. 28 to 31.

PROVISIONAL PATENTS, 1901.

FEBRUARY 25.

3964. **Improvements in electric igniters for internal-combustion engines and the like.** Anthony George New, The Voltage, Woking.

3965. **Improvements in automatic and safety subsidiary devices for controlling electrically-propelled vehicles and the like.** Anthony George New, The Voltage, Woking.

3967. **Improvements in dynamo-electric generators and electric motors.** Albert Dickinson and Thomas Preece, Armley Electric Works, Edinburgh-avenue, Armley, Leeds.

3972. **Improvements in machines or mechanism employed in the manufacture of pipes or tubes or for covering telegraph and telephone cables and wires with lead or other metallic substances for electric purposes.** Ernest Alexander Claremont and John Stratton, 4, St. Ann's-square, Manchester. (Complete specification.)

3982. **Improvements in electrical accumulators.** Henry William Cobb, 49, Crowther-road, South Norwood, London.

4005. **Improvements in or relating to electrical ship log apparatus.** Thomas Ferdinand Walker and Thomas Sydney Walker, 55, Chancery lane, London.

4008. **Improvements in controlling apparatus for electric lifts.** Herbert John Haddan, 18, Buckingham-street, Strand, London. (August Stigler, Italy.)

4007. **Improvements in telephonic apparatus for central stations.** Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

FEBRUARY 26.

4050. **Improvements in electrical switches.** Ludlow Patton Perkins and Henry Humphreys, 40, Victoria-buildings, Manchester.

4068. **A safety device for overhead systems of street electric transmission of power.** Cecil John Reginald Le Meeurier, 19, Perrymead-street, Fulham, London.

4098. **Improvements in railway electric signalling apparatus.** Washington Hume, 52, Chancery-lane, London. (Complete specification.)

4114 **Improvements in or applicable to the trolley system of electrical traction.** Sidney Harper Heywood, 70, Deansgate, Manchester.

4122 **Improvements in make-and-break switches or interrupters for electric circuits.** Georges Eugène Gaiffe and Gaston André Gabriel Contremoulins, 11, Southampton-buildings, Chancery-lane, London.

4123. **Improvements in and relating to slack-cable safety gears for electrically-operated lifts, elevators, and the like.** Charles William Hildred and Henry Cecil Walker, 60, Queen Victoria street, London.

4149. **Improvements in electrically-operated switches.** John Henry Spangler, 18, Buckingham street, Strand, London. (Complete specification.)

FEBRUARY 27.

4215. **Improvements relating to electric switches.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The Telephonfabrik Aktiengesellschaft, vorm. J. Berlinger, Germany.)

4243. **Improvements in electrical circuit breaking and making devices.** J. W. Beauchamp, 6, Lord-street, Liverpool.

FEBRUARY 28.

4259. **The preparation and use of calcium compounds for the electro-depositions of metals other than calcium.** James Kelly, 27, Branston-street, Birmingham.

4290. **Improvements in mica insulation for electric apparatus.** The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Charles F. Peterson, United States.) (Complete specification.)

4305. **An improved tidal meter for generating and transmitting electrical energy.** Richard William Derbyshire 73, St. Stephen's road, Upton Park, London.

4330. **Improvements in the connections or contacts of incandescent electric lamps for lighting and heating.** Herbert John Dowsing, 115, Cannon-street, London.

MARCH 1.

4337. **A new or improved stopping-place indicator for electric cars and electric railways.** James Bates MacKenzie, 2, Market-street, Bradford.

4366. **Improvements in safety devices for the trolley poles of electric cars.** Charles Revill Bellamy, William John Turner, and Daniel Richard Wallwork Hardman, 34, Castle-street, Liverpool.

4382. **An improved method of breaking the electric circuit in the overhead wires of electric tramways, railways, and the like, and apparatus therefor.** Cecil Charles Hewett, 185, Fleet-street, London.

4388. **Improvements in devices for producing, by the electric volatilisation of metal wires, flashes for use in photography.** Jules Courtier, 70, Chancery-lane, London. (Complete specification.)

4401. **An electric heater for liquids.** Thomas Kerrison Bellis 15, Bury street, St. Mary-axe, London.

4422. **Improvements in electric primary batteries.** Charles Albert Hussey and Stephen Greely Clarke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4429. **Improvements in or relating to electric storage batteries or accumulators.** Frédéric Marie Chaplet, 111, Hatton-garden, London.

MARCH 2.

4467. **An improved magnetic brake for motors for electric lifts and other purposes.** John Bush and Matthew Thomas Medway, 90, Lausanne-road, Peckham, London.

4469. **Improvements in electrolytic cells and in electrodes therefor.** August Alfred Vogelsang, 139, Queen Victoria-street, London. (Complete specification.)

4494. **Improved process for making electrodes for accumulators.** William Phillips Thompson, 322, High Holborn, London. (Akkumulatoren und Electricitäts-Werke Aktien-gesellschaft, vorm. W. A. Boese und Co., Germany.) (Complete specification.)

4501. **Improvements in electric switches.** George Wallace Coxson, 11, Burlington-chambers, New-street, Birmingham.

4508. **Improvement in accumulator plates.** Henry John Horatio Pickard and James Samuel Evans, 55, Chancery-lane, London. (Complete specification.)

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4509. Improved composition of paste for filling the cells of reticulated accumulator plates. Henry John Horatio Pickard and James Samuel Evans, 55, Chancery-lane, London. (Complete specification.)

4519. Improved construction of rail for electric and other railways or tramways. Charles Frederick Hengst, 166, Fleet street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on March 23.

1899.

25591. Apparatus for wireless telegraphy. Guarini. (Date applied for under International Convention, May 27, 1899.)

1900.

3949. Electrical speed indicator. Collinge and Collard.

3998. Voltmeters. Wise. (Aktien-Gesellschaft Electricitätswerke, vorm. O. L. Kummer und Co.)

4461. Electric cables or conductors. Glover.

4630. Electric accumulators. Müller.

5860. Electrical apparatus for hoisting or other intermittent work. Scott.

6301. Means for electrically igniting miners' safety lamps. Best.

7657. Cord grips for electric lampholders, ceiling roses, and the like. Burbey.

7792. Electrically-operated brakes for centrifugal drying machines or hydro-extractors. Longsdon and Dale.

7997. Electric gear for cranes. Kammerer.

8347. Trolley head employed in connection with electrically-propelled cars or vehicles. Taylor and Hudson.

11097. Electrical accumulators or secondary batteries and manufacture of same. Woodward.

15225. Electric arc lamps. Bremer.

17487. Telegraphones. Paramore.

19674. Electric railways working on the surface-contact system. Lake. (Brown.)

20778. Electric arc lamps. Heany.

20779. Electric arc lamps. Heany.

22585. Flexible supporting structures for electric lamps. Brewster.

23582. Electric block signalling and supplying electric current to trains in connection therewith. Cruvellier.

23892. Magneto-electric device for igniting explosive mixtures. Sturm.

1901.

776. Electrically-operated ploughs. Meissner.

1966. Positive rods for secondary electric batteries. Rore, Halifax, and Antrobus.

2117. Mechanism for actuating electrical igniters for internal-combustion engines. Abel. (Gasmotorem Fabrik Deutz.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Mar. 2	559	549	+ 10	26,409 *c*	22,994
Birmingham Trams.	,, 2	4,159	4,181	- 22	35,119	—
Blackburn Corp'rat'n	Jan. 13	1,191	—	—	2,724	— *b*
Blackpool Corporatn.	Feb 28	189	159	+ 30	29 710	21,883
Blackpool-Fleetwood	Mar. 2	139	177	- 38	1,228	1 290
Bolton Corporation..	,, 3	1,279	854	+ 425	12,697	6,625
Bradford City Trams	,, 3	797	385	+ 412	6,699	3,088
Bristol Tramways Co.	,, 1	3,670	2,743	+ 927	—	—
Carlisle Tr'mw'ys Co	,, 2	—	—	+ 122	975	—
Central London Ry.	,, 2	6,028	—	—	54,807	—
City & South London	,, 3	1,985	1,459	+ 526	18,073	10,473
Cork E. T. and L. Co.	Feb. 28	348	334	+ 14	2,846	2 543
Dover Tramways ...	Mar. 2	159	140	+ 19	1 373	1,309
Dublin & Lucan E.R	,, 2	74	58	+ 16	636	471
Dublin U.T., elec. cars	,, 1	3,040	2,938	+ 102	—	—
Dublin S.D. Electric	,, 1	642	639	+ 3	—	—
Dundee Tram Co. ...	Feb. 27	435	359	+ 76	—	—
Glasgow Corporation	Mar. 2	8,206	8,267	- 61	—	—
Halifax Corporation	, 3	735	559	+ 176	36 471	28,671
Huddersfield Corp'n.	,, 2	722	649	+ 73	33,186 *b*	30 614
Hull Corporat'n E.S.	,, 2	1,496	723	+ 773	65.688 *b*	—
Liverpool Corporat'n	Feb. 23	7,627	6,900	+ 727	62 070	52 588
Liverpool Overhead	Mar. 3	1,431	1,432	- 1	13,188	12,932
Portsmouth Corpn...	,, 2	549	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	,, 3	2,912	—	—	—	—
Southampton Trams	Feb. 28	536	360	+ 176	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	,, 22	381	244	+ 137	2,766	1,784

b Since April 1, 1900. *c* From June 1, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	10-11 xd
—— 40,001-70,000	5	—	10½-10⅝
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	—	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	—	85-90
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1⅝-1⅞
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	103-103 xd
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	109-113
—— Ordinary	5	—	15-16
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	5	—	2½-2⅝
—— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	2	—	1½-2 xd
—— 5 per cent. Debentures	5	—	3¾-4¼ xd
—— 4 per cent. Deb. Stock, Red.	100	—	93-90
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	—	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1⅞-2⅛
—— 7 per cent. Cumulative Pref.	2	—	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
W. T. Henley's Telegraph Works, Ordinary	5	—	16-17
—— 4½ per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	—	107-111 xd
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21½
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	38-42
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	11-12
—— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	—	11-12
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6⅞-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	..	70-75
Bournemouth and Poole, Ordinary	10	—	12½-12⅝
—— 4½ per cent. Cum. Pref.	10	—	10-12
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-80,000	5	—	6⅞-7⅛
Charing Cross and Strand	5	..	9½-10⅛
—— 4½ per cent. Cum. Pref.	5	—	5½-5⅝
Chelsea Electricity Supply	5	—	6-6½
—— 4½ per cent. Debentures	100	—	109-113
City of London, Ordinary	10	..	6½-7½
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	..	101-103
County of London and Brush Provincial, Ordinary	10	—	8-9
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4⅝-5⅛
—— 4½ per cent. First Mort. Deb.	100	—	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7⅛-8⅛
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	—	1½-2
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	12½-13½
—— ,, 85,001-96,769	5	—	7-8
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1½-1⅝
—— £5 Shares	5	—	7-7⅛
—— £4½ Shares, New	4½	—	5⅝-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	165-185 xd
—— 4½ per cent. First Shares Mortgage Debenture	$100	—	101-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	—	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15
—— 7 per cent. Pref.	5	—	8½-9½
—— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
—— 30,001-109,437	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9-9½
—— Pref. Half-Shares	5	—	4½-5⅛
—— ,, deferred	5	—	4-4½
City and South London, Consolidated Ordinary	100	—	46-50
—— Ordinary	10	—	4-5
—— 4 per cent. Debenture Stock	100	—	115-120
—— 5 per cent. Pref. Stock '91	100	—	132-137
—— ,, ,, ,, '96	100	—	127-132
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-15 xd
Brisbane Tramway	100	—	104-108
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9½-10½
British Electric Traction, Ordinary	10	..	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	11½-12½
—— 5 per cent. Perpetual Debenture Stock	100	..	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4½-5
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	100	—	96-99
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	10	—	4⅜-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10⅝
—— 5 per cent. Cum. Pref.	10	—	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
—— 4½ per cent. Debenture Stock	100	..	107-109
Telephones.—			
National Telephone, Ordinary	5	—	8½-8¾ xd
—— 6 per cent. Cum. First Pref.	10	..	11-13 xd
—— 6 per cent. Cum. Second Pref.	10	..	11-13 xd
—— 5 per cent. Non. Cum. Third Pref.	5	..	4½-4⅝ xd
—— 4 per cent. Deb. Stock, Red.	100	..	98-101
—— 3½ per cent. Deb. Stock, Red.	100	—	94-97
Oriental Telephone and Electric Company	1	—	1-1½

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NOTES.

American Institute of Electrical Engineers.—The January number of the *Transactions* of this institute contains some interesting papers read before the members last year. At the end of the volume are given two discussions under the headings of "Townsend on Transformers" and "Sheldon on Electrolytic Corrosion" respectively.

Submarine Torpedo Boats.—The naval estimates which were presented to the House of Commons this week make provision for the construction of five submarine torpedo boats. Some of these were said to be already in course of construction, and to be of the "Holland" type. This class of boat is propelled when under water by electricity from accumulators, which are charged from oil-engines. These latter also serve to propel the boat when at the surface. From accounts which are to hand of other types of submarine vessels, the Admiralty are experimenting with the best type.

State Electrical Laboratory in New York.—The New York State Senate will shortly consider a Bill for the establishment of a laboratory of electric engineering in connection with Union College in Schenectady. It proposes an appropriation of over £30,000 for the erection and equipment of the laboratory and between £5,000 and £6,000 a year for its maintenance. In consideration of this appropriation the State is to have the title to the land and 25 four-year free scholarships annually in electric engineering at the college. The selection of Union College is determined by the fact that the works of the General Electric Company are situated at Schenectady, and from them greater facilities are to be obtained.

American Telephones.—In a lecture on telephones recently before the New York Electrical Society, Mr. Kempster B. Miller pointed out that a board of 6,000 subscribers had hitherto been the limit of any telephone undertaking in America. Within three or four months, however, this will not be the case, for by that time the New York Telephone Company hope to have completely installed at their Cortlandt-street exchange a board of 9,400 subscribers, which will be one of the largest in the world. It is confidently asserted in the States that within five years or so the total number of telephones in the old city of New York will aggregate 100,000. In the year 1900 no less than 14,210 new stations were established in the district of Manhattan and the Bronx, which is practically the old city of New York.

Sydney Electric Trams.—In connection with the further conversion of the tramways in Sydney, N.S.W., to electric traction, we gather that some little difficulty arose recently in Elizabeth-street, owing to the disturbance of the telephone wires. It was the intention of the Postal Department, according to the *New South Wales Railway Budget*, to lay trunk wires in the telephone tunnels, and to remove the existing wires in Elizabeth-street in order to allow of the tramway overhead wires being erected. There was considerable delay, however, in putting the telephone wires underground, and until this was done it was decided not to run the electric trams on the new route, although the wiring had been practically completed. By this time probably the contemplated change in the telephones has been carried out, and the conversion of the next section of tramways may shortly be expected.

Society of Model Engineers.—The second visit in connection with the Liverpool branch of this society took place on Saturday, Feb. 23, when, by permission of the general manager, Mr. S. B. Cottrell, a party of members and friends inspected the Overhead Railway Company's power station at Bramley Moore Dock. The second annual general meeting was held on March 6, when the officers and committee for the ensuing session were elected as follows: chairman, Mr. T. S. Dawson; vice-chairman, Mr. S. H. Croker; treasurer, Mr. E. Thorp; hon. secretary, Mr. F. T. Stewart; committee, Messrs. Rimmer, Jackson, Kirby, Bootle, and Hastings. It was then decided to reduce the subscription to 5s. per annum, with an entrance fee of 1s. for new members, and that, if possible, a more central place of meeting be procured. Further particulars may be obtained on application to the hon. secretary, Mr. F. T. Stewart, 14, Adelaide-road, Kensington, Liverpool.

Overhead Tramway Conductors.—We gave in last week's issue descriptions of two means of preventing danger to the public when other trolley wires are broken, or when a falling telegraph or telephone wire makes connection with the trolley wire. In the last event, complete immunity from danger is furnished by either device. We notice, however, that the Dundee Tramway Department have adopted an alternative, which, we think, is not to be recommended, in view of the apparatus which we described in our last week's issue. Instead of relying on automatic earthing of the trolley wire when a telephone conductor falls across it, they propose in Dundee to provide on each tramcar a bamboo cane with an insulated cable, with the two ends of the cable bared. The conductor of a car then, in the event of a wire having fallen, proceeds to hook the upper end of this insulating wire on to the trolley wire to make connection with the lower end of the insulating wire and the earth. This would, of course, blow either the sectional fuses or the main cut-outs in the station, but we think that the arrangements suggested by Mr. R. Ulbricht, of Dresden, would give much more satisfactory results.

Electric Marine Railway.—An electrically-operated marine railway, probably the first in the world of its kind, was opened recently at Liverpool, Nova Scotia. On this occasion a vessel was hauled up a distance of 500ft. and lowered down again, all the apparatus and gear working satisfactorily. Some interesting facts about the railway are given in the *Canadian Engineer*, from which it appears that the equipment consists of a 30-h.p. induction motor, the motor shaft being geared to a heavy worm shaft and wheel. The worm-wheel shaft carries a pinion wheel, which gears into another large wheel, on the shaft of which is placed a large heavy sprocket wheel; over this sprocket wheel the heavy 2in. chain meshes into heavy sprocket teeth. This chain hauls the vessel up on a cradle over a track projecting out into the River Mersey to a distance of 500ft., on a grade of ½in. to the foot. The track and cradle are built of heavy pine timber. Whereas it formerly took from four to five hours to haul up a vessel, the motive power used being horses, the same work is now performed in 20 minutes. From the description, a slipway would be a more accurate description of the undertaking than a marine railway.

Competition.—We notice in the first issue of the *Electrical Review* of America for the current month an editorial article headed "The Factory and the Foreigner." In this article comment is made on the ease with which anyone from abroad is allowed to go through electrical manufacturing works in the States. The argument of the editor of our contemporary is this: that in view of the heavy competition which will arise between America, England, and the Continent, the permission to view works should not be granted so readily. The idea seems to be that the trade secrets of the American manufacturer are

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so valuable that he should close his doors, and keep all the information he has to himself. We should be the last to urge that this should not be done if it in any way pleases the American electrical engineers, but we are not at all sure that the closing of the works would have the result which the editor seems to think of giving manufacturers in the United States an advantage over their rivals. It is a curious fact that, as a rule, the manufacturing firm who makes the most parade of its trade secrets has fewer secrets worth guarding than the firm who allows free access to its works, always taking care to glean from those who go round their impressions of what they see. It is not in the manufactories that we fear competition on this side, but the industry requires more freedom from State interference.

Niagara Falls Switchboard.—Mr. A. B. Weeks describes in the *Electrical Review* of New York the switch gear now at work at the Niagara Falls Power Company's station. We gather from his description that this switchboard is the outcome of the experience of the station, which has now existed for many years. For handling the large currents which are generated, and also for dealing with the high-voltage circuits, many novel devices have been introduced. For instance, all switches throughout the station are operated by compressed air from small levers which can easily be worked by hand. Another point in which experience has been gained at the station is that circuit breakers for 5,000-h.p. circuits are much more reliable than fuses. An emergency switch is also provided for each of the large machines, having for its object the interruption of the field circuit in the event of a persistent short-circuit occurring on the lines supplied by the alternator in question. An ordinary short-circuit which tends to clear itself will not operate this switch, which requires a certain amount of time to act. In the earlier days the exciting current was supplied by rotary converters, which take their current from the alternating-current 'bus bars. Thus, when a severe short-circuit occurred, the 'bus bar voltage would drop and cause the rotary converter to fall out of step and interrupt the supply. As now independent exciting machines are provided for the excitation, the emergency switches have to be installed to give safeguard against such short-circuits.

Electro-Capillary Action.—The *Scientific American* for March contains an extract from the *Bulletin* of the Academy of Cracow, in which Constantin Zahrzewski describes a series of experiments which he has recently made upon the E.M.F. produced by capillary action. In these experiments it seems he used an apparatus consisting of two large glass vessels united by a capillary tube of glass, silvered on the interior. The vessels were half filled with water, and each vessel contained a metal electrode placed in the water at a short distance from the opening of the tube. The movement of the water through the capillary tube was produced by compressing the air in one of the vessels. The experimenter found that the movement of water through the tube gave rise to an electric current, the direction of this current depending upon that of the water. It was found that the E.M.F. depended upon the difference of pressure at the ends of the tube, and also upon the distance of the electrodes from the opening; when the electrode contained in the vessel toward which the current flows is removed farther from the end of the tube, the effect is diminished. The thickness of the layer of silvering seems also to have an effect upon the E.M.F., this being diminished as the thickness of the layer is increased. We should like to know what were the electrodes used in the experiments, and to be assured that the E.M.F. existed in spite of the fact that silver electrodes were employed as well as a silver lining for the capillary tubes.

Electrical Patents.—In looking through the list of patents issued during 1900, it is interesting to note how many of these are issued to the various electrical firms respectively. Thus we learn that last year the British Thomson-Houston Company obtained no less than 101 new patents. It does not follow, however, that these 101 inventions were made during the year by the staff of the British Thomson-Houston Company, as a very large number of them were communicated to the firm by the General Electric Company of America, and the patents are held in this country by the British Thomson-Houston Company as agents. The next highest number of patents granted stand to the name Messrs. Siemens Bros. and Co., who have protected 19 new inventions during the year. These, of course, represent actual improvements made by the members of the staff of the company, as the German firm of Siemens and Halske have also applied for and received 18 new patents. We notice with interest that Mr. C. B. Steinmetz is still actively working on electrical subjects, and that during the past year he obtained 14 patents in this country. Of course, with the patent law as it at present stands, it does not by any means follow that the whole of the above are valid. Amongst the American applications, for instance, we notice that a large number are for details of construction, which can hardly be classed as inventions. It has still to be seen how far these patents for details can really be claimed as inventions under the English patent law.

Electric Lighting Notices. — Elsewhere in this issue will be found an account of a case brought by the Marylebone Borough Council against the Metropolitan Electric Supply Company, Limited, which was heard before the magistrate last week. Eight summonses in all were issued, the ground of complaint being that the company had not adhered to the plans for laying mains which had been submitted to the Council. In six of these instances the company pleaded that they were guilty of having deviated the mains from the position in which they were shown on the plans as submitted. It was urged, however, on behalf of the company that in no case was the public at all interfered with in consequence of the deviation. The only offence which the counsel for the defence admitted was that the engineer had laid five electric mains more than had been shown in one of the notices in question. We have not seen the full report of the case, but it seems to us that the magistrate took a most exaggerated view of the technical offence which had been committed. As the law now stands, a company has no right to break up the streets in order to lay mains without giving notice of one month and depositing plans with the council concerned. It is quite impossible for the company to tell exactly whether it can find room for the mains which have to be laid, as we do not believe that any local authority has a complete plan of the pipes and mains in its streets. In consequence of this, we are not at all surprised to find that deviations of a radical character have often to be made. If this be so, it is manifestly absurd to fine the company £56 for a technical offence which they were practically powerless to prevent.

Tramway Track Pavements.—The vexed question of maintaining the street surface adjacent to a tramway rail always presents itself in any town in which trams are worked. In the first instance it is usual to make the street surface slightly higher than the tramway rails, and then complaints are made that damage is done to the wheels of other vehicles using the streets because of the projecting edge of the pavement, which is frequently of granite setts.

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In course of time this complaint ceases, and with the wear of the granite setts the rails begin to project above the pavement line. As the wheels of the cars then run along the rails before mounting, a groove is worn out in the pavement, which accentuates the difference. The ideal system is, of course, to do away entirely with the tramway rails, using automobiles, but the full conditions for such a service have not yet been solved. We notice that in certain towns in the States new work has been laid down in which the rails are of the ordinary "T" form with a heavy head, but with no groove. The pavement blocks next to the inside of the rail are then bevelled off so as to leave space for the flanges of the tramway wheels. Although special blocks are provided along the inside edges of the tramrails which are keyed in under the head of the rails, we think that there must be considerably more obstruction to the ordinary traffic than with the girder rail more frequently used in this country. Another point which has been experimented on in America is the use of vitrified blocks for paving the space between the rails. These it is said are giving great success, but we have no information as to the extent of the ordinary traffic in the streets in which such blocks are used.

The Nobel "Peace Prize."—Scientists will be interested to know that the Board of Education has now received through the Foreign Office a copy of the provisional special regulations for the award of the Nobel "Peace Prize." Dr. Alfred Bernhard Nobel, the inventor of dynamite, it may be remembered, left in 1896 a large sum of money for the most important discoveries in physics, chemistry, physiology, or medicine, for the most remarkable literary work of an idealist tendency, and for the greatest service rendered to peace. It is in regard to the award for the latter service that the special regulations have been received. The committee responsible for the regulations have decided that institutions and societies, as well as individuals, shall be eligible for the "Peace Prize," proposals for which must be sent to the Comité Nobel Norvégien, Victoria-terrasse, 3, Christiania, Norway, so as to reach the committee not later than April 1 next. Among the persons entitled to nominate competitors for prizes are the following: (1) members of the Norwegian Nobel Committee; (2) members of the legislative assemblies and Governments of the various States of the world; (3) members of the Commission du Bureau International Permanent de la Paix; (4) members and associates of the Institut de Droit International; and (5) university professors of law, of political science, of history, and philosophy. An abstract in English of the statutes of the Nobel Foundation and of the Nobel prizes (other than the "Peace Prize") can now be obtained on application to the secretary of the Board of Education, Whitehall. An appendix containing the regulations for the "Peace Prize" will be issued as soon as possible as an appendix to the abstract.

Berliner Telephone Patent.—We have now before us the full text of the judgment which was given in the United States Circuit Court on Feb. 27 of this year, in which the judge decided that the Berliner telephone patent was invalid. This patent, which was owned by the American Bell Telephone Company, was dated Nov. 17, 1891. The curious fact, however, was that the application for the patent was made by E. Berliner on June 4, 1877, rather more than 14 years before. In the original application it was stated that "these simple instruments will reproduce any musical sound uttered in the neighbourhood of one of them; but for the reproduction of special sound, such as speech, they are not adapted." The inventor also stated that he accomplished his objects by means of a make and break in the circuit, and the judge held that the drawings submitted with the application showed that it was intended to transmit sound by the erroneous method of interrupting the contact of the electrodes and breaking the circuit. He accordingly held that there was conclusive evidence that Berliner had not invented, and did not intend to apply for a patent for, a constant-contact speech transmitter. The rest of the judgment is well worth a perusal, as being an example of the working of the American patent law. During the interval which elapsed between the application for and the granting of the letters patent great progress was made in the art of telephoning. The Bell Company, who have obtained the control of the application, hoped to get a new lease of their monopoly by incorporating into the patent inventions which have since been made. The judge's decision, which has taken him 15 months to arrive at, is looked upon in the States as a great victory for the independent telephone companies. We understand that an appeal against the judge's finding is still possible.

American Patent Law.—A recent judgment in the United States on an appeal from a decision of the Commissioner of Patents relating to certain details of an electrical measuring instrument is particularly interesting, as showing one point of resemblance between the American and our own patent law. We gather from a note in the *Electrical World* that two of the claims were on mechanical operations, consisting in drawing a section of a metal over a mandrel, and subjecting it to pressure until a desired configuration is acquired, and then turning down the lateral edges. The decision of the Court, as it appears in the *Official Gazette* of the United States Patent Office, was that "this is a simple and well-known operation which contains no element of patentable novelty." Respecting two other claims at issue, the judgment runs: "The appellant has discovered that by taking a spool of sheet metal with a coil properly wound around it, and adjusting it in a certain manner on pivot pins, and adjusting the needle in a certain manner through the instrumentallty of the pivot which supports it, he can accomplish a desired purpose." The Court held that "this process or method, while it may require the use of delicate mechanism for its actual development and manifestation and to effect the desired adjustment, seems to be a mental operation entirely independent of such mechanism; that the process is first in the logical order of things, and the mechanism only a sequence." Several authorities bearing on the point were relied upon by the Court. It had been laid down, for instance, first, that processes involving a chemical or other elemental action, if new and useful, are patentable; second, that a process which amounts to no more than mere invention of the machine is not patentable; third, that a process or method of mechanical nature not absolutely dependent on a machine, although perhaps best illustrated by the mechanism, may, if new and useful, be the subject of a patent, even though it involve no chemical or other elemental action. In the States the decision of the Court in the case in question is looked upon not only as sound in law, but as establishing a precedent of the highest value to inventors.

Electrical Dredger.—In certain parts of California there are large deposits of gravel which contain an exceedingly small percentage of gold, which under the ordinary conditions it would not pay to work. These deposits are now being gone through by means of dredgers on which the motive power is electricity. The largest of these is at Sailor Bar, on the American River, about six miles from Folsom. The power for the work is taken from the Sacramento Electric, Gas, and Railway Company, which

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has its power plant not far from the place where the dredgers are working. The object for which the electrical power station was laid down, however, was to transmit power 22 miles into Sacramento, for which purpose the three-phase transmission at 11,000 volts is employed. To supply energy to these dredgers three 325-kw. oil-cooled transformers are used, which transform this voltage down to 500 volts on the dredgers, which work with chain buckets. A 150-h.p. three-phase variable-speed motor is used to drive the chain of buckets. These discharge the dirt into a revolving screen, which takes out the larger stones and lets the rest fall into a sluice box, where it is carried down by a stream of water over riffles, which catch the gold much in the ordinary way as is done in placer mining. A 75-h.p. motor supplies the water to wash the dirt through the screens, and a 150-h.p. motor is required to provide a large volume of water for the sluice boxes. On the dredger there is also a 20-h.p. motor for elevating and lowering the end of the bucket chain. It is curious to note that these dredgers are often worked in a pond excavated by themselves at a considerable elevation above the water-level of the river. The dirt is then, after being washed for gold, discharged behind the dredger, and so fills up the rear of the pond, while the working edge is continually being advanced as the dirt is removed. In order to keep up the water-level of the pond, a 40-h.p. three-phase motor is used to run a centrifugal pump forcing water up from the river. This plant, as illustrated in the *Electrical World*, was supplied by the General Electric Company of America, but we understand that the Westinghouse Company have also equipped a dredger which is working near Oroville. By means of these electrical appliances the cost of labour is so kept down, that it is said to be worth while working any ground which will yield 5 dwt. of gold for every cubic yard washed. This opens up a large field for these electrically-equipped dredgers, provided that the power supplied can be had at a reasonable rate.

Progress in Bradford. — Unfortunately, it is not often that an electrical engineer can look to the representatives of the gas industry for accurate information as to the progress of electrical undertakings, or for accurate comparisons between the advantages of electric light and gas lighting for street purposes. We are pleased to note, therefore, that the paper recently read by Mr. Charles Wood, F.C.S., at the annual meeting of the Manchester District Institution of Gas Engineers, is a marked exception in that it deals most fairly with all controversial matter, and gives most useful information of the progress of electric light and power distribution in Bradford. Mr. Wood at first deals with the use of incandescent gas for street-lighting. There are in Bradford no less than 10,346 incandescent burners in the streets, which, according to Mr. Wood, are giving most satisfactory results. Until 15 months ago both the gas and electricity undertakings at Bradford were controlled by one committee, and he considered that advantage had certainly been given to the electricity department. That was so because electricity was supplied practically at cost price, and the department was paid for most of the street-lighting which it did. The gas department, on the other hand, was made to contribute large sums annually towards the expense of other Corporation departments, besides providing 98 per cent. of the public lighting of the city. Mr. Wood then proceeded to deal with the increase in the sale of electricity, noting that last year more than 93 per cent. of the electrical energy sold was supplied to motors, and this year he expected that more energy would be sold for driving motors than for lighting purposes. In the above comparison the energy used for tramway purposes is not taken into consideration. Dealing with the question of electrolysis of gas-mains, Mr. Wood stated that in Bradford there had been several miles of electric tramway in operation for 2½ years, but so far as he had been able to detect with certainty, there was no damage done to the pipes by electrolysis. There had been one gas-pipe destroyed by being directly connected to a faulty cable, but otherwise there had been no trouble. He thought that the distance between the gas-pipes under the pavement and the rails of the tramways had something to do with the immunity from electrolytic damage. Without a doubt, the stringent Board of Trade regulations have often more to do with the result, and we think that Mr. Wood's fear that in the future considerable damage may be found is not likely to be realised if, as he states, there have been no clear indications of damage in the 2½ years of working.

The Proposed Manchester Tube. — Up to the present the scheme for providing a quicker and better form of communication between the different parts of the city of Manchester by means of an electric underground railway, has not advanced far beyond the stage of preliminary discussion and financial calculation. A statement as to the course proposed to be pursued, however, has been made, giving some particulars of the venture, from which it appears that the circular system will be introduced. It is pointed out in the local Press that such a circle, if it embraced only the area contained within an imaginary line drawn round the principal railway stations, would be rather circumscribed, but an outer circle would serve to connect such distant places as Longsight and Trafford Park. This outer circle, indeed, would supply the want caused by the alleged inability of the Tramways Committee to establish a system of through routes, or to inaugurate, for the present at any rate, an outer circle of tramways. To the north of Manchester there is a very populous district, and it is suggested that the outer circle, if decided upon, should embrace such places as Pendleton, Broughton, Cheetham, Harpurhey, Newton Heath, Openshaw, Longsight, and Alexandra Park. So far, at least, as the inner circle is concerned no great engineering difficulties, it is expected, would be met with. The red sandstone would allow the tunnel to be lined with concrete in the ordinary way, instead of with the steel casing which is necessitated by the London clay. A double tube, as in the case of the Central London Railway, is in contemplation, so that traffic could be managed in either direction without the possibility of collision. A second scheme is for the construction of a tube connecting London-road, Exchange, and Central Stations, with intermediate stopping places. This line would be 2⅝ miles long, and its cost is estimated at two millions. In view of the fact that the Corporation have just taken over the tramways in the city, it is generally anticipated that considerable opposition would be offered by them to any scheme which would interfere with the success of the system. Congestion of the streets in large towns and cities is admittedly a great evil, and the only practical means by which this may be relieved is by the introduction of underground communication. It is, therefore, in the interest of the city that such a scheme as suggested above should be matured, and in the event of any opposition on the part of the Corporation being successful it will be another case of the municipal authority quashing private enterprise, the introduction of which would be directly for the benefit of the inhabitants.

New South Wales Tramways.—The New South Wales Railway and Tramways Commissioners are setting a good example to government departments in other parts of the world. We have just received their report for the

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quarter ended Dec. 31, 1900, including the statistics for the whole year. Dealing with tramways, the position at the end of 1899 is compared with the present state of things. Thus, at the end of December, 1899, the number of miles open was 69½, against 78¼ miles on Dec. 31, 1900; revenue £97,372, against £134,835; expenditure £83,411, against £115,269; tram miles run 956,458, against 1,650,028; earnings per tram mile 2s. 0½d., against 1s. 7½d.; expenditure per tram mile 1s. 9d., against 1s. 4¾d.; percentage expenditure to earnings 85·66, against 85·49; and number of passengers carried 15,355,078, against 23,193,639. The increased mileage includes the three following routes, which were opened for traffic during the past year: Kensington race-course to the rifle range; Military-road to the Spit, middle harbour; and Kensington line to Randwick race-course—representing a total length of just over two miles. It is interesting to note what wages and salaries the Government pay to their tramway employés. In the engineer's department a draughtsman receives £3 a week, while engineers are paid 12s. a day, electrical mechanics 9s., dynamo attendants 9s., armature winders 12s., labourers and firemen 8s., cleaners 3s., fitters and turners 10s., trimmers 7s. 6d., greasers 3s. 6d., electric light trimmers 5s., watchmen 6s. a day, apprentices £30 per annum, and linesmen 50s. a week. These are, as a rule, the payments made on appointment, and are subject to rises. We notice in a recent issue of the Sydney *Daily Telegraph* a very comprehensive article by Mr. W. M. Fehon, the traffic expert amongst the Commissioners, entitled "Railway Federation," in which he sketches out a form of federation, based upon a seven years' average, under which the railway capital accounts could be consolidated. Editorially commenting on this, the *Daily Telegraph* points out that at present the position of the railways under the constitution is a very unsatisfactory one. "If the federation of the railways," the editor concludes, "added but a few shillings an acres to the value of our lands south, north, and west, as it certainly would do, the Government of this State would be enriched by many millions." We might add that if the policy of State ownership of tramways now obtaining in New South Wales becomes the policy of the Federated Commonwealth, an asset would be created the growing importance of which it is impossible to overestimate.

Electrical Transmission from Coal-Mines.—Mr. H. W. Hart, dealing with this question in the March number of the *Electrical World*, takes the case of the Albemarle Mine, near Bland, New Mexico, where some three years ago the Cochiti Gold Mining Company erected a large cyanide mill, installing at the same time a large Corliss engine for driving the crushers, rolls, etc. Then the question of fuel arose, as wood cost something like £1 per cord, and owing to the exceedingly rough nature of the surrounding country the supply was very limited. At Madrid, some 32 miles away, there were large coal deposits belonging to the Santa Fé Railroad. As bituminous coal of an excellent quality and almost unlimited quantity could be obtained at a nominal price, it was decided—a careful examination having proved that there was no available water power—to instal a modern steam plant at Madrid and transmit power electrically to the Albermarle mine at Bland. Current was turned on for the first time on April 13 last year. With the old steam plant, using cord wood as fuel, the total cost of supplying power for hoisting and milling 200 tons of ore per 24 hours was about £45 per day. The cost of doing the work with electrical energy is just over £10 per day for treating 300 tons of ore. Whereas formerly the coal company at Madrid had to ship water in tank cars a distance of 40 miles for feed purposes. On the introduction of the power plant for the transmission of electrical energy, feed water was obtained from the Galisteo River, some 14,000ft. away, through a 4in. pipe. A motor-driven deep-well pump, with the pump barrel 200ft. below the surface, delivers water to a small receiving tank, from which the force pumps deliver it through the 4in. pipe line to two steel storage tanks, having a capacity of 100,000 gallons. The power-house equipment, when complete, will consist of two General Electric three-phase, revolving-field type, 605-volt, 60-cycle generators, direct-connected to 32ft. by 48ft. Allis-Corliss engines, running at 90 revolutions per minute. There are also three step-up transformers of 200 kw. each of the vertical air-blast type, wound to transform a voltage of 605 to 20,000, and having a full-load efficiency of 97 per cent. The boiler equipment consists of two batteries, each consisting of three 175-h.p. return tubular boilers, built to stand a working pressure of 125lb. The coal is drawn from the coal-bins through spouts at convenient points in front of each of these boilers. The pole line of transmission is designed to eventually carry two circuits of wire, the three wires of each circuit being placed at the points of an equilateral triangle, the distance between wires being 24in. A telephone circuit of hard-drawn copper is placed 5ft. below the power circuits. The power circuits are transposed every half mile, the telephone every five poles. A satisfactory point is that no difficulty is experienced from inductance on the telephone circuit. During the course of construction many difficulties were met with owing to the character of the country, and on one particular section the heavy pine timber made it necessary to clear a right of way for several miles, some 6,000 trees being cut out. Poles for the entire line had to be hauled on wagons from a point near the Albemarle mill. A supply box is placed at each telephone station, and in it are kept all materials required for repairing that particular section of the line. Glass insulators of the Provo type, manufactured by the Hemingray Company, were used, mounted on special locust pins, which were boiled in paraffin. The energy loss in the line when delivering 600 kw. to the mine is 8·5 per cent. The equipment at the receiving end of the line consists of three 180-kw. transformers, reducing the potential from 18,500 volts to 605. The transformers are of the vertical air-blast type. A distributing board of blue Vermont marble is equipped with primary and secondary switches for each motor circuit, and the necessary instruments. The motors at this end of the line are one 150 h.p. for compressor; one 100 h.p. for hoist; two 150 h.p. for mill; one 20 h.p. for sawmill; two 20 h.p. for Peletin tanks; one 10 h.p. for solution pumps; one 10 h.p. for machine shop; one 1 h.p. for transformer blower; 10 h.p. for lights—making a total of 621 h.p. At the generating end the motors are: one 20 h.p. for motor-generator set; one 10 h.p. for coal conveyor; one 10 h.p. for ash conveyor; one 10 h.p. for coal crusher; one 1 h.p. for transformer blower. At the pump-house, 14,000ft. from the power-house, there are two 10-h.p. 450 revolutions per minute motors geared to triplex feed pumps for forcing water up to power-house, and one 10-h.p. motor belted to an artesian deep-well pump. This makes a total of 702 h.p. in induction motors. The demand on the power plant is practically for continuous service, but on Sunday mornings the plant is shut down in order to take up wear and make any necessary adjustments. The engine, however, at times, has run 21 days without interruption. The entire electrical equipment was supplied by the General Electric Company, and the author was responsible for the design and construction of the plant.

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THE TRAFFORD PARK POWER WORKS.

The first electrical station to be worked in England with the special object of supplying power in bulk to large manufacturers is that of the Trafford Power and Light Supply, Limited. The works of this company are not yet so far completed as to give the economy in generation which will ultimately be obtained; they are, however, supplying already a number of important works at prices which are below those charged anywhere else in the United Kingdom. We also believe that the prices will compare favourably with the charges made in many power distribution systems abroad in which the energy is obtained from water. In any scheme for the distribution of electrical energy in quantities it is essential, in the first place, that the prices charged shall be such as to induce long-hour consumers to take a supply. If this is done, it is found that new factories are attracted into the districts which can be supplied, as is witnessed by the large growth of new industries round the Niagara Falls power works.

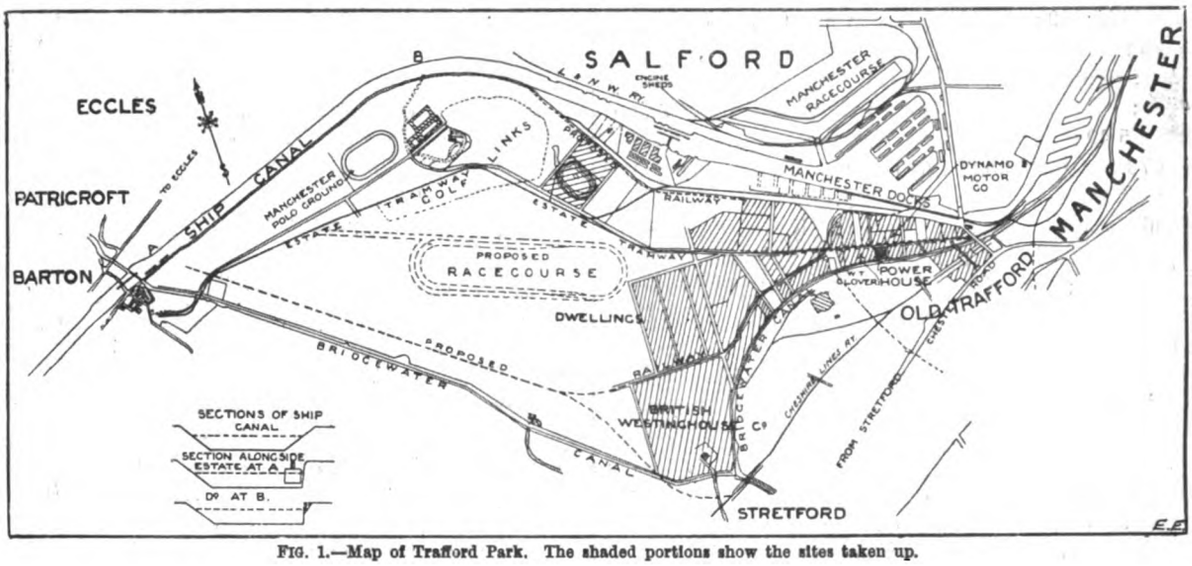

FIG. 1.—Map of Trafford Park. The shaded portions show the sites taken up.

Trafford Park, which has a history going back for many centuries as the estate of the Trafford family, was acquired for industrial purposes some few years ago by the Trafford Park Estate, Limited. The map (Fig. 1) which we give herewith shows how conveniently situated the estate is for the establishment of large manufactories. This will be evident by the exceedingly numerous plots which have already been taken up on the estate, the factories on many of which are already running. Amongst these are the

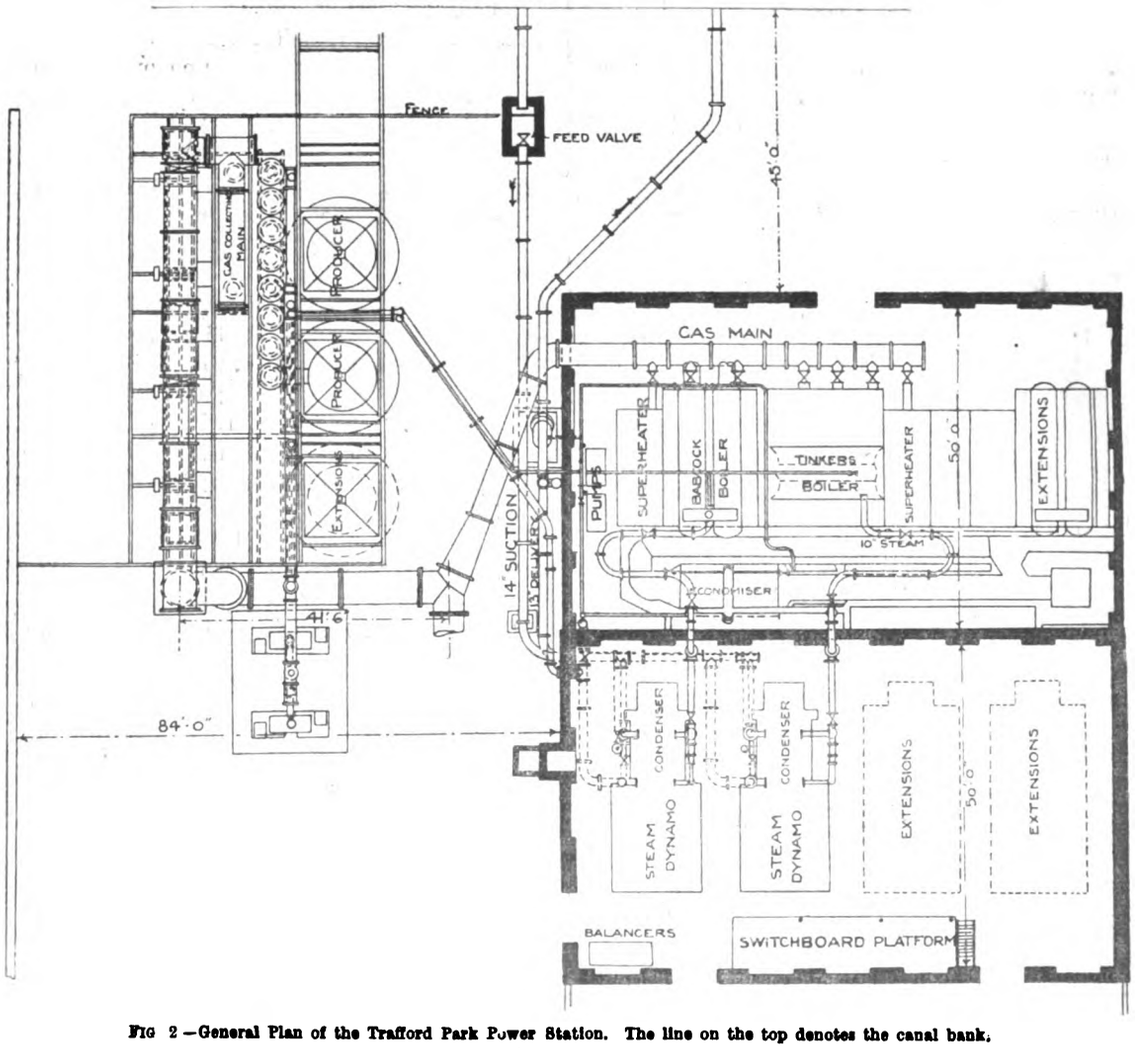

FIG 2.—General Plan of the Trafford Park Power Station. The line on the top denotes the canal bank.

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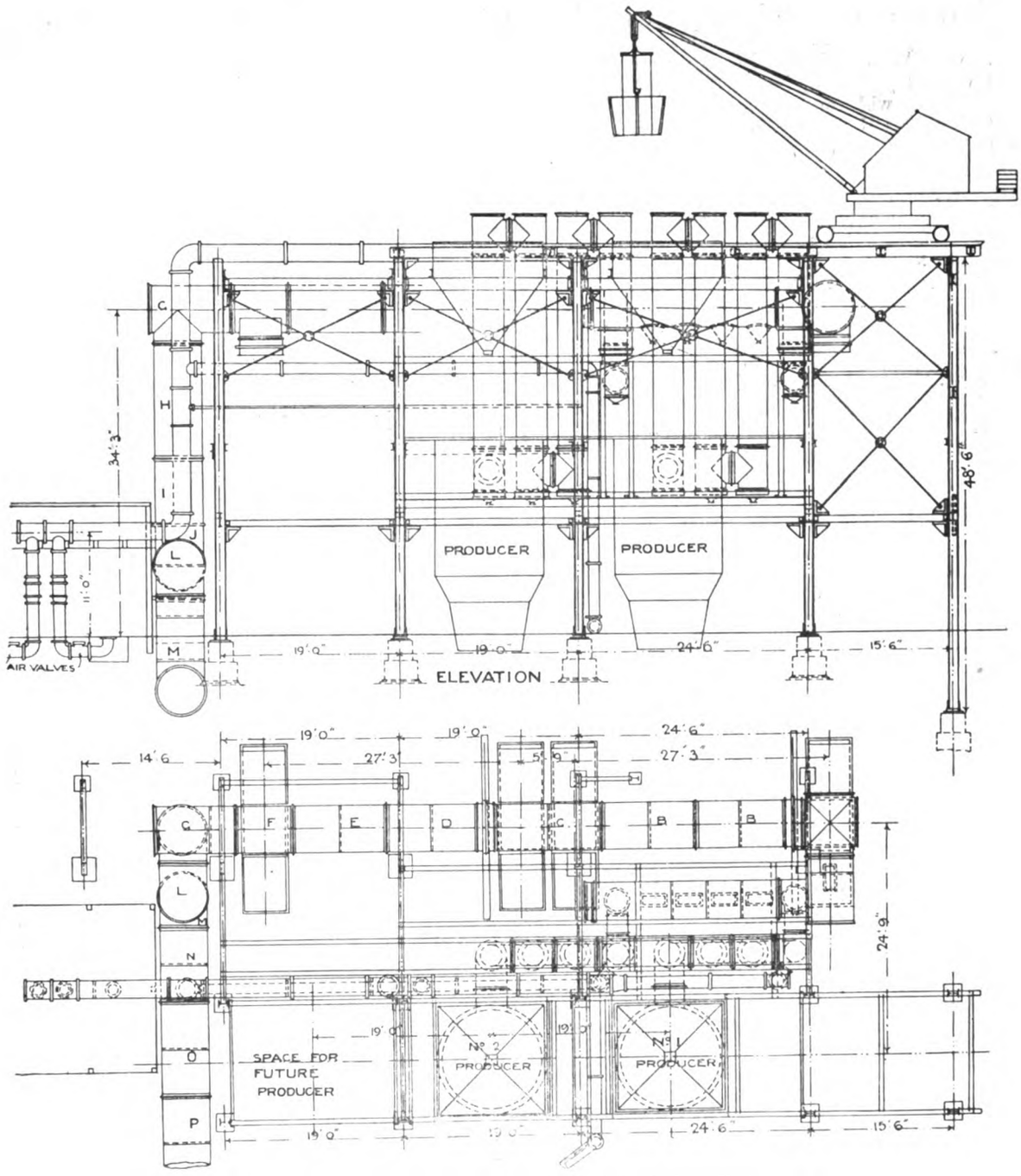
extensive new works of Messrs. W. T. Glover and Co., Limited, for the manufacture of electrical cables and accessories connected with the laying of the same. Again, the Lancashire Dynamo and Motor Company, whose name is appearing frequently in the list of accepted tenders for public contracts, have a well-equipped factory in working order on the estate. Another electrical firm just about to build are Messrs. Royce and Co., of Manchester, while the British Westinghouse Company have secured a very large block on the estate. The roof principals of the latter company's factory are now being erected. We mention these names as an example of the way in which the electrical industries have approved of the facilities offered on the estate, but it is more than probable that the power company will obtain its largest consumers, and also its longest-hour consumers, amongst the many other industries in connection with which warehouses or factories are erected or in course of construction. Amongst these the grain elevators and stores figure largely. It will be seen from the map that the Manchester Ship Canal forms the boundary on two sides of the estate, while the other two boundaries are made by the Bridgwater Canal. The Manchester Ship Canal is 50ft. wider than its normal width where it adjoins the estate, and ships can be moored and discharged at any point along this canal. The Bridgwater Canal also provides a cheap means of transporting coal, iron, and other materials on to the estate on the south-east and south-west sides, and also for the removal of manufactured goods. Ample railway connections are provided in addition to the water transport facilities. We believe that the conception of the power scheme was due to Messrs. W. T. Glover and Co., who organised a limited liability company for its equipment. Before embarking upon this enterprise the company retained the services of Messrs. Lacey, Clirehugh, and Sillar and Mr. L. B. Atkinson, and these gentlemen have jointly advised the company on the various questions which have arisen from time to time during the progress of the works. We are indebted to them for the information we are able to give below. We also gather from Mr. Clirehugh that the scope of the power distribution company is not restricted to the estate itself, as it is able to supply in bulk to no less than three local authorities whose districts adjoin the estate. The power distribution company have offered these authorities exceedingly low terms for the supply of power in bulk, which terms are, we understand, some 20 per cent. lower than those of the South Lancashire Power Company—in fact, if the load in the local authorities' system gives about a 14 per cent. load factor, the charge works out under the proposed scale to 1·87d. per Board of Trade unit. We understand that the negotiations



FIGS. 3 AND 4.—Plan and Elevation of the Mond Gas Producer Plant.

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for the supply of two out of three of these local authorities are so far advanced that contracts are likely to be signed shortly.

The Power Works.

In the design of these power works, Messrs. Lacey, Clirehugh, and Sillar have introduced a new combination of a steam plant with a gas-producer, which has not hitherto been tried in electrical power works. Of course, for many years boilers have been used in ironworks which have been fired by blast-furnace gases, but we believe, that the Trafford Park undertaking is the first case in which a gas-producer plant has been laid down with the special object of providing a gaseous fuel for boilers. This gas-producer is of the Mond type, and we understand that Dr. Mond has taken considerable interest in the undertaking. We are debarred from giving the full particulars of this gas plant, but the general arrangements and advantages will appeal to our readers. In the first place, it is proposed not only to distribute electric energy from the Trafford power works, but also to distribute the Mond gas for heating purposes. This will increase the output of the gas plant and enable larger quantities of that valuable by-product—sulphate of ammonia—to be obtained. We need hardly say that with a gas-producer of this kind the cost of extracting the by-products goes down exceedingly rapidly with an increase in the size of the plant.

As far, however, as generation of electrical energy is concerned, there are many advantages from gas-firing the boilers. The first and most important is that of cost. With the coal, or rather the slack, which will be used at the works, either when firing direct under the boiler or for the generation of power gas in the gas-producer, the first cost under normal conditions averages about 7s. per ton. It costs on an average about 1s. 6d. per ton to handle the coal on its way to the furnace and to remove the ashes afterwards, which brings the cost up to 8s. 6d. per ton. It is found by actual experience that one ton of sulphate of ammonia can be recovered from every 23 tons of coal which are burnt in the gas-producer. With sulphate of

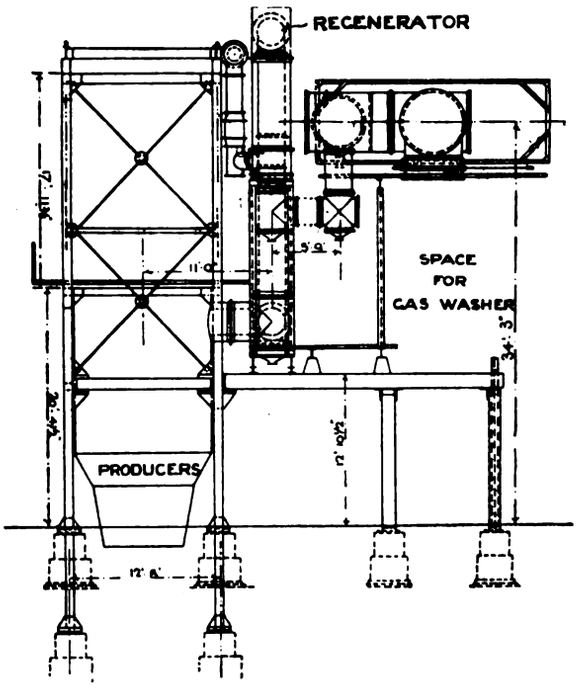

Fig. 5.—End Elevation of the Gas Producer.

ammonia just over £11 per ton, this means that the residuals obtained from every ton of coal are worth about 10s., or 3s. more than the original cost of the coal if the labour items are not increased. As regards the handling of the coal, it will be seen from the accompanying drawings that the cost of labour in connec-

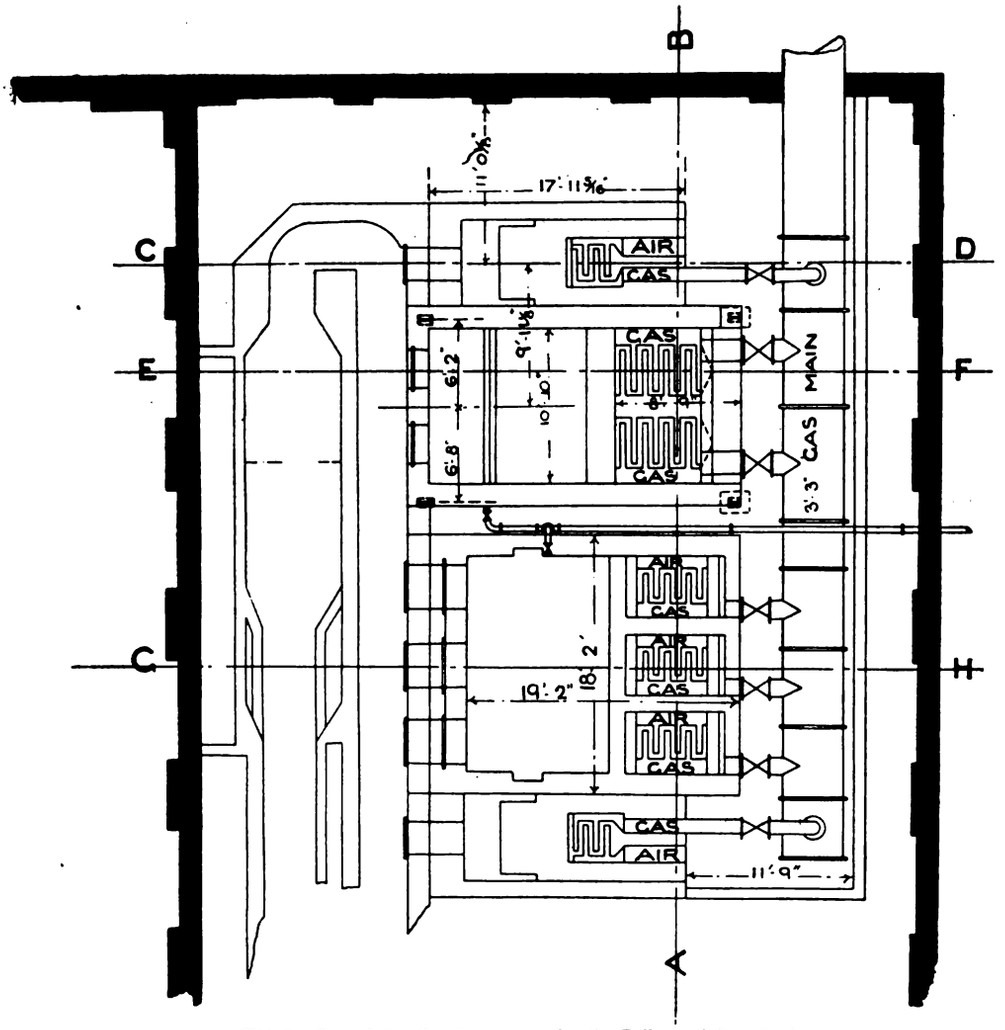

Fig. 6.—Plan of the Gas Furnaces under the Boiler and Superheaters.

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tion with the gas-producer is exceedingly small. In the Trafford Park district this slack coal is bought in boxes, which are brought alongside the works in barges. These boxes are actually filled under the screens at the coal pits, and hence the colliery owners will supply the slack coal in boxes at a cheaper rate than in bulk in consequence of the greater ease in handling. A general plan of the power works is shown in Fig. 2, while an elevation and plan of the two first gas-producers are shown in Fig. 4. The crane seen in Fig. 3 runs over the producers, and when turned round can lift these boxes charged with coal direct from barges in the Bridgwater Canal. When the boxes have been brought by the crane immediately over to hoppers of the producers, the bottoms of the boxes are released, and the coal falls into the hoppers over the producers. These large hoppers act as bunkers, and the coal is dropped down into the gas-producers as required. The coal falls by gravity on to the firebars of the producer, and a mixture of air and steam is passed through the incandescent mass. It may be mentioned here that the steam for that purpose is obtained from the exhaust of the engines. As will be seen later on, there are practically two steam-engines on one shaft driving each of the large dynamos. As it is improbable that at first the whole of the steam from one set will be required for the producers, the exhaust piping is so arranged that the one engine of the set can be worked condensing while the other

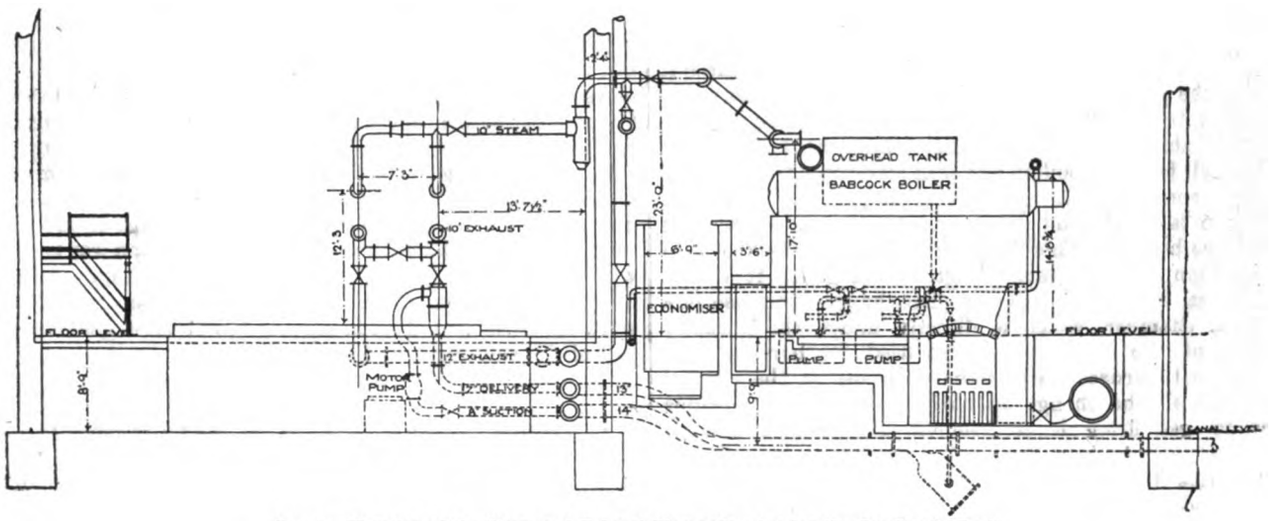

FIG. 7.—Elevation of the Steam and Exhaust Pipes; also showing the Gas Supply Duct.

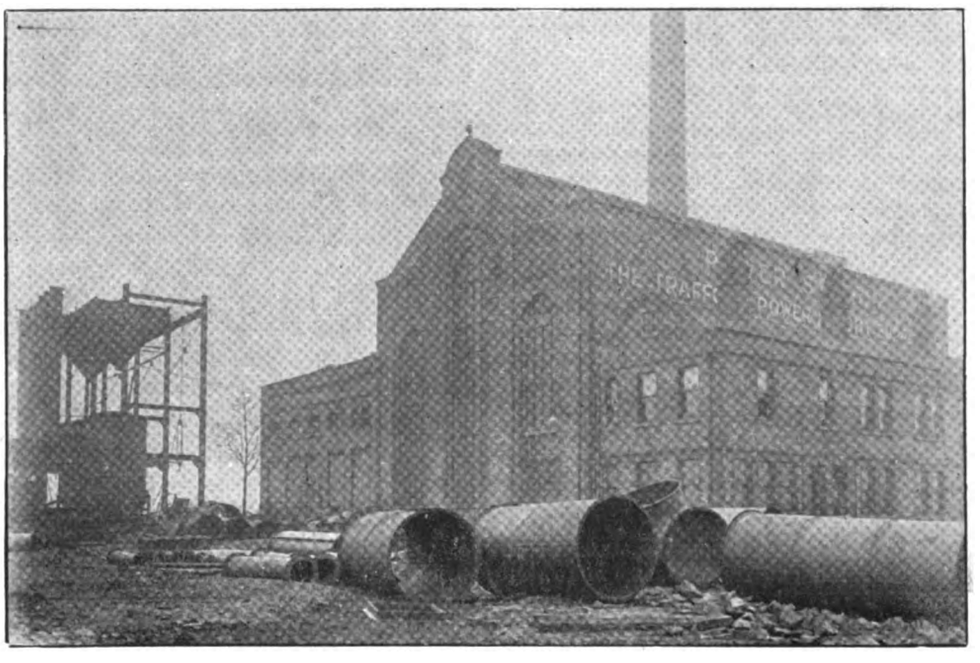

FIG. 8.—General View of the Trafford Park Power Station.

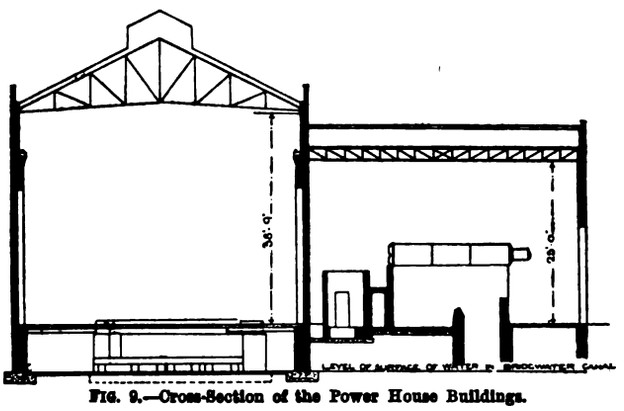

FIG. 9.—Cross-Section of the Power House Buildings.

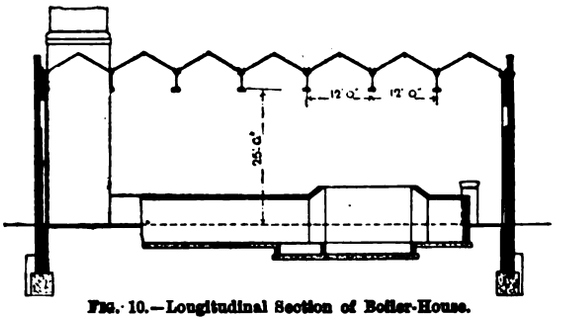

FIG. 10.—Longitudinal Section of Boiler-House.

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engine is passing its exhaust through the producers. By this means an independent boiler to supply steam for the producer, as has usually to be employed, is saved, while at the same time the engines are worked condensing whenever possible. Another view of this producer is shown in Fig. 5. The gas as it leaves the producer is passed through the large regenerator pipes seen in the drawing. From these it goes to the gas-washers, which will be placed in the space indicated in Fig. 5, and after having had the ammonium sulphate abstracted the gas passes into the supply pipe which will feed the boilers, and will also supply the system of pipes conveying the gas to various parts of the estate. In Fig. 6 is shown the arrangement for burning this gas under the boilers. This illustration should be looked at in conjunction with the elevation given in Fig. 7. It will be seen from these two together that the gas is burned in a firebrick chamber, which is directly under the ordinary firebars of the boiler which are used for burning coal. These coal furnaces are actually in use at the present time, and all the change that has to be made to change over to gas firing is to remove the firebars and to uncover the arch above the gas furnace. This arch is made of firebrick with a number of interstices through which the incandescent products of combustion pass up through to the boiler. The lower part of the combustion chamber, which is shown in Fig. 6, and in sectional elevation in Fig. 7, consists of two chambers divided by a zig-zag partition of firebrick. The air is admitted on one side of the chamber, while the gas is admitted at the other. The air and gas pass along the spaces left between the firebrick partition, and then rising over it mingle the one with the other. We understand that the combustion takes place just over the firebrick partition, while the arrangements are such that there is no danger of explosion taking place at the point of admission, as the air and gas are not mixed until they have risen to a certain height in the furnace. The crown arch of firebrick becomes exceedingly hot, and thus ensures complete combustion of the gaseous mixture passing through it. It will be seen that at the side of each of the sets of boilers, one of which consists of three furnaces and the other of two, there is a small independent furnace. These two smaller furnaces are to be used for heating up the Schmidt superheaters, two of which are being provided. This independent firing of the superheater will enable the degree of superheat to be accurately adjusted. It is proposed to work with 300deg. F. of superheat on the steam at the superheater, which will give at least 250deg. at the stop valve of the engine. These superheaters are being supplied by the firm of Messrs. Schmidt and Co., of Cassel, and the firm have guaranteed that if the engines under ordinary conditions take 17lb. of steam per indicated horse-power without the superheat, that the consumption shall not be more than 10lb. per indicated horse-power when the superheat mentioned above is obtained.

The general design of the buildings of the power-house can be seen in Fig. 8, while Figs. 9 and 10 give sectional elevations of the same. It will be seen from Fig. 10 that the roof of the boiler-house has its ridges at right angles to the main ridge of the engine-house. The large pipes seen in the foreground in Fig. 8 are parts of the main pipes for the gas between the producer and the boiler. The erection to the left of the main buildings is for the producer plant, which at the time the photograph was taken was still in course of construction. Only the hoppers and producers were in place, and a considerable amount of work had still to be done in the erection of these generators and of the running rails for the crane.

Boilers.

The boilers at present installed are of two kinds. Thus, at either end of the boiler-house there are two Babcock-Wilcox boilers, as shown in Fig. 2. The two boilers to the right of the boiler-house, which is marked extensions on the illustration, are actually in place. In the middle of the boiler-house there is a new type of boiler made by Messrs. Tinkers, Limited, to which we hope to refer at greater length in a future issue. It is a tubular boiler with several novel points in its construction. The feed water for these boilers is taken from the Bridgwater Canal, and is forced into the boilers by three-throw feed pumps; two of these pumps are now installed, and they are driven by electric motors by means of a double-reduction gear with rawhide pinions. The motors, gear, and pumps were supplied by Messrs. Royce, Limited, of Manchester, and they work wonderfully quietly; in fact, the gears were so silent when we inspected the plant that they could hardly be heard. The motor armatures are double wound, and are connected up to a series-parallel controller which has no less than 14 different steps. In this way the speed of the pump and the quantity of water delivered regularly to the boilers can be varied over a very large range, while good economy is still obtained in the motor.

The steam-pipe arrangements can be seen from Fig. 7 in elevation, and in plan they are shown in Fig. 2. It is proposed in the ordinary way to work each of the large engines independently from one of the sets of boilers. The gas supplied to the furnace of that boiler can then be regulated easily according to the load on the engine; also the risk of a total interruption to the supply is reduced

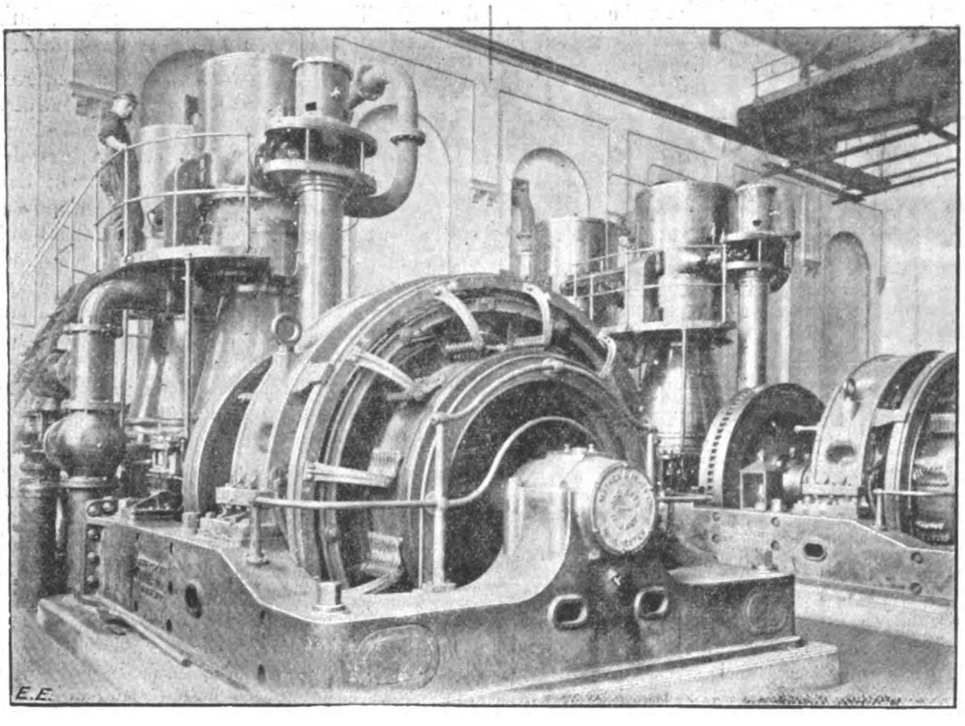

Fig. 11.—General View of the 660-kw. Steam Sets—Raworth Engines and Mather and Platt Dynamos.

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very much by working thus independent units of plant from independent sets of boilers without cross-connecting the steam-pipes. There is, however, an interconnection between the two sets of steam-pipes provided, as will be seen in the illustrations, so that steam can be passed from one to the other if the need for so doing should arise.

THE STEAM DYNAMOS.

These consist of Mather and Platt multipolar direct-current dynamos direct coupled to Raworth engines. The dynamos are compound wound, but can be worked as shunt machines later on if need be. It is found, however, at present that there is considerable advantage in running them as compound machines, in view of the large fluctuations in load which take place when the large consumers of power switch on and off. These fluctuations will, of course, become proportionately less as the number of consumers increases, and it is proposed to run machines shunt-wound when working in parallel. The output of these dynamos is 1,200 amperes at any voltage from 500 to 550 at a speed of 200 revolutions per minute. Each dynamo is of the 12-pole type, the yoke ring and magnet cores being of cast steel. Arrangements are made so that the lower half of the ring can be lowered into the foundations, enabling any magnet winding to be taken off or to be easily inspected if necessary. The armature is of the slotted type, the bars being laid in insulating troughs, and entirely embedded in the iron of the core, which is the usual practice in generators of this type, and efficiently protects the windings from damage. Special attention has been paid to the question of efficient ventilation both of the armature and commutator, and the machine can consequently carry the full load for long periods with but a small rise in temperature. The commutator is of large diameter and width, and of a design and construction up to the highest standard of modern practice. The current is collected by carbon brushes mounted in special holders, which admit of the contact pressure being adjusted as may be required, and each holder is fitted with hold-off attachment. These machines can be seen both in Fig. 11, which gives nearly an end view of one of the sets, and also in Fig. 12, which shows the whole of the engine-room, with the switch gallery and the boosters. The engines are best seen in Fig. 11. These are of the Raworth-Universal type, and, as mentioned above, consist practically of two independent engines, each of 500 h.p., mounted on the same shaft.

(To be continued.)

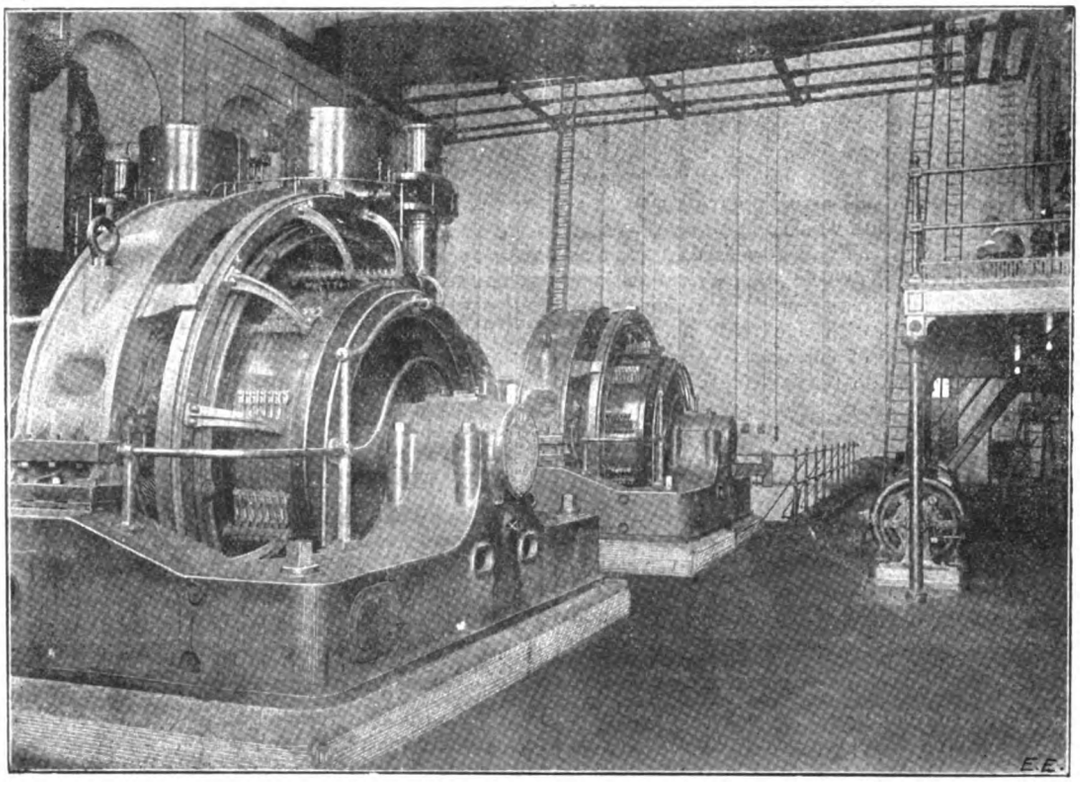

FIG. 12.—View of the Engine-Room, showing Dynamos, Switch Gallery, and Balancers.

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 188.)

The use of a brick chamber for the transformer, and two smaller brick boxes—one to contain the primary and the other the secondary switch-fuse gear—makes a capital job. The chamber for the transformer can be built large enough to contain a 50-kw., but for the start can be partly filled with bricks, and a much smaller transformer used. A space in front of the transformer 1ft. 6in. clear will give plenty of room for the jointer to stand in; and as the top of the chamber can be made to lift entirely off, the greatest depth that will be required will be the height of the largest transformer plus, say, 6in. clearance between the under-side of the pit cover and the transformer top. The primary and secondary mains can pass right through their respective switch-fuse boxes, tappings to feed the transformer being taken off through combined switches and fuses. These switch fuses should be so designed that they can only be removed by hand, singly, as it is well never to trust to high-tension switches that cannot be seen. Combined switches and fuses are not to be recommended entirely, as a high-tension fuse blowing in one's hand is not to be desired; but under the above circumstances, especially if there is not much room, it would seem that they are about the only things to use. The iron boxes containing them would necessarily be filled with thick oil or made with watertight covers, according to the class of insulation on the cables used. Another point in the favour of a brick chamber is that radiation of heat from the transformer takes place more readily.

For high-tension distributing boxes the above-mentioned switch fuses are sometimes used. In this case also it is well to build a shallow brick box to contain the switch-fuse box, instead of covering it with soil; water gets away better and it is easier to get at. On a low-tension network, where fuses are not used, a brick box of 9in. work and with a floor space of about 25 square feet and 6ft. or so in depth, can be built to contain a distributing pillar, such as is used on the Manchester network. One would wish, however, to fuse a low-tension network; this could be done at the feeding points very well, small sections of the network being fused. Fuses would not be so necessary if the system of main-laying was the solid system with single conductors, for reasons before stated.

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When the design for a sub-station (underground) is got out, the cable system must be thought of. If conduits are used, they can be laid right into the station. If armoured cables are used, pipes can be built into the walls; the troughings for solid-laid systems should not be brought through the walls, but should terminate outside, the cables passing into the station through earthenware ducts of suitable form. All low-tension cables, from whichever side approaching, should enter at one end of the sub-station and high-tension cables at the other. The crossing of cables is much better done outside the station in the ground.

Turning our attention to gear used in the sub-station, perhaps transformers come first; and perhaps the most important point to consider after having obtained a good transformer is its ventilation. The writer came to this conclusion some years ago, with the result that the patterns used by one very large firm for street-box transformer cases were all altered to provide for ventilation. Probably the only firm which has seen the importance of ventilation in the transformer itself (leaving out the containing box) is the Berry Transformer Company, and they so design their transformers as to obtain a good current of air through the windings. In the writer's opinion, good ventilation would go far to prevent increasing iron losses. To this end, where transformers in watertight cases are used in underground sub-stations, their lids need not be entirely closed down; but in brickwork street boxes the lids must be closed, and effectually. It is therefore necessary in this latter case to dry the transformer thoroughly before putting it on the mains. It is always best to dry all transformers wherever they are to be used. The drying of a transformer can be easily accomplished by connecting its high-tension terminals across a circuit where the pressure is equal to the pressure which would be given by its low-tension winding, were the transformer connected as designed, the low-tension terminals being then short circuited. The high-tension or primary circuit should have an incandescent lamp placed in series with one lead—such a lamp as will allow the same amount of current to pass which the primary winding was designed to take. The transformer so connected will get up a good heat in two days or so, and can be left connected as long as convenient—not less than a week. The cover must be off while drying. Another way of drying a transformer, but more risky, is to connect it to the mains and close it down in its case after having introduced a pot containing calcium chloride; this will take up all the water. The writer once obtained from a 6-kw. transformer 2½oz. of water in this way; the weight of the water was obtained by weighing the chloride both before and after use.

As to the heat set up in unventilated transformers, the high temperature of 168deg. F. has been measured on the outside of the iron circuit, and as the copper circuit was completely enclosed it must have been much hotter. This transformer had been on the mains for about two weeks, but had not been fully loaded. The load on transformers in sub-stations should be measured from time to time by means of a recording ammeter, left connected for a night at a time. The Reason demand indicator has been tried for this purpose, but does not seem to answer very well, as it takes some time to record, while top load is reached and passed very quickly. Some transformers of which the writer has had experience while in use on mains, and which have given excellent results, are the Brush, the Berry Transformer Company's, and transformers made by Messrs. Johnson and Phillips and Messrs. Crompton and Co.

Transformers for use on cable networks are better without switches and fuses of their own. If placed in a sub station, the switching and fusing is best done at a transformer circuit board, and need be single-pole only. The cables (high-pressure) by which the transformers are connected to the switchboard should be single-conductor, rubber-insulated, and lead-covered. The lead covering can then be earthed, and the cable, where it enters the transformer case, will need no protection in the form of insulating bushes. Transformer cases must always be earthed, and every transformer should have an earth shield inserted, when built, between the high and low tension windings. If this is not done, the insulation between the high and low tension windings may at some time break down, thus putting high pressure into the low-pressure mains. In cases of this sort, the insulation between windings and case sometimes holds good. The writer has come across two cases of this sort during the last five years, but as the low-tension network was protected by several Cardew earthing appliances no harm was done. Switchboards are best constructed with marble bases, as marble can be more easily kept clean than slate. If slate is used as a base, it should be enamelled. It is a good plan to enamel high-tension boards red and low-tension black. As high-tension switchboards have to be cleaned very often, a base that can be easily cleaned must be used. It will be found that if enamelled slate is used, the enamel will with repeated washings of methylated spirit be entirely removed in a short time. Both methylated spirit and benzoline are excellent things for cleaning switch gear; but if the board is built on marble, and the marble becomes stained, the stains can be removed better with dilute sulphuric acid, quickly brushed on and quickly sponged off. If the dilute acid is allowed to remain on for any length of time, the marble will be pitted.

Having chosen the material for the base, the switch gear which is to be mounted on it should be of very ample proportions and strong in construction. Terminals should be large, and such as will ensure good contact. Laminated contacts give the best results. The fuses on high-tension boards should, if there is room enough, be kept distinct from the switches. On single-phase concentric cables, it will be sufficient if one pole—the inner or high-potential—is switched and fused if the outer conductor is earthed, as is usually the case; the outers of all cables (high-tension) can be connected together on common 'bus bars. For the low-

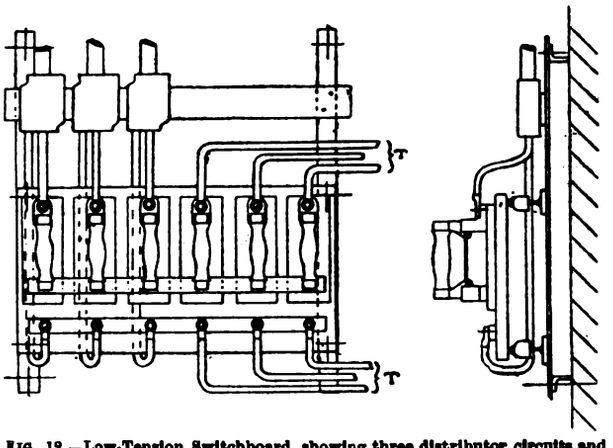

FIG. 12.—Low-Tension Switchboard, showing three distributor circuits and low-tension connections for three transformers, marked T.

tension distribution boards, the switches and fuses can be conveniently combined, as in this case still more room is required for the switch gear, as there are usually far more low-tension cables than high-tension in a sub-station. If the distributing system is two-wire, then one-wire, only the inner, if concentric cables, need be switched and fused, the other wire being clamped direct to a common 'bus bar by means of a stud (iron), fixed in the 'bus bar, and a brass nut; the cable end being sweated solid into a thimble, which is placed on the stud. Iron or steel studs give more strength than brass studs; but brass nuts must be used, as if iron or steel were used they would rust to the studs. In the case of a three-wire distribution, the neutral wire could go on to the common 'bus bar, and the two outer wires be switched. Switchboards can be conveniently mounted on insulating bolts, as shown in Fig. 12, the base of the bolt being first secured to the iron battens before mentioned.

Transformer switches can be combined on one base with the distributing switches—*i.e.*, the high-tension side on the high-tension board, and, similarly, the low-tension on the low-tension board. Cable-dividing boxes, for use with concentric fibre or paper insulated cables, should be fixed above their respective switchboards, the single-conductor rubber-covered dividing cables being brought out through glands in the bottoms of the boxes, and clamped by means of sweated thimbles direct on to the switchboard terminals. As the boxes will have to be filled with compound, care must be taken to see that the cable glands are well packed before the box is filled, as if the smallest aperture is left, the compound will leak out with the warmth of the sub-station, disfiguring the switchboard below. In an above-ground

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station the cable boxes would be below the switchboards. If oil is used for filling cable boxes, it will gradually find its way along the copper of the cables, and if the boxes are above the switchboards, the switch terminals will always be very dirty with oil; sometimes the oil dries on and prevents the switch from acting. All cables entering boxes before going on to their switchboards must be clamped to the sub-station walls, or to the iron battens on the walls, so as to prevent the cables from slipping, owing to their spring, and thus causing their connectors inside the boxes to come in contact with the sides. Spare switches and fuses should always be kept ready for use in all sub-stations, also spanners and any other tools necessary for disconnections. At least one pair of rubber gloves should be kept in each station The sub-station should always be kept neat and trim—all the high-tension apparatus at one end, and the low at the other. All the ironwork should be earthed. A Cardew earthing appliance should be fixed in each sub-station, one pole being connected to the earthed ironwork, and the other pole to one of the low-tension network 'bus bars.

Probably some of the best-arranged sub-stations for single-phase distribution are to be found at Cheltenham. The older ones were built of concrete, faced on the inside with ordinary rough bricks; but the later ones have been constructed entirely of brickwork, the inner facing being white glazed bricks. The first mentioned have had their walls covered on the inside with two or three coats of Blundell, Spence, and Co.'s petrifying paint, with the result that they also have clean, white, and glossy walls. (When this paint is used, it must be applied in small quantities only, and well rubbed into the brickwork; if it is put on

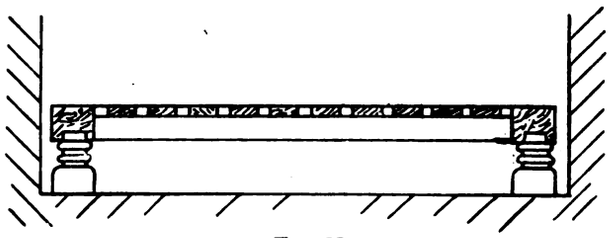

FIG. 13.

with a full brush it will run, making a very unsightly job indeed.) In these sub-stations the floor at the high-tension end is an insulated floor, constructed as shown in Fig. 13. The wood grating, which can easily be taken to pieces for cleaning, is supported on brown stoneware insulators, and thus is always kept dry. It is constructed of good pitch-pine, and rubber mats are kept lying on it. An insulated floor is a good thing when the high-tension operations are conducted by a man who knows what he is about, but perhaps is apt to give a false sense of security to others. Such a floor would be no good, for instance, if one were using a high-tension switch with one hand while resting the other hand on an earthed transformer case.

Fig. 12 shows the general arrangement of switchboard connections, and method of fixing the boards, in use at Cheltenham for three 30-kw. transformers and three distributing mains (low-tension). The arrangement on the high-tension side is exactly similar, except that a better class of connecting cable is used, and generally more attention is paid to insulation. The outers of the high-tension cables are coupled together inside the cable-dividing boxes instead of on the switchboard. Each high-tension dividing box is designed for three cables. The connecting cable for the outer pole of the transformer (primary winding) is brought out through a gland designed for it, and the connecting cable for the inner pole is taken through a switch fuse off the high-tension feeder switchboard.

It will be found the best practice for the mains engineer to design the whole of his switchboards and cable boxes, as these things cannot be bought in suitable form from the makers of such gear.

(To be continued.)

Harrogate.—The Local Government Board have sanctioned the borrowing by the Town Council of £10,000 for electric lighting purposes.

ELECTRIC RAILWAYS.

BY MAJOR P. CARDEW.

The first of the series of three Cantor lectures on "Electric Railways" to be delivered by Major Philip Cardew, was given on Monday last at the Society of Arts. Being the introductory lecture, the greater portion of the hour was taken up by a *résumé* of the history of electric traction, and a rough survey of the state of electric traction as applied to railways at the present time. Major Cardew commented on the fact that the art of locomotion had been practically stationary from the time of the Romans up to the beginning of last century. The Roman art of road-making had been exceedingly little improved upon during the interval, and it was not until the introduction of the steam locomotive that improved means of locomotion were at all realised. He thought that even as there had been a vast increase in the speed and ease of travelling due to the introduction of the steam locomotive, so there would be a corresponding increase due to the introduction of electric railways. In the same way as the steam locomotive had out-distanced all its rivals in economy and speed up to the present, so he thought electric railways would out-distance steam. The advantage could only be gained by the introduction of electricity, in consequence of the great ease with which electric energy could be transmitted. Dealing with the history of the subject, Major Cardew pointed out that up to the time of Faraday electric railways were commercially impossible, as the only source of electricity was the voltaic cell. Even with the introduction of dynamos and motors, the ideas which resulted from working with voltaic cells still tended to hamper progress. There was the error that so many held, that no more than 50 per cent. efficiency could be obtained from a motor, because the maximum output from a battery was obtained when the internal resistance was equal to the external. At the same time, the maximum output could be obtained from a motor when the counter E.M.F. was half the applied E.M.F. In this instance, of course, the full-load efficiency could only be 50 per cent., but no motor would stand a load on that basis. A mistake had been the confusion between the maximum output and maximum efficiency. The first electric railway was laid down in the Berlin exhibition in 1879, and was afterwards exhibited at Paris in 1881. This ran with an insulated third rail, the track acting as a return. The Portrush electric railway was the next to be constructed, and that was working at the present time. It used 300 volts on a raised third rail, but this had to be replaced by overhead construction some few years back in consequence of an accident to a cyclist. In 1884 the Blackpool conduit tramway was put down in a position most trying for conduit work, as in times of storm the sand from the seashore was blown on to the road and filled up the conduit. Conduit lines, however, were now being worked successfully at Washington, New York, and other places, and were shortly to be introduced in London. In 1889 a new system of conduits was tried at Northfleet in which the cars were worked in series. It was a most ingenious system, but the objections to series working were too great to render the undertaking commercially successful. In 1893 the Liverpool Overhead Railway showed what could be done with electric traction on heavier lines on a superstructure raised above the ordinary traffic levels. The success of this line was largely due to Mr. T. Parker, who boldly undertook to carry out the scheme, and attained the success which his efforts deserved. In 1891 the overhead trolley system, which had been first developed in the States, was first introduced into this country at Leeds. The result of the earthed return was interference with the telephone circuits, in consequence of which a joint committee was appointed, which instructed the Board of Trade to draw up rules to regulate such tramway undertakings. After a conference on these rules, at which all interested were represented, they were put into force, and he thought they had proved sufficient to prevent any injury to underground pipes. The South London Electric Railway was the first tube line to be constructed, and was the forerunner of many enterprises of a similar kind now working or in course of con-

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struction. The use of three-phase currents for electric railways had been largely developed on the Continent, and Major Cardew showed on the screen a number of views taken on railways in Switzerland worked with polyphase currents. The great advantages of electricity over steam were hardly to be expected on long journeys, such as the journey to Scotland, which should be undertaken at night in sleeping-cars, as without a considerable increase in the maximum speed there would be little saving of time. Without a doubt the speed could be increased to 100 miles per hour, and it was practically certain that in special cases speeds of 120 miles per hour could be maintained. But the question was always whether the traffic on such lines could be made to pay for the construction, as special tracks would have to be provided. He thought, however, that electric railways had a special field in connecting up towns, say, 100 miles apart. The advantages gained would be a more frequent service, increased regularity in service, and reduction in the time taken on the journey. The economy with the use of electricity would result from having light trains running at frequent intervals.

Major Cardew then proceeded to quote from Mr. W. Langdon's paper at the Institution of Electrical Engineers on the advantages of electric locomotives, and stated that he thought Mr. Langdon underestimated these advantages as far as repairs of rolling-stock and locomotives were concerned. There was no doubt that with this frequent service there would be increased receipts, but the capital expenditure required for the change was considerable, and it was not easy to estimate what the actual effect of the change would be. Firstly, the power would cost less because it would be generated in bulk and not in detail, as in the case of locomotives. Next, the daily run of a given motor or locomotive would be largely increased. He found that the average run now was about 54 miles per day with a steam locomotive, whereas 300 miles per day were often obtained even on a system of electric tramways. The third advantage was that the motive power was not restricted, as in a locomotive, but could be increased in order to gain higher speeds up steep grades. The wear of the rails was reduced, and the loss of adhesion, which resulted in the waste of energy in slip, could be considerably lessened by distributing the motors throughout the train so that a greater proportion of the total weight might come on the driving wheels. Another advantage would be that an absolute block system could be obtained by causing one train automatically to cut off the supply of current to the section behind it. Coming more to the apparatus to be used, he thought that for the design of motors his audience could not do better than read the Cantor lectures on electric motors delivered last year by Prof. Carus-Wilson. He proceeded to give a brief *résumé* of the working of a series-wound motor to show that, although it took the largest current when starting, it was then working at a condition of least economy. Major Cardew contended that some means of independently exciting the field magnet of a motor would be adopted, in order to cut down the great waste of energy and resistance when starting. He described the Ward-Leonard system, which had this object in view, but hinted that some other system would shortly be brought before the public which would reduce the actual power taken from the line when starting to one-third of its present value, and would also enable a larger proportion of power to be returned to the line when stopping the train. The series-parallel controller had for its object the reduction of starting losses, and Major Cardew estimated that, while with a single motor in getting up full speed an average efficiency of only 45 per cent. was obtained, a 56 per cent. efficiency could be obtained by using two motors in series in the early steps of the trolley. If four motors were used, commencing with all in series and going by steps to all in parallel, this efficiency could be increased to over 60 per cent., but he was not sure that the extra complication was worth the slight saving. Reverting to the separately-excited motors, he thought that considerable economies could be obtained by their use when starting.

(To be continued.)

THE BRITISH INSULATED WIRE COMPANY'S STAFF DINNER.

That this well-established annual has lost none of its popularity was amply demonstrated on Friday evening last, when about 170 guests congregated at the Adelphi Hotel, Liverpool, to partake of the above company's hospitality. The event incidentally gave one the opportunity to renew many old acquaintances; the visitors' contingent—made up, as usual, of units from all parts of the country—being particularly strong. Exceeding good cheer was the characteristic feature of the proceedings, which were ably piloted through by Mr. W. Marriner Brigg. An excellent dinner having been served to an orchestral accompaniment, the CHAIRMAN proposed "The King" in a few well-chosen words, which called forth a hearty response.

The next toast was that of "The Electrical Industry," proposed by the Hon. A. STANLEY, M.P., whose combined eloquence and wit struck a high note and convulsed his hearers with laughter. He did not know anything about electricity, but up to six o'clock that morning the Irish members in the House were talking of law and order, and if Irish members could talk of law and order, he was convinced he could talk about electrical matters. This he proceeded to do, mentioning that in 1896 there were £61,000,000 invested in electrical concerns in this country, while in 1900 this amount had increased to £124,000,000—a fact which, he thought, spoke sufficiently well for the progress of electricity. But if these figures were not in themselves sufficiently convincing, he need only add that the rate of interest on the invested millions had never fallen below 5½ per cent. With regard to the recent accident in Liverpool, it pointed to the necessity of giving electrical engineers a free hand in providing against such occurrences. Mr. Stanley went on to make some amusing references to wireless telegraphy, and the talk of establishing connections with Venus and other planets of that order, but for want of space and other reasons—mainly other—we must refrain from dealing at length with this portion of his speech. Suffice it to say that a sort of guarantee for the success of any future experiments in this direction which may be conducted on this side of the Atlantic was suggested in the reputed interest taken in the matter by Mr. S. Z. de Ferranti, with whose name the toast was coupled.

In replying, Mr. S. Z. DE FERRANTI proved himself quite equal to the challenge, and related an amusing anecdote which had been called to mind by the remarks of the previous speaker. But here, again, pressure on our columns prevents us from entering into detail. Mr. Ferranti expressed the pleasure it gave him to address so many old friends. As regarded the future development of the electrical industry, he thought this depended very largely on the efforts of the young men around him. The development of the past had been very great, but the future offered enormous possibilities in comparison, and the country was undoubtedly going ahead. Fortunately, electrical work was now looked upon in a more friendly light than had been the case some time ago, and greater facilities were being given for the distribution of electrical energy over wide areas. He also referred to the probable developments of electric traction on main-line railways.

The next toast was "The Visitors," proposed by Alderman T. SNAPE and responded to by Mr. W. M. MORDEY.

Mr. J. S. RAWORTH proposed "The British Insulated Wire Company," to which Mr. J. B. ATHERTON made an able response. Referring to American and German competition, Mr. Atherton said that, given fair play, they could look into the future with confidence.

In proposing "The Directors of the British Insulated Wire Company, Limited," Mr. G. H. NISBETT drew a humorous sketch of the mean policy adopted by some boards of directors, with the object of showing how enlightened were the methods of his own Board in comparison, and how alive they were to the interests of their shareholders.

This practically terminated a most successful evening, or, perhaps, it would be more correct to say our mental

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notes as to what occurred after this stage of the proceedings are somewhat confused. An excellent programme of vocal music followed upon the orchestral performance. On the following morning a large number of the visitors took advantage of the opportunity afforded them to visit the company's works at Prescot, where the enormous amount of work on hand indicated more eloquently than the words of the previous evening the growing prosperity of the company's undertaking.

ELECTRIC LIGHTING ENQUIRY.

Question of Increased Pressure.

At the opening of the proceedings on Thursday, the 7th inst., Sir Courtenay Boyle announced that the Board of Trade had decided against the contention of the counsel representing the City of London Corporation. The Board of Trade had the power to alter the rules and regulations, and therefore had the power to alter a proviso in the set of regulations issued in 1896.

Mr. R. W. WALLACE informed Sir Courtenay Boyle that although the Westminster Company had had a consultation with the representatives of those consumers who would not change over to the 200-volt supply, they had been unable to come to any agreement in the matter.

The case for the Chelsea Electric Supply Company was then opened by Mr. MOON, who explained that up to the present the company had had no trouble through the clause in question. They were supplying 1,500 consumers at 200 volts, and 500 consumers at 100 volts. They had had no objectors at present, as all the changes over to the higher voltage had been done voluntarily.

Mr. P. STILL said he was the chief engineer of the Chelsea Electric Supply Company, whose system was a continuous-current one. At first they had given a three-wire supply at 100 volts, but they used high tension to transmit the power between the main station and the sub-stations. The change over to the higher voltage would not affect the feeders, but would give a very considerable economy in the capital outlay for the distributors from the sub-stations. With the gradual changing over, the cost of supply to a few consumers at 100 volts would increase much in the same way as the number decreased. In order to induce their consumers to take the higher voltage, they had offered to supply at a cheaper rate. Thus the 100-volt consumers were charged 6d. per unit, while the 200-volt supply was given on the maximum demand system, with a charge of 6d. for the first 1½ hours' supply and 3d. per unit afterwards. The average price obtained from these consumers was 5d. per unit, and it had resulted already in the reduction of £3,000 per annum in the accounts. The 6d. per unit was not enough for the 100-volt supply, and they had given notice that they would charge 7d. per unit from July 1 next.

Sir COURTENAY BOYLE said he should like to hear an argument later on as to this course being in accordance with the terms of the order, that they were not to give undue preference to any consumer.

In answer to Mr. Moon, Mr. STILL went on to state that he estimated that the extra penny per unit represented the extra cost of supplying 100 volts to a few consumers. The consumers had a benefit from the change because the wires installed in their houses would be able to carry twice as many lamps at the higher voltage, or if the number of lamps were kept the same the voltage drop on their mains was very much less. He thought that in 1896 200-volt lamps were not so good as the 100-volt, but now he considered that both as regarded light and efficiency there was nothing to choose between the two. As regarded the company, he thought that they would save from £3,000 to £4,000 per annum in consequence of the change.

Cross-examined by Mr. Littler, Mr. STILL said that the practical advantages to the consumer consisted in the reduction in price, and also in the increased regulation of voltage in consequence of less drop in the house mains. He did not consider it was a practical suggestion to put motor-transformers in the consumers' houses, or to run two sets of mains in order to supply at the 200 volts. He gave an estimate of £500 as the cost of a 45-kw. rotary converter, but did not consider it feasible to put down such motor-transformers to supply even a street of 100-volt consumers. The increase of cost to supply these consumers was not in the production, but in the delivery of the current. Under further cross-examination on the question of the voltage drop, he considered that it was not an uncommon thing to have a four-volt drop in the consumers' wires when all the lamps were on, and this would be reduced to a 1 per cent. drop with 200 volts. With respect to the life of the lamp, he was not surprised to hear that the electrical engineer of the Great Northern Railway specified a 2,000-hour life for a 100-volt lamp and only a 1,000-hour life for the 200-volt lamp. He had tested 200-volt lamps which lasted more than 1,500 hours, but in any case, with either voltage supplied, he did not consider it at all advisable to run them for more than 1,000 hours. His company had not obtained the London County Council's consent, because they had not changed their standard voltage. Any change over that had taken place had been done voluntarily by the consumers to get the reduced price. They had had no complaints as to the alleged extra cost of the lamps or as to the decreased light. He did not consider that the fire risk was any more, but admitted that certain changes had to be made in the fuses, wall plugs, switches, and lampholders. The cost of these changes was not much.

Re-examined by Mr. Moon, Mr. STILL explained that a rotary converter to supply one street would result in a great waste of energy. The losses were almost as great when running light as when working under load, and the all-day loss would be exceedingly high. Even assuming it were feasible it would not apply to the case in point, as their 100-volt consumers were not collected in one street, but were dotted over the district.

Mr. SYDNEY BAYNES, the electrical engineer to the St. Pancras Council, gave some history of the introduction by himself of the higher-voltage lamps at Bradford. In St. Pancras they had a certain amount of difficulty in inducing consumers to take the higher-voltage supply. One consumer who had been induced had to be threatened that the supply would be discontinued before he gave way. The St. Pancras order was dated 1883, but he was not aware that the regulations of 1896 did not apply. They had received the regulations from the Board of Trade with the statement that they would be enforced from a certain date, and he assumed that they applied to St. Pancras.

Cross-examined, Mr. Baynes had to admit that he had no right to threaten to cut off a consumer as had been done. The consumer in question had asked for an assurance that the 200-volt supply would not cost him more, but he could not bind the Vestry on such a matter. Now that the change had been made, he had had no complaint from the consumer that the cost was more. There would certainly be less variation of pressure with higher voltage supply. The 200-volt lamp might cost a little more, and it would last quite as long as it was necessary. He did not think that any lamp should be used more than 700 hours. The difficulty with the St. Pancras voltages had been that the wrong voltage lamps had been used.

Cross-examined on behalf of the London County Council, the question of the threat to cut off was again taken up, the counsel putting it that the threat was directly contrary to law, and that it showed the spirit in which local authorities used the powers conferred upon them. In reply to Mr. Balfour Browne, he said he was aware that the Edison-Swan Company would supply both 100 and 200 volt lamps at the same price. Neither should be used more than 700 hours. Although the Board of Trade regulations of 1896 did not apply to St. Pancras, the Vestry had acted upon them as if they did.

Mr. MOON here pointed out that in the case of the Metropolitan Electric Supply Company they wished to raise their voltage from 50 to 100. The company, he said, started with a high pressure, and were bound to transform, therefore, at the consumers' terminals. The regulations gave the consumers the right to have either 50 or 100 volts pressure, and at the present time the company were bound to supply at both.

The PRESIDENT said that was a special case, and must be dealt with after the general issues had been disposed of.

Mr. CANE announced that although the City of London Electric Lighting Company still continued to support the application, he did not propose to call any witnesses or to address the court on the subject.

Mr. MASSEY then said he appeared on behalf of the Crown, and in the event of any alterations being made in the regulations he would ask the president to see that the Crown was protected. The Crown was a consumer in a large number of places, and at Buckingham Palace current was supplied at both 100 and 200 volts pressure. Personally, he did not object to the change.

The PRESIDENT: Then what have you to say here?

Mr. MASSEY said that when it came to the question of the overhauling of the old wiring for 2,000 or 3,000 lamps in the State rooms of the palace, at present supplied at 100 volts pressure, it was found that the cost of conversion would be £1,500. Rather than bear that expense, the company continued to supply at 100 volts when the pressure was increased to 200. But although this was for their own benefit, they charged the Crown more than they charged the consumers taking the 200-volt supply. The Crown could not compel them to change to 200 volts, but it appeared the company could go on supplying at 100 volts if they so desired. In this particular case he had it in black and white that, rather than pay the £1,500 for replacing the old wiring for the 200-volt supply, the company preferred to go on supplying at 100 volts. He submitted that any alterations the Board of Trade might make in the regulations would merely be for the temporary relief of the undertakers, because sooner or later

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their mains would be sure to overload again. Then they would either have to break the law by not maintaining the standard pressure, or perhaps take on the five-wire system. As showing the position some electric lighting companies took up, Mr. Massey quoted the case of a hospital which required 3,600 lamps. The company refused to supply them with current because they could not balance their circuits within 10 per cent., which was practically impossible with such a large supply.

The PRESIDENT: The question is, How does this damnify the Crown?

Mr. MASSEY said because they would have to have another change when the mains became overloaded in the future as they had been in the past. In the case of a large building, you were faced with this difficulty: that you must bring into the premises more than one pair of terminals. If the five-wire system were introduced, as at Manchester, you would have to bring in more than two pairs of terminals, and he maintained that it was possible to get a shock of 400 volts although the middle wire might be earthed. Of course, transformers might be introduced, but why should the consumer pay for the transformers to save a little copper in the company's mains? The suggestion he had to make was that the following words should be added at the end of the proviso in question if amended: "Provided always that none of the cost of conversion shall be borne by the consumer."

The PRESIDENT: Have you authority to make this proposal?

Mr. MASSEY said he was instructed to put forward this representation on behalf of the Crown. He agreed by all means that an arbitrator should settle what the cost of the conversion should be, and also the compensation to be paid to the consumer for disturbance and inconvenience.

Lieut.-Colonel CROMPTON was then called and examined by Mr. Moon. He said he had been connected with the electrical enterprise from the beginning. He had had the question of the change of pressure before him for some time; in fact, he was one of the originators of the scheme. The same controversy over the change of pressure from 50 to 100 volts arose in 1882 and 1883, and much the same rusty arguments were brought forward then as now. It was said that the efficiency of the 100-volt lamp was not as good as the 50-volt lamp, that the light was not as good, etc., but it was clearly proved that the objectors were quite wrong. He had heard to-day that the 100-volt lamp was all that could be desired. He was connected with the Kensington and Knightsbridge Company, who commenced to supply at 100 volts. They chose that pressure because it was the pressure for which they could get the best lamps at that time. He had been continuously testing 200-volt lamps up to last week, with the result that he found that a certain number of makes had as good an efficiency as the 100-volt lamp. Certain makers, however, had never succeeded in making the 200-volt lamp with as good an efficiency as the lower-voltage lamp.

Mr. MOON: It was suggested that the longer carbon filaments in the 200-volt lamp are a disadvantage. Is that the case?

WITNESS: Theoretically it makes an improvement in the lamp; practically it makes the mechanical use of the lamp rather more difficult. Continuing, witness knew of no disadvantages of the change to 200 volts pressure, but there were many advantages. It was undoubtedly the case that a serious difficulty to the suppliers was that of finding space in the streets for their mains, and if they were compelled to go on supplying at 100 volts to certain consumers considerably more space would be required. The advantages, however, were by no means one-sided. For instance, with the higher pressure there was only half the variation in the mains, and consequently a better light was obtained. In proof of the superiority of the 200-volt supply, witness stated that all new enterprises were adopting that standard pressure.

Cross-examined by Mr. Littler as to the maximum limit of pressure which could safely and satisfactorily be employed, Colonel Crompton thought that at the present time the Glasgow pressure of 250 volts was the limit. In the case of the Windsor Hotel, he did not know what effect the change would have, but the consumer could not be damnified unless his house had been badly wired and fitted in the first instance.

Mr. LITTLER: If I give my consent to the change, ought I suffer any loss?

Colonel CROMPTON: I should say you ought to have 10 per cent. on the work you are forced to do.

Mr. LITTLER: Thank you; that is more than I ever expected you to say.

In answer to further questions, WITNESS denied that it was the fact within his knowledge that the 200-volt lamp cost 33 per cent. more for current than the 100-volt lamp. It was said that the consumption of current might be more in the 8-c.p. lamps and smaller ones. The efficiency of the 16-c.p. lamp had never been questioned, but there was some doubt about the 8-c.p. lamp. He did not agree with this, however. The facts had proved that the thinner filaments in the 200-volt lamps were not a disadvantage, nor was it true that there was a greater fluctuation of the light than in the 100-volt lamps.

Mr. LITTLER: Is there a lamp filament thin, strong, and long enough to give a satisfactory 200-volt light?—Yes.

Continuing, it was not the fact that a 200-volt lamp lasted a shorter time than the 100-volt lamp. The 16-c.p. 100-volt lamp would have a useful light for 800 hours, and the 200-volt lamp compared quite favourably with it.

Under cross-examination by Mr. Walter, Colonel Crompton repeated that the main advantage to the consumer was that he got a steadier pressure with the 200-volt supply. As the variation in pressure was controlled by the percentage of loss in the mains, the variation was about half that of the lower pressure, and consequently a steadier light was given. Pressed as to whether such a small variation as 2 per cent. would affect the light, witness said it made a substantial difference. Of course, if the mains became overloaded in the future, there would have to be another change, but he could not conceive that this would happen. Another advantage to the consumer was that the pressure in his own premises was more constant. As regarded the company, the saving to them would not be great. It would be in the nature of about 1/10d. per unit. This was the figure given by Prof. Kennedy on the last occasion. Witness had checked it, and found it to be correct. On the question of insulation, there was a difference between the 200-volt insulation and the 100-volt, but this was very slight. In some cases he had known it had not been necessary to change the fittings for the 200-volt pressure. The change of fittings was rendered necessary mainly on account of bad insulation. The efficiency of the 100-volt lamps varied considerably according to the maker, and no one suffered so much from the flood of cheap lamps of this voltage that had been put upon the market than the consumer. The longer filament in the 200-volt lamp would not cause the destruction of the lamp more quickly than the shorter filament used in the 100-volt lamp. Witness admitted that the destruction of the lamps was due to the mechanical disintegration of the filament.

Mr. WALTER: That being so, does it not follow that a 200-volt lamp which has a longer filament will wear out sooner than the 100-volt lamp?

WITNESS could not agree. The proof of the matter was that the one lamp lasted as long as the other. He was not aware that there was a diversity of opinion on this point. In carrying out tests he did not confine himself to two or three lamps; he took several at random from a number sent in for testing purposes. The price of the 200-volt lamp was the same as that of the lower-voltage lamp.

In reply to Mr. Lyttleton, witness admitted that it was by superior skill and industry that the 200-volt lamps were made efficient. He did not, however, think that that was a reason for charging a higher price than for the other lamps.

Cross-examined by Mr. Glen, witness said that, as a rule, the companies would not supply electricity to consumers until they had inspected the fittings. The 200-volt lamps had been in use for a number of years now, and he had heard no complaints from consumers as to their cost and durability except in the case of cheap lamps. He admitted that it would be unfair to make the companies pay for replacing wires and fittings which in the first place were bad.

This concluded the evidence in support of the applicants' case on the general issues, and the Court adjourned till the 12th inst.

The following memorandum as to consumption of current by 200-volt lamps was put in by Prof. Kennedy on this day:

In order to find out whether or not the allegation that 200-volt lamps were much less efficient than 100-volt lamps, the Westminster Electric Supply Corporation made a very careful comparison in the following manner (these figures have already been placed before the Board of Trade): The consumption of a number of consumers whose pressure had remained the same during the corresponding quarters in two consecutive years was compared with the consumption of those whose pressure had been changed in the interval. The quarters taken were the Lady Day quarters of 1898 and 1899, and the whole of the consumers on the company's mains were included except those where local conditions rendered fair comparison impossible. The total units sold in the first quarter of 1898 were 1,540,266, and the units retained for comparison were 1,111,347—over 70 per cent. of the whole. These units were used by 2,505 consumers, 2,031 of whom had remained at the same pressure in both quarters, while the remaining 474 had the pressure changed between March 31, 1898, and Jan. 1, 1899. Of those supplied at the same pressure during both quarters the consumption increased from 927,533 units in 1898 to 955,829 units in 1899, an increase of 3 per cent. of those supplied at 100 volts in 1898, and 200 volts in 1899; the consumption increased from 184,314 units in 1898 to 192,137 units in 1899, an increase of 4 per cent. It will be seen that this increase is practically the same as where the pressure had not been changed, which appears to me entirely to dispose of the suggestion that the new lamps use more current than the old ones. I draw special attention to the very large scale on

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which this comparison has been made, and to the fact that it really represents practical working, and not laboratory experimenting on the lamps. I think the conditions were such as to eliminate practically all accidental variations in special cases. Sir Courtenay Boyle had asked that later figures should be produced which bear on the same point. Time does not allow of the comparison of nearly 12,000 quarterly accounts which would have to be made in order to get figures of the same kind as those given above. The change of pressure has, however, been in progress since the beginning of 1897, and, therefore, if 200-volt lamps are less efficient on our circuit than 100-volt lamps, there should have been a progressive increase in the consumption per lamp each year. We find, however, that in the year 1897 the number of units used per lamp per annum on our circuits was 16·1; in the year 1898, when 43 per cent. of our customers were changed over to 200 volts, it was 16·2; in the year 1899, with 75 per cent. changed over, it was 16·6; but in the year 1900, with 97 per cent. changed over, it had again fallen to 16·3. These differences, both up and down, appear to me to be quite within the limits of variation which may be expected, and there is nothing to show that either the rise or the fall is due to the changing over from 100 to 200 volts. It seems fair to say that in the last four years the consumption of current per lamp has remained practically constant. As the lamps are now practically all of 200 volts, while in 1897 very few were supplied at that pressure, it appears to me to show conclusively that as regards the lamps used on the Westminster Company's circuit the watts used per candle-power must have been practically the same at both voltages. It may be added that during the same four years the revenue per lamp per annum has fallen from 7·44s. to 7·08s., 6·68s., and finally to 6·45s. This, of course, shows that even if there had been a very considerable increase of current used per lamp per annum, and a heavier cost from renewals (neither of which we believe), the reduced price paid by the consumer per unit must have more than counterbalanced them. The corresponding average prices obtained per unit during the same years are 5·54d., 5·25d., 4·83d., and 4·75d. In 1897 the rate of charge was slightly higher than now, but since Jan. 1, 1898, it has been the same, the only difference being that the reduction of 8 per cent. on account of 200 volts was not made in 1898, while it was made in 1899 and 1900. Consumers also derive an additional benefit by a reduction in meter rent, owing to the smaller sized meters for 200 volts; this amounts on an average to ·1d. per unit. The following figures also tend to show that 200-volt lamps are certainly not less efficient on the Westminster circuit than are 100-volt lamps. The figures refer only to the Mayfair and Belgravia parts of our district. The other district, Westminster, has been so much affected of late years by the large number of lamps in Government offices connected to our circuit, and also by the supply to the Army and Navy Stores, that any comparison is impossible. The two districts named contain, however, over 75 per cent. of the total number of lamps installed, and the maximum load in amperes, divided by the number of lamps connected, has gradually fallen from ·1036 in 1895 to ·1017, ·0998, ·0991, and ·0977 in successive years, while in 1900 it was only ·0964. As the proportion of lamps alight at the time of maximum load is pretty constant, the maximum load would have certainly increased in proportion to the number of lamps installed had the efficiency of 200-volt lamps been less than that of 100-volt lamps. Although I consider that the figures given above are conclusive as to the points essentially affecting the consumer, they cannot, in the nature of things, deal with exact measurement of candle-power. I therefore put in the results of experiments which I made about two years since on 8-c.p. and 16-c.p. lamps of 200 volts by four different makers, on which I based my evidence on this matter.

ALEX. B. W. KENNEDY.

TUESDAY, MARCH 12.

On the enquiry being resumed, Mr. DANCKWERTS, K.C., opened the case for the city of London. He first suggested that the question of the power of the Board of Trade to revise the clause should be submitted to some lawyer of eminence, whose decision would be accepted by all parties. The legal arguments could then be made before the gentleman selected. He proceeded to argue that the proviso requiring the consent of the consumers before changing over to 200 volts had been inserted in the 1896 regulations, because previous to that the undertakers were bound to supply at some pressure between 115 and 45 volts. He looked upon the regulation to that effect as an agreement between the company and the consumer, which could not be changed without the consent of the consumer, and he held it was for this reason that the proviso now objected to by the companies had been inserted in the 1896 regulations. He looked upon the question as being one in which the companies got all the advantage of the change, and even then the advantages as regards the increased capacity of the present mains would be only temporary. After a considerably longer statement of his case,

Sir COURTENAY BOYLE put forward the following suggestions as to a proposed clause which the Board of Trade might be prepared to accept as carrying out some of the suggestions which Mr. Danckwerts had made. Sir Courtenay Boyle, who said he was not announcing any decision of the Board of Trade, then read the following clauses, which would replace the consent clause in the 1896 regulations:

"Provided that no change shall be made in the pressure of the supply to any premises which are or were supplied with energy by the undertakers except with the consent of the consumer, but where the consumer withholds his cousent after the undertakers have offered to pay the reasonable cost of, or incidental to, the change, the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, dispense with the consent of the consumer on such conditions as the Board impose."

"The Board of Trade may, if they think fit, in any case refer to the arbitration of a single arbitrator appointed by them the question of the conditions to be imposed under this provision."

"The arbitration shall be subject to the provisions of the Arbitration Act of 1889, as if the arbitration were pursuant to a submission, and should also be subject to the like provisions as an arbitration in pursuance of a special Act under Part I. of the Arbitrations, etc., Act, 1874."

The various counsel present agreed that if some such clauses could be adopted as agreeable to all parties it would save time in the continuation of the enquiry, and after a certain amount of argument the enquiry was adjourned until the 14th. Sir Courtenay Boyle suggested that any amendments to the clause given above should be forwarded to the Board of Trade before the next meeting.

THURSDAY, MARCH 14.

At the opening of the enquiry the Hon. L. LYTTELTON, K.C., said that, as representing the London County Council, he had considered the clauses proposed by Sir Courtenay Boyle, and had an amendment to propose. Arguing on the grounds that the change over to the higher voltage should be made at no cost to the consumer, and that the undertakers were the sole gainers on the change, he thought all controversial points should be settled at the expense of the undertakers. His first suggestion was that any dispute on the question of the change over should be taken before the Board of Trade, and considered that 19 out of 20 cases should be settled in that way. In the event of one of the parties not agreeing, the Board of Trade should appoint an arbitrator to settle the indemnity to be made to the consumer by the undertaker. The cost of the reference to the Board of Trade and of the arbitration should be borne by the undertaker, unless the arbitrator said that the consumer had been vexatiously withholding his consent. In the proposed amendment as read out the undertakers were to be made responsible for both the direct and indirect expense to the consumer in carrying out the change.

Mr. A. H. WALTER agreed to the suggested amendment on behalf of the Corporation of London. As the undertaker alone was benefited, he ought to bear all the reasonable cost arising out of the same.

Mr. WARMINGTON, on behalf of the Westminster Supply Corporation, said that the proposed amendment would mean that a large number of small cases would have to be argued either before the Board of Trade or before an arbitrator. Under the terms of the amendment the Board of Trade would only hear the case if both the parties were agreed in submitting it to them, and a consumer who withheld his consent to the change would not be likely to sign a reference. He did not agree with the proposal as regards costs.

Mr. E. MOON followed on the same line, arguing that the consumer, having his costs practically assured to him, would resist the change over even more than at present. He thought that the idea of an indemnity in consequence of the change over was an erroneous one, and that the consumer's consent was only required in the 1896 regulations because the high-voltage lamps were then in an experimental stage. If the costs of arbitration were to be as suggested, it might pay the company better to continue supplying the refractory consumers with the low voltage, charging them the maximum rates under their Acts, which they had a right in law to do.

Sir COURTENAY BOYLE then intimated that he had had sufficient argument before him to enable him to advise the Board of Trade on the matter, but he could not promise the counsel for the London County Council and the Corporation of London that he would accept the wording of their amendment. He must, therefore, leave it to these counsel and to others appearing as objectors as to whether they would call their evidence on the controversial questions. This evidence must be called at this stage if at all.

After an adjournment to consider the question, the objectors decided to bring out their evidence, which was being heard when we left the enquiry at mid-day.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E.C. Anonymous communications will not be noticed.*

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CONTRACTORS AND CONTRACTING.

We have no intention of discussing the Brighton matter, which is referred to in the correspondence given elsewhere, but to call attention to another phase of contracting which needs a remedy. Upon the face of it, the system is admirable of having work done by a contractor selected under open competition. The abstract and the concrete, however, do not always run on all fours. Perfection assumes a competent engineer, an equally competent contractor, and a sensible employer. The system breaks down in practice when these things are not obtainable. Generally the grumbling lies between the engineer and contractor, the employer's interests being safeguarded by the engineer. In some cases the employer tries to run alone, and probably comes to grief. The point to which we call attention belongs to those brought about in the latter contingency. We may, without going far wrong, assume an average of twenty tenders sent in for every large installation. The sending in of a tender means considerable expense to every contracting firm. In the first place, a payment is demanded for the specification, returnable if a *bonâ fide* tender is duly sent. The greater expense comes in because of clerical and drawing office work, the taking out of quantities, the checking of figures, and so on. Under no circumstances does the contractor recoup this outlay directly unless he obtains the contract. It needs little knowledge of commercial economy to see that the expenses thus incurred become part and parcel of the wages bill of the factory. One of the factors determining the ultimate cost of work is the wages bill, hence employers should not unnecessarily add to the works wages sheet. We do not see any remedy for the abolition of tenders, hence the cost of this part of contracting is a necessity. The same does not hold in the following case. A number of employers—indeed, an increasing number—insist upon a banknote of greater or less value—say, generally fifty pounds—being enclosed with a tender, returnable when the tender, so to speak, is *proved* to be a *bonâ fide* tender. It is said, though not in so many words, that contractors must not be permitted to remedy a mistake, and that if a clerk in his addition fails to "carry one," and so makes the total ten, a hundred, or ten thousand pounds less or more, the mistake is not to be remedied; and if it so happen the error decreases the total, the work must be done for the incorrect total, or the contractor be mulcted to the tune of fifty pounds. An error is an error, and should be remedied without fuss. There is no valid reason for fining a man fifty pounds because of a clerical error. Further, this deposit of fifty pounds is not of much account when only a single case is considered; but one firm may have twenty tenders out, and that means the lock-up of a thousand pounds for perhaps three months, or, rather, it is the lock-up of that amount for ever. That for one firm; but there is a multiplicity of firms, and it is easy to see how from twenty to fifty thousand pounds may be always locked up under the circumstances

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described. We simply take an average number of firms with an average number of tenders out, and show the result. We are not unaware that in many foreign contracts large deposits have to be made, but these are of a different character, for a different purpose. Contractors are human, their clerical staff is liable to err, and assuming tenders honestly made there is no reason for a penalty. Assume an error making the total too high, the tender is out of the running, and the contractor loses the work, the penalty thus being large and naturally enforced. If the total amount is too low by error, perhaps when corrected it merely lets in another contractor, giving a little trouble, but in the majority of cases leaving the erring tender in the same position as it would have been if correct at first. There is still the case where the corrected error still leaves the total under that of the next highest tender, and here the employer has to pay more than he expected; but surely such cases ought to be determined on their merits. This latter case may involve very considerable trouble. A municipality may have borrowed upon the original, not the corrected estimate, and so may have borrowed too little, and have all the trouble of obtaining further borrowing powers—*i.e.*, if the amount is large—but even in this case there seems no vital impediment to an equitable arrangement regarding the trouble and expense.

FORTHCOMING EVENTS.

FRIDAY, MARCH 15.

Institution of Mechanical Engineers.—At 8 p.m. ordinary meeting. Paper on "Combined Trolley and Conduit Tramway Systems," by Mr. A. N. Connett.

SATURDAY, MARCH 16.

Royal Institution.—At 3 p.m., the Right Hon. Lord Rayleigh on "Sound and Vibrations" (Lecture IV.).

Institution of Junior Engineers.—At 6.30 p.m., Westminster Palace Hotel, anniversary dinner.

MONDAY, MARCH 18.

Society of Arts.—At 8 p.m., "Electric Railways," by Major P. Cardew (Lecture II.).

TUESDAY, MARCH 19.

Institution of Junior Engineers.—At 8 p.m., "Works Management," by Mr. A. H. Barker (Lecture IV.).

North-East Coast Institution of Engineers and Shipbuilders.—Meeting at Newcastle-on-Tyne.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "The Æsthetic Treatment of Bridge Structures," by Mr. Jos. Husband.

WEDNESDAY, MARCH 20.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper on "Indoor Electric Light Fittings at the Paris Exhibition," by Mr. G. E. Turnbull.

FRIDAY, MARCH 22.

Institution of Junior Engineers.—At 8 p.m., engineering question night.

Royal Institution.—At 9 p.m., discourse on "Some Recent Work on Diffusion," by Dr. Horace T. Brown, LL.D., etc.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On the Expansion of Silica," by Prof. Callendar; and "The Spectroscopic Apparatus at University College," by Dr. E. C. C. Baly. Council meeting at 4.30 p.m.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "The Hunslet Railway and Bridge over the River Aire," by Mr. O. L. MacDermott.

SATURDAY, MARCH 23.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Sound and Vibrations" (Lecture V.).

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Glasgow's Water Supply," by Mr. James B. Wyllie.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE QUIN TROLLEY WIRE PROTECTION DEVICES.

SIR,—In your issue of the 8th inst. you describe Mr. Quin's ingenious automatic cut-out, designed for this purpose.

But, from the diagram of connections, it would appear that the device is only applicable where current is fed into the trolley line from a single feeder—*i.e.*, to those (short) trolley lines which can be fed from a single station and by means of a single feeder. For those lines which are fed by several feeders, and at several points, it would appear that the device is inapplicable—at any rate in the form described—for it is fairly obvious that the current necessary to operate an E.M.F. coil can as easily get to the coil from the further side of the break (by means of the feeders which feed sections further from the station), as from the near side of the break.

Perhaps you can explain, Sir, how Mr. Quin overcomes this difficulty, for to me it seems rather a serious one.—Yours, etc.,

PUZZLED.

Birmingham, March 11, 1901.

[The difficulty which our correspondent has in understanding Mr. Quin's device is due to the fact that he does not realise the arrangement of feeding the trolley wires by means of sections. Each section of the trolley wire is fed from one point only; the division between one section and the next is made at sectional insulators, which occur, as a rule, at about a quarter of a mile intervals. The fuses in the sectional pillars, which, as a rule, feed four lengths of trolley wires, two in each direction, are replaced in Mr. Quin's system by automatic cut-outs operated in the way described in our last issue.—ED. *E. E.*]

SIR,—I would feel greatly obliged to you if you would make clear one point in connection with this system, which would appear, from the brief account of it given in your last issue, to be a very serious objection, indeed, to the universal adoption of the scheme. The shunt coils of the automatic switches in the street pillars are excited off the trolley wire by the 500-volt supply from the generating station, and these coils, to quote from your last issue, "when energised, hold on the switch levers, which otherwise fly off and break circuit." From this it would appear that if the 500-volt supply was interrupted all the automatic switches on the system would open, making it necessary, before the traffic could be resumed, for a man to go round and close them again, and, further, this would have to be done every morning before the cars could start.—Yours, etc.,

A. JOHNSTON.

[Mr. Johnston is correct in his surmise that the whole of the automatic switches would go off if the supply were discontinued. It would only be necessary, however, for the conductors of the leading cars to put up the automatic switches again as they come to each switch pillar. A note in the article describing this system mentioned the fact that these switches have to be put on each morning by the conductors of the first cars that go out. The extra safety given by the device more than compensates for this slight additional labour.—ED. *E. E.*]

BRIGHTON CABLE TENDERS.

SIR,—Enclosed are copies of correspondence on this subject, which may be of interest to your readers. I think the letters fully explain the position in which the controversy stands at present.—Yours, etc.,

A. H. HOWARD, Secretary.

Cable Makers' Association, Westminster, S.W.,
March, 1901.

[COPY.]

Town Hall, Brighton, Feb. 27, 1902.

Dear Sir,—Your letter of the 8th inst., the receipt of which I acknowledged on the 9th inst., has been submitted to the Lighting Committee of the Corporation, and in reply thereto I am instructed to inform you that you are

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in error in stating that several of the recent tenders sent in for cables for the Corporation of Brighton were substantially lower in amount than the tender of the Union Cable Company, which was accepted; that when consideration had been given to the effect of the alterations made in the conditions by the persons and companies whose tenders were apparently the lowest, it was found by the committee that they were, in fact, not so, and that the Union Company's tender was undoubtedly the most advantageous to the Corporation.

I am further directed to inform you that the Lighting Committee of the Corporation are willing at any time to consider any suggestions made by the association or any of its members for the alteration of the conditions attached to the specifications for the supply of cables for the Corporation, but they cannot consent to any alteration in the conditions, when once issued, being made by persons tendering, inasmuch as alterations so made would render a fair comparison of the tenders received exceedingly difficult and, perhaps, impossible.—Yours faithfully,

(Signed) F. J. TILLSTONE, Town Clerk.

A. H. Howard, Esq., Hon. Sec., Cable Makers' Association, Westminster, S.W.

[COPY.]

Cable Makers' Association, 2, Queen Anne's-gate, Westminster, S.W., March, 1901.

Francis J. Tillstone, Esq., Town Clerk, Town Hall, Brighton.

Re Cable Tender.

Dear Sir,—Your letter of Feb. 27 has been considered by the Cable Makers' Association, and I am requested to point out that the facts of the case do not support your contention that the foreign tender accepted was undoubtedly the most advantageous to the Corporation. This is shown by the prices of the various firms, as stated below:

	Cables.	Carriage on empties.	Total.
Johnson and Phillips	£13,335 0 0	£30 0 0	£13 365 0 0
W. T. Glover and Co.....	13,731 13 4	89 9 2	13 821 2 6
B.I.W. Co. (by rail)	13 859 0 0	95 0 0	13,954 0 0
B.I.W. Co. (by sea).....	13 859 0 0	75 0 0	13 934 0 0
Foreign tender accepted, including carriage			13,952 0 0

The carriage on the empty drums given in the second column is obtained from the weight of the drums necessary and the railway company's charges to each manufacturer's works, so that even taking into account this cost of carriage (which is assumed to be included in the foreign tender), there is a difference in price in favour of the lowest British firm of £587.

The only other point which might be taken as increasing the cost of the British tenders is the stipulation that if the drums are not returned, carriage paid, within three months from date of delivery, two-thirds only of the original price charged would be allowed. As presumably the extensions of the circuit are carefully planned out, and the order of laying cables arranged, three months' time should be ample for emptying and returning drums, and the probable cost of keeping some few drums beyond the three months would be very small. But even if every drum were kept more than the stipulated time, the one-third of the cost paid to the manufacturer would still leave Messrs. Johnson and Phillips's tender considerably below the accepted one. The total number of drums required would be 130. These would be of various sizes and prices, but the average price would certainly not be more than £3 per drum, or a total cost of £390. Assuming that none of these drums are returned within three months, the Corporation would have to pay £130 as a maximum charge. This would still leave Johnson and Phillips's tender £457 below that of the Union Cable Company.

Referring to your statement that the Corporation is willing to consider any suggestions for the alteration of the conditions, but cannot consent to any alteration in the conditions when once issued: it is obviously impossible for anyone to suggest alterations to a specification which they have not seen; and your proposition is untenable, unless it is taken to mean that all tenderers must accept the conditions, however onerous they may be, and then ask as a favour that those objected to may be modified. I would point out that this is not a sound business proceeding, and any responsible firm would object to agreeing to conditions which they could not carry out.

The conditions of the Cable Makers' Association were published in October last. Copies have been sent to all consulting engineers and station engineers; among others, to your consulting engineer at Brighton. They were, moreover, published largely in the technical Press. Therefore, so far as is possible, the suggestions which you say your Corporation is willing to consider were made to your consulting engineer, and through him, of course, to you.

As you are aware, the Cable Makers' Association, in dealing with mains for town lighting, has endeavoured to standardise the general conditions of contracts, but does not consider the question of price, so that in no sense could it be looked upon as a ring for obtaining excessive profits.—Yours faithfully,

A. H. HOWARD, Secretary.

ELECTRICALLY-DRIVEN UNIVERSAL PORTABLE DRILLING MACHINE.

With respect to the illustrated description of this machine which appeared in our last week's issue, we now learn that the tool in question was entirely designed and manufactured by Messrs. Mather and Platt, of Manchester, and that the details of it have been patented by that firm. The arrangements of the various parts of the tool, including the driving motor and the electromagnet for securing the tool on to the face-plate, leave nothing to be desired, and will make the drilling machine of very great service on large castings, such as the frames of alternators and large multipolar direct-current dynamos.

A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.*

BY MICHAEL B. FIELD, A.M.I.C.E.

A problem which often confronts the central-station engineer is the measurement at the power-house itself of the voltage obtaining at distant parts of his network which supplies current for, say, lighting and power purposes. In fact, it is very often of far greater importance that the engineer in charge should know accurately the value of the voltage existing at the distributing network, or, better, the lamp terminals or motor terminals, as the case may be, than that obtaining at the central-station 'bus bars themselves. In cases where the distributing network lies at some considerable distance from the power-house, and is fed with current by means of "feeders," the drop of voltage in the latter may vary from zero, when the network is very lightly loaded, to 10 or 12 per cent., when the network is heavily loaded. Under such circumstances the engineer requires, of course, so to regulate his generators that the voltage at the network or lamp or motor terminals remains constant; in other words, he must raise the 'bus-bar voltage in the power-house above the normal by an amount equal to the drop in the feeders. In such cases a very usual course to adopt is to mount on the switchboard in the central-station voltmeters which are connected to points of the network by means of "pilot" wires, and thus indicate the true voltage existing at those points. The engineer in charge can then readily regulate his generators so that, under varying conditions of load, the voltage indicated by these voltmeters is maintained constant.

In the year 1882 Dr. Hopkinson patented an arrangement for effecting the same purpose without resorting to the employment of pilot wires. His method consisted of compounding the shunt windings of electromagnetic voltmeters with a few turns of thick wire, through which the main feeder current, or a proportionate part thereof, flowed. In this way a voltmeter connected to the near end of a pair

* Paper read at a meeting of the Glasgow Local Section of the Institution of Electrical Engineers, Feb. 13, 1901.

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of feeders might be compensated for the drop along the feeders, and would thus indicate the voltage existing at the far ends, and obviate the necessity of employing pilot wires. There is, of course, no great disadvantage in employing pilot wires for the purpose named beyond the cost of the same, which will amount to at least £90 per mile per twin wire. If it be possible to save this sum, which, especially in the case of long-distance transmissions or networks covering extensive areas, will amount to a very considerable sum, by merely adding a suitable arrangement of resistances at the switchboards, it will, of course, be advantageous to do so. Moreover, by obviating the pilot wire, we obviate the trouble often connected therewith; and while speaking on this point I would call attention to the fact that it is by no means uncommon for pilot wires to give trouble. What the reason usually is I do not know. Whether it is that while laying them they are considered as an adjunct of no vital importance, and, therefore, the necessary care is not devoted to their instalment, or whether it be for other reasons, is not a matter for discussion here. Compounding coils of the above description are, of course, quite inapplicable to voltmeters constructed on the D'Arsonval principle—*e.g.*, Weston voltmeters—and in consequence of the almost universal preference shown by central-station engineers for instruments of this class for continuous-current work, the writer some little while ago devised a method whereby any voltmeter whatever may be compensated for the feeder drop of either a two, three, or multiple wire system without necessitating constructional modifications of any kind, and, beyond that, can be arranged to indicate the average voltage obtaining at any group of distant feeding points.

The method is capable of very general application, but three instances of its use are of special interest to central-station engineers, and it is the object of this short paper, firstly, to describe briefly these three applications, and, secondly, to investigate analytically the accuracy of the same. The three cases for consideration are: (*a*) the measurement on the same instrument not only of the actual voltage existing at various feeding points of a two-wire network, but also the average of the voltage at all the feeding points, or the average voltage at any desired group of feeding points of the network; (*b*) the measurement of the individual feeding-point voltages and the average voltage at any group of feeding points of a network on the three, five, or other multiple wire systems; (*c*) the measurement by means of a low-tension electrostatic multi-cellular voltmeter of the voltage at the far end of a long single or multiphase power transmission line working at extra high tension, and possibly possessing a comparatively large self-induction.

Let us imagine a large distributing network supplying current for lighting and power purposes over a considerable area. It is evident that a voltmeter in the power-house so arranged that it indicated directly the average of the voltage all over the network would provide the engineer in charge with much more valuable information than one arranged only to indicate the actual voltage at some particular point of the network, for it is clear that the engineer should strive to maintain the average voltage at the normal value. Now, although it is not easy to obain the true average of all points of the network, this may be approximated to by measuring the average voltage existing at all the feeding points; this information would, as a rule, be a sufficient guide to enable the central-station engineer to maintain the average voltage over the network itself at its normal value. It might further be advantageous for the engineer to be able to measure the average voltage existing at some one group or other of feeding points—*e.g.*, during one portion of the day he might perhaps wish to pay most attention to keeping the average voltage throughout the commercial portion of the town constant, and at another time it would be of more importance to maintain the average voltage throughout the residential portion of the town constant. He might further wish to know at any instant what was the actual voltage at the end of some one long feeder supplying an outlying district, more especially if this feeder contained a booster, so that the voltage was capable of independent regulation; all of these conditions become possible by the method about to be described.

Case A.—The additional switchboard apparatus necessary for this case—for, say, a continuous-current system—consists of a low-reading Weston voltmeter with a suitably graduated scale—*e.g.*, an ordinary 600-volt Weston with the series resistance removed would serve perfectly—a multiple-contact voltmeter switch, a set of voltmeter resistances which would be mounted in an out-of-the-way place at the back of the switchboard, and, further, a series resistance for insertion in each feeder circuit. These latter resistances would be similar to those usually supplied with Weston ammeters, and would be such that the drop across them

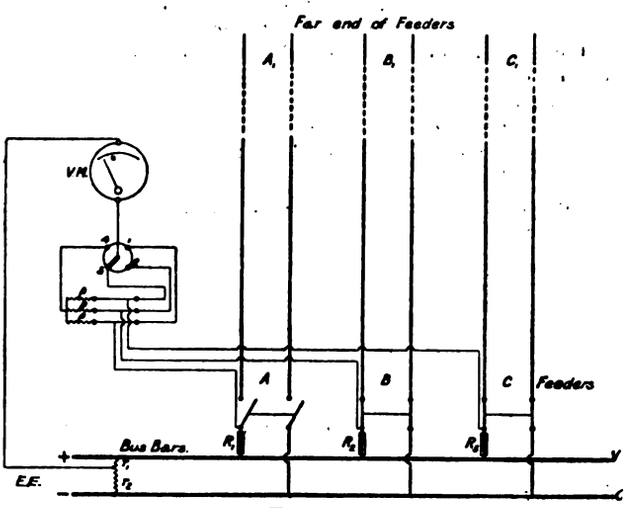

FIG. 1.

with the maximum current would be of the order of two-tenth volt, or less where exceptionally heavy feeder currents are dealt with. The multiple-contact switch would be arranged for as many "positions" as groups of feeding points required. Suppose, for example, three feeding circuits, A, B, C, left the station, a four-way voltmeter switch might be advantageously employed. With the switch successively in the first three positions the voltmeter would indicate the feeding-point voltage of the network at A_1, B_1, C_1 respectively, while with the switch in the fourth position the voltmeter would indicate the average voltage at the feeding points A_1, B_1, C_1. Two distinct arrangements are shown in Figs. 1 and 2. Fig. 1 shows the simpler of the two, but involves the disadvantage that the average voltage of A_1, B_1, C_1 can only be

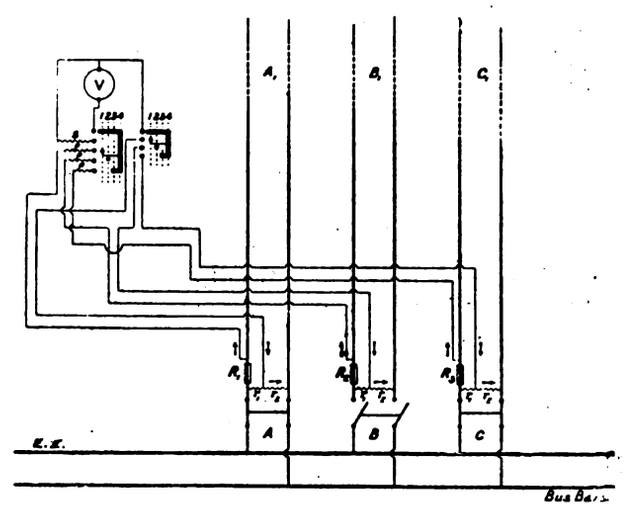

FIG. 2.

obtained if all three feeding circuits are switched in. It is, moreover, only possible to determine the individual values A_1, B_1, and C_1 if the corresponding feeders be switched in. In Fig. 2, on the other hand, a modification is shown whereby the individual voltages A_1, B_1, C_1, and the average of A_1, B_1, C_1, are given correctly by the voltmeter with the switch in the corresponding positions, whether some of the feeder circuits be switched in or not. This involves extra complication in the multiple-contact

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switch, in which case it may conveniently be constructed on the same lines as a miniature tramcar controller. In Fig. 2 the contact cylinder has, for the sake of clearness, been developed on a plane. R_1, R_2, R_3 are the inserted series resistances in the feeder circuits; shunt resistances (divided into r_1 and r_2) are connected in Fig. 2 across each pair of feeders, in Fig. 1 across the 'bus bars. The letter ρ represents that the particular connecting wires so distinguished must have sufficient resistance to prevent any appreciable interchange of current between the various feeder circuits when the switch is in the fourth position. V.M. is the voltmeter, and s a shunt which is connected across the terminals of the voltmeter when the switch is in the fourth position in order to keep the calibration of the voltmeter correct.

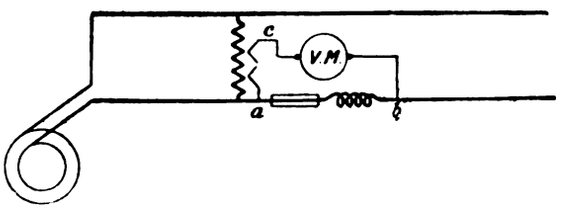

FIG. 3.

Briefly explained, the principle involved is as follows: If r_1 be $\left(\frac{1}{n}\right)$th part of r_1+r_2, the drop of pressure down r_1 will be $\left(\frac{1}{n}\right)$th part of the 'bus-bar volts. Again, if R_1 be $\left(\frac{1}{n-1}\right)$th part of the whole feeder (go and return) resistance, the drop along R_1 will be $\left(\frac{1}{n}\right)$th of the total drop. The voltmeter, then, if connected to one feeder, measures $\left(\frac{1}{n}\right)$th part of the 'bus-bar voltage less $\left(\frac{1}{n}\right)$th part of the drop—*i.e.*, $\left(\frac{1}{n}\right)$th part of the voltage existing at the far end of the feeder. If a number of feeders be simultaneously connected to the same voltmeter, this latter will indicate the average of all the individual voltages. The connecting wires must, however, as already stated, have sufficient resistance (ρ) to avoid any appreciable interchange of current between the different feeder circuits. The action of the shunt, s, which is necessary with the arrangement shown in Fig. 2, but not with that shown in Fig. 1, will be found fully explained in the analytical treatment of the subject.

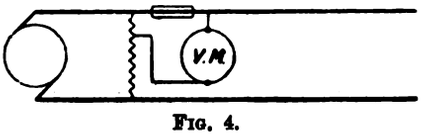

FIG. 4.

It may here be mentioned that the writer, on subsequent investigation, found that particular cases of his method had been anticipated by Mershon in America, and by Crompton and Ashley, and later by Heap, in England. Mershon's patents relate exclusively to alternating currents, since he bases them fundamentally on the use of either current or potential transformers, or both. Fig. 3 shows one of Mershon's arrangement, though many equivalent arrangements are illustrated in his patent specifications. Mershon's object is to compensate the voltmeter not only for the ohmic but also for the inductive drop of the line, and his arrangement is only used in connection with single lines—*i.e.*, it corresponds to case (*a*), where the number of feeder circuits is unity. As is evident from Fig. 3, the shunt resistance $r_1 + r_2$ of Fig. 1 is replaced by a potential transformer whose ratio is $n : 1$. Further, a resistance and a self-induction are inserted in the line whose values are $\left(\frac{1}{n-1}\right)$th times those of the line resistance and self-induction respectively. Referring to Fig. 3, we see, then, that the drop from a to b will be $\left(\frac{1}{n}\right)$th of the whole drop and in phase with it, whereas the secondary voltage of the transformer is $\left(\frac{1}{n}\right)$th of the generator voltage, and if the terminals be correctly chosen in phase with it. Thus the voltage bc, or that measured by the instrument, is $\left(\frac{1}{n}\right)$th of that existing at the end of the line. The anticipations of Crompton and Ashley, and, later, by Heap, are merely case (*a*), where the number of feeder circuits is unity—*i.e.*, they compensate the voltmeter for the drop of voltage in a single pair of feeders by using shunt and series resistances as explained. The diagram of connections for this simple case is shown in Fig. 4, and needs no further comments.

(To be continued.)

CATALOGUES.

We have received from W. T. Henley's Telegraph Works Company, Limited, a copy of their new price-list of electric light cables and wires, insulated with vulcanised and unvulcanised indiarubber, etc. From the tables given, the carrying capacities and other electrical data relating to the different sizes and types of cables manufactured by the firm may be ascertained at a glance, while the prices and data relating to the insulation, etc., of the different cables are also given in tabular form. Single vulcanised indiarubber wires and cables of different classes, having minimum insulation resistances per mile of from 300 to 5,000 megohms, are dealt with in the first portion of the list. Then follow twin vulcanised indiarubber wires and cables, having insulation resistances of from 300 to 2,500 megohms per mile, while the third section deals with concentric vulcanised indiarubber wires and cables. Finally, we have a miscellaneous section in which, as the heading indicates, miscellaneous types of cables are dealt with, besides flexible cords, fitting wires, bell wires, jointing materials, wires insulated with guttapercha, twin paper-insulated wires, etc. The admirable arrangement of the list with a view to facilitate reference will be appreciated.

From the British Thomson-Houston Company, Limited, we have to acknowledge the receipt of four admirably-executed pamphlets. Of these, No. 88 is a revised edition of a previous pamphlet issued by the British Thomson-Houston Company, dealing with inclined-coil measuring instruments. A number of particulars are given relating to switchboard ammeters and voltmeters constructed on the principle in question. Portable ammeters and voltmeters are further dealt with, besides a compact form of indicating wattmeter for incandescent lamp testing, already described in these columns. We also notice a neat form of scale doubling multiplier for use with portable meters. This multiplier has been designed to enable measurements higher than the usual scale limit to be made. Pamphlets Nos. 86 and 89 also supersede previous issues. The former describes the firm's recording wattmeters designed for different systems of supply. Diagrams of the connections for the different systems are given, which add to the usefulness of the pamphlet. Pamphlet No. 89 deals with slow and moderate-speed belt-driven generators, describing the principal features of standard machines. An illustration is also given of a small iron-clad bipolar generator, in which the field frame completely surrounds the armature, thus affording protection to the armature and field spools from mechanical injury. This special type of generator is claimed to be eminently adapted for small isolated plants in virtue of its compactness. Pamphlet No. 51, the last of the four, describes in detail with illustrations the firm's G.E.-58 type of traction motor, which is suitable for both narrow and standard gauges, and possesses all the salient features of the British Thomson-Houston Company's other well-known types of traction motors. The motor with a four-turn armature is rated at 37 b.h.p., and with a six-turn armature at 27 b.h.p. In the design of this motor it may be mentioned that special attention has been given to the bearings, which are made equal to those of standard-gauge motors, in view of the fact that the renewal of linings is frequently the principal item of maintenance cost of a motor it is explained.

Messrs. Hayward Bros. and Eckstein, Limited, have issued a two-leaved illustrated pamphlet describing, amongst other specialities, their newly-invented floor-light for use in electricity works. In this floor-light the iron frame is kept entirely below the surface of the glasses, which latter are set as close together as possible. The narrow spaces or joints between

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the lenses are run in with a specially-prepared non-conducting composition, which completes the insulated surface. An insulated platform is thus obtained, while the lighting of the area below is at the same time provided for. It should be mentioned that the lenses are of the studded pattern, whereby good foothold is ensured and the danger which, we presume, might otherwise arise from the collection of moisture on the surface minimised. We understand that floor-lights of this type have been supplied to the electricity works at Glasgow, Brighton, Wallsend-on-Tyne, etc.

Messrs. Johnson and Phillips have just issued a new trade list of their vulcanised indiarubber cables and wires. We gather from this that special arrangements are made at the works for testing all cables before being sent out of the factory. The test is made after the cable has been immersed in water for at least 24 hours. The rooms are fitted with transformers capable of working up to 20,000 volts, and, as a rule, high-tension cables are tested at much higher pressures than they are required to work at. Another feature of the firm is their excellent system of registration in the different departments, by which any fault may be traced to its origin.

Messrs. Bergthell and Young have forwarded us their No. II. list of the "Bandy" type of generators and motors. The general specification of the motors shows that they are of high class. For instance, the machine will not be affected in any degree by an overload of 25 per cent. for one hour, or an overload of 50 per cent. for periods of 15 minutes, while the temperature is guaranteed not to exceed 72deg. F. irrespective of the length of run which may be required. The magnet poles are parts of the frame, and between them and the armature is interposed an independent pole-ring carrying pole extensions made up of laminated iron. Owing to the form of these, sparkless running of the motor is obtained, and local currents in the pole-faces are reduced. The commutator is made up of hard-drawn copper, which, on account of its construction, interlocks each commutator bar with the two adjacent bars. In this type of machine such a thing as a "high bar," due to heat or centrifugal force, is unknown. Mica insulation is used between the bars, while the commutator is securely fixed at both ends in mica rings. The standard volts of both motors and dynamos are 120, 240, and 500 volts.

LIGHT RAILWAYS.

The Warrington General Purposes Committee have asked Major Cardew to advise them on the engineering provisions contained in the draft agreement submitted by the promoters of the Warrington and Northwich light railway.

In consequence of an impression that the Nuneaton light railway scheme had been abandoned, the promoters' solicitor (Mr. Warwick Webb) has informed a correspondent of the *Coventry Standard* that one or two points of detail remain under consideration by his clients and the Board of Trade. As soon as these are settled the order will be confirmed by the Board of Trade, and the promoters will then be in a position to proceed with the scheme.

A somewhat important point was raised before Sir Courtenay Boyle this week on a light railway order in Salop. Mr. Munns, for the promoters, said they were a statutory company, and desired to have Section 8 of the New Companies' Act inserted in their order, so that they might have the power of paying commission on underwriting shares the same as a limited liability company, which was illegal under a statutory company. Sir Courtenay Boyle said, without deciding the point, he could not advise the Board of Trade to give a light railway company an advantage over all other existing light railways, but the promoters could go to Parliament to have the law amended if they thought proper.

At a recent special meeting of the Isle of Axholme Light Railway Company a resolution was adopted agreeing to sell the railway to the North-Eastern Railway at a price to be agreed upon.

The Board of Trade have recently confirmed the orders authorising the deviation of a light railway authorised by the West Hartlepool Light Railways Order, 1897, and for other purposes; the construction of light railways in the county of Lancaster, from Ormskirk to Southport; the construction of a light railway in the county of Essex, between Kelvedon and River Blackwater; and the construction of light railways in the borough of Morley and the urban districts of Drighlington, Gildersome, and East and West Ardsley, in the West Riding of the county of York.

An order has been made by the Light Railway Commissioners, and submitted to the Board of Trade for confirmation, authorising the construction of the Blackpool and Garstang light railway.

At a meeting of the General Purposes Committee of the Bolton Corporation, held on Monday last, the Bolton, Turton, and Darwen light railway order was submitted, and protective clauses ordered to be obtained in regard to the gas and water mains.

PHYSICAL SOCIETY.

At the ordinary meeting held on March 8, 1901, Dr. R. T. Glazebrook, foreign secretary, in the chair, a paper on "**A Theory of Colloidal Solutions**" was read by **Dr. F. G. Donnan.**

Mr. Appleyard exhibited three pieces of apparatus. The first was a slide-wire bridge for measuring conductivities of wires. The slide wire, instead of forming two arms of the bridge, forms only one, and the length used is proportional to the conductivity to be measured. If the arm which contains the standard wire used is altered, it becomes necessary to alter the divisions of the scale on the slide wire. This is done by a mechanical arrangement. The second piece of apparatus was a mechanical gauge for measuring the diameters of spheres. The sphere to be measured is placed between a metal face plate and a pieces of glass at the end of the short arm of a pivoted lever. The end of the long arm of the lever moves over a graduated scale, which is calibrated to show directly the diameter of the sphere. The third piece of apparatus was a galvanometer fitted up for lamp and scale work. The illumination was produced by a four-volt ¼-c.p. lamp, and it was shown that very good results could be obtained from this by using a large condensing lens.

Prof. Threlfall said he had usually used a straight piece of the lamp filament itself instead of using the lamp in conjunction with a cross wire.

A paper by Prof. R. W. Wood on "The Production of a Bright Line Spectrum by Anomalous Dispersion and its Application to Flash Spectrum," was postponed until the next meeting at Burlington House, when the subject will be experimentally illustrated by Mr. Watson.

The society then adjourned until March 22, when the meeting will be held in the chemical laboratories of University College, London.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Cooke's Patent Tramway System, Limited.—Capital, £5,000. Object: to adopt an agreement made by this company (by P. Ehrenfeldt, Feb. 21, 1901) with H. J. Cooke and P. Ehrenfeldt, for the acquisition of certain patents granted to them, to develop and turn to account the same, and to construct and maintain rail and tram roads; as electricians, builders, and contractors; producers of gas and electricity etc.

Steel Chain Company.—Capital, £25,000. Object: to acquire certain patents on the terms of an agreement with J. M. Davis and A. G. Strathern, and to carry on the business of weldless and other chain and cable manufacturers, mechanical, marine, electric, general engineers, etc.

British Electrical Manufacturing Company, Limited.—Capital £10,000. Object: to adopt an agreement made by this company with D. R. Broadbent for the acquisition of the business of electrical engineers, etc, as carried on by J. D. F. Andrews at Fulham, to develop the same, and to carry on business as electricians, producers and suppliers of electricity, manufacturers of cables, lamps, accumulators, etc.

APPOINTMENTS VACANT.

Chief Mechanic, Southend Corporation Electricity Works; £2 per week, March 21. Details in our advertisement columns.

Electrical Engineer, Nelson Corporation, £200 per annum, March 25. Details in our advertisement columns.

Clerk of Works, Heywood Corporation, £2 per week, March 18. Details in our advertisement columns.

Fitter-Driver, Maynooth, Ireland, accustomed to high-speed engines, dynamos, and accumulators.

Switchboard Attendant, Carlisle Corporation, March 25. Details in our advertisement columns.

Electric Boats.—A system of canals under Government ownership is proposed to be established in New York State, on which electrically-driven barges and boats will be introduced. Each vessel would be about 150ft. long by 25ft. wide, with a draught of 10ft. The estimated cost of the scheme as it is at present framed stands at between 10 and 11 millions sterling. Electric power would also be employed to pull the boats into and out of the locks, operate the gates and valves, and to furnish light, consisting of four arc lights on each lock proper and one on each approach.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

359. Describe a combined balancer booster, and state fully the part it acts in connection with electric lighting. Show connections.—P. N.

[N.B.—This question comes from South Africa, and we will be glad to receive clear and concise answers to it.—ED. *E. E.*]

360. What are the advantages or disadvantages of putting a flexible coupling between the engine and generator of a direct-coupled alternator? State the effect, good or bad, which the introduction of a flexible coupling will have on parallel running.—S. L.

ANSWERS.

Question No. 353.—In designing a shunt regulating resistance for a large dynamo, how should the resistance be proportioned between the different contacts of the regulating switch in order that each movement of the latter shall give, say, one volt variation throughout its entire range?

Answer to No. 353 (*awarded* 7*s.* 6*d.*).—In practice it is usual to divide the resistance into equal steps, as this simplifies the calculation and allows resistances of standard amounts to be made up in quantities without consideration of the particular machines with which they are to be used. The results obtained with such resistances are usually quite satisfactory, for with small ranges of voltage variation, say not over 20 per cent., and with the magnet iron worked at ordinary saturation, equal resistance steps give very nearly equal voltage steps. This results from the fact that, as the terminal voltage gets lower and the magnets less saturated, the necessary alteration in shunt current per volt becomes less, and an equal step resistance has just this effect of gradually reducing the change in shunt current per step as more and more resistance is inserted.

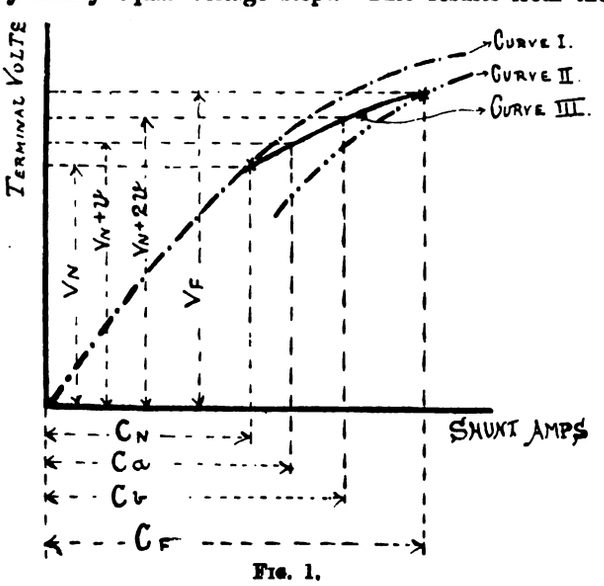

FIG. 1.

A quite exact equality is, of course, seldom obtained in this way, and when such is required it becomes necessary to consider the resistance in connection with the design of the dynamo to which it belongs. To begin with, a saturation curve of the machine must be obtained either by calculation (as explained in any text-book) or, preferably, by actual test. This curve, connecting terminal volts at constant speed and shunt current, will be required (*a*) with no current in the armature, and (*b*) with full-load current in the armature—supposing that the regulating resistance is intended to give equal voltage steps, starting from no load at the lower voltage and gradually increasing the volts as the load increases, until the higher voltage limit is reached with full-load current. If the equal voltage steps are required with a given constant current in the armature, it will, however, only be necessary to obtain the curve for that particular current.

The former case is the more usual, and so will be considered. Having plotted the no-load and full-load curves (Curves I. and II. in Fig. 1), a third curve (Curve III.) should be drawn from the maximum voltage point, V_F, on the full-load curve to the minimum voltage point, V_N, on the no-load curve, and lying approximately midway between the two curves at intermediate points, as shown. This last curve represents the actual shunt current corresponding to every voltage throughout the range, with the correct current in the armature.

Let r = the resistance of the shunt winding itself when cold;

v = the required voltage variation per step;

C_N, C_a, C_b, . . . C_F = the shunt currents, read off Curve III., corresponding to the voltages V_N, V_N+v, V_N+2v, . . . V_F;

$V_F - V_N$ being the required voltage range.

Then $\frac{V_F - V_N}{v}$ = number of steps required.

The total amount of regulating resistance = $\frac{V_N}{C_N} - r$; the amount of regulating resistance left in, with one step cut out = $\frac{V_N+v}{C_a} - r$; the amount of regulating resistance left in, with two steps cut out = $\frac{V_N+2v}{C_b} - r$, and so on for the remaining steps, from which the required value of each step is at once obtainable. The more saturated the magnets of the dynamo are, the more will the "resistance per step" increase, the values at the "all-in" end being always smaller than those at the "all-out" end.

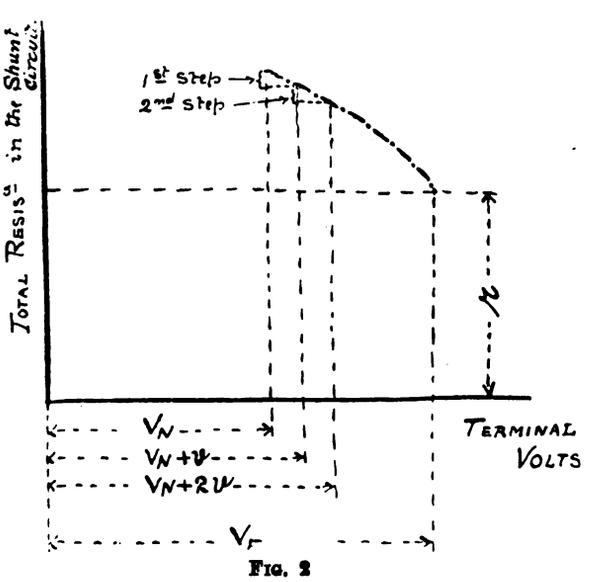

FIG. 2.

When a large number of steps has to be dealt with, the above somewhat tedious process may be simplified by calculating out only the two extreme points and one or two intermediate ones, and connecting the whole by means of a curve, as shown in Fig. 2. The values of the remaining steps can then be quickly read off the curve.—Q

Answer to No. 353 (*awarded* 7*s.* 6*d.*).—The design of a shunt regulating resistance to give equal increments of voltage per contact is governed by the induction curve for the machine, and the point on that curve at which the machine normally works. Let *o a* be this curve, values of

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the shunt current being plotted as abscissæ, and values of the open-circuit voltage as ordinates, the speed of the machine being constant and normal. If in actually running the machine to obtain the values the speed should vary, being n' instead of n when any pair of readings;

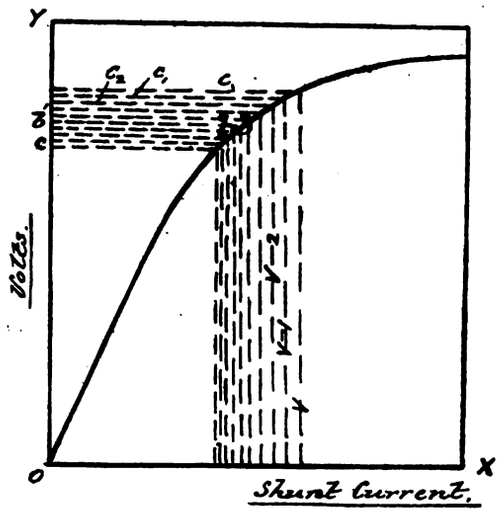

FIG. 1.—Induction Curve.

V' and C_s', are taken. the true values for the curve may be obtained from the equations:

$$V = \frac{n}{n'} V', \text{ and } C_s = \frac{n}{n'} C_s'.$$

The variations are produced in this trial, of course, by an adjustable resistance, and read by an ammeter in series with the shunt, the voltmeter being across the terminals (Fig. 2). Let, now, b be the point of normal working, and

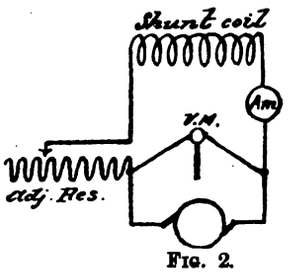

FIG. 2.

firstly let us assume the armature E.M.F. is to be altered by one-volt steps. In other words, the open-circuit voltage has these increments. From b' distances corresponding to one volt are taken above and below, as shown. From these are drawn lines cutting the curve in points, from which are dropped ordinates which give the values of the shunt current for the different voltages. At the lowest of these values the whole resistance must be in; at the highest the actual shunt windings only, we may suppose, would be in, having the resistance R_s.

At voltage—

V – 1 total field resistance is $\frac{V-1}{C_1} = R_1$ } $R_2 - R_1$ across contacts;

V – 2 " " " $\frac{V-2}{C_2} = R_2$ } $R_3 - R_2$ across contacts;

V – 3 " " " $\frac{V-3}{C_3} = R_3$ } etc.

In general, however, the increased voltage is required at the terminals with a constant or increasing current, more usually the latter. In this case the characteristic curve of the machine is required, the excitation being such that on open circuit the voltage is the minimum to which the regulating resistance can cut down. Let $a\ a'$ (Fig. 3) be this curve, set out from open circuit as far as the maximum current with which the regulation is to act. Since the terminal voltage is to rise proportionally with the current (in so far as it may be accomplished with one-volt steps), let the voltage rise at the maximum current be v. If b-b' be set off as shown in the diagram, representing v to the volt scale, the intercepts between $a\ b'$ and the curve represent the increase of internal voltage to be made up by alteration of the excitation. The line $a\ b$ is therefore divided into v equal parts, and vertical lines are drawn through the points giving us the internal voltage addition for each step of the resistance—viz.,

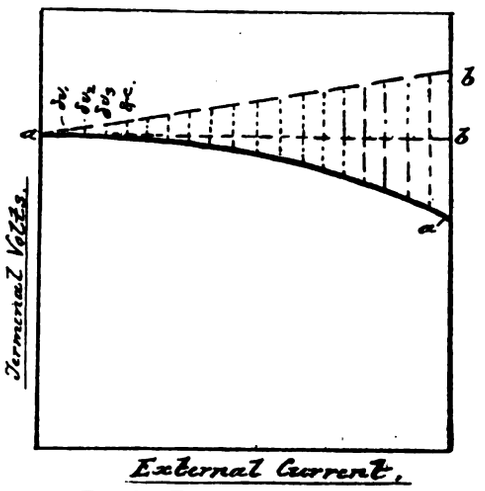

FIG. 3 —External Characteristic.

δv_1, δv_2, δv_3, etc. Turning to the induction curve (Fig. 1), we have $o\ c$ equal to $o\ a$, and from c the lengths corresponding to δv_1, δv_2, δv_3, etc., are each set off from c upwards. Projecting horizontally to cut the curve, and then vertically down, the exciting current for each voltage is obtained. The total resistances of the shunt circuit are then given by

$$R_0 = \frac{V}{c_0}$$
$$R_1 = \frac{V+\delta v_1}{c_1} \Big\} R_0 - R_1 \text{ between first two contacts;}$$
$$R_2 = \frac{V+\delta v_2}{c_2} \Big\} R_1 - R_2 \text{ " second " ;}$$
$$R_3 = \frac{V+\delta v_3}{c_3} \Big\} R_2 - R_3 \text{ " third " ;}$$
etc.

where V denotes the minimum voltage represented by $o\ a$ or $o\ c$.

The above investigation of the matter is exact, and presents no great difficulty. It can be simplified somewhat if a straight line characteristic is assumed—*i.e.*, if the armature drop is taken as directly proportional to the current. Thus, if the drop at maximum load is v' volts at the terminals, and it be required to have a rise, as before, of v volts there, the range of the regulating resistance must be $v + v'$ volts, and at any fraction $\frac{1}{n}$th of the maximum current, it must give $\frac{v+v'}{n}$ volts rise internally. The further operations are then exactly as in the open-circuit case first considered. It may be noted that the circuit should have the calculated resistances when warm.—ZIPHERN.

Answer to No. 353 (awarded 5s.).—To calculate a shunt regulating resistance to give one volt drop per step throughout its range, it is necessary to know the saturation curve of the dynamo. Given this, the method of procedure is the same in all cases, and an example will be the clearest way of showing how it is done. The dynamo considered was built to give 500 amperes at 110 volts for lighting purposes when running at 450 revolutions per minute, and was also capable of charging accumulators at 145 volts without increase of speed. The resistance of the shunt was 15 ohms when hot. The curve shown (Fig. 1) was taken by driving at a constant speed, separately excited, and measuring the exciting current and the voltage generated. To give the figures for the resistance in every step would occupy too much space, but we give a few at the beginning, at the middle, and at the end, and the rest are shown in the curve (Fig. 2).

In the following table the first column gives the volts

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generated; the second, the shunt current which produces that voltage, scaled on the saturation curve; the third, the

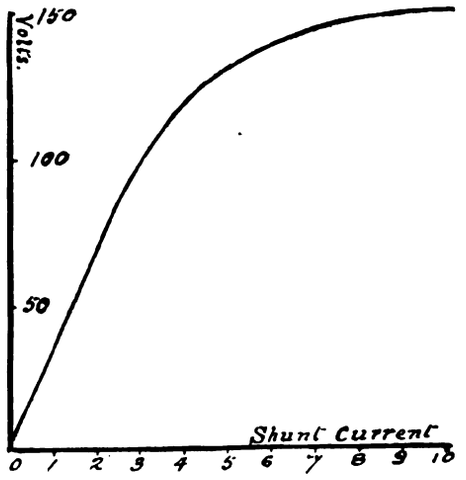

FIG. 1.

total resistance; the fourth, the amount of regulating resistance in circuit; and the fifth, the resistances between

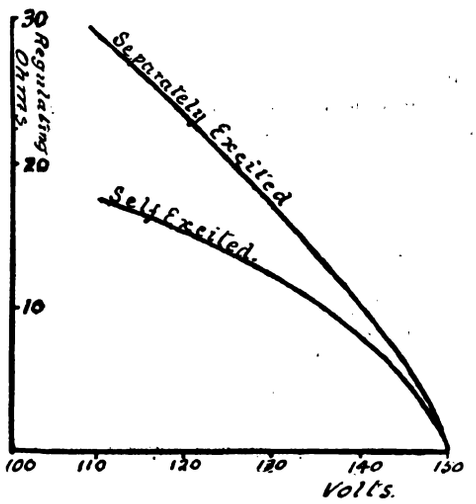

FIG. 2.

two adjacent stops, the stops being numbered from the *all-out* position:

Volts	C in shunt	Total resistance.	Regulating resistance.	Resistance between points.
150	10	$\frac{150}{10}$ =15 ohms	0 ohms	—
149	9·4	$\frac{149}{9\,4}$ =15·85 ohms	·85 ohms	1 & 2 — ·85 ohms
148	8·8	$\frac{148}{8\,8}$ =16·8 ohms	1·8 ohms	2 & 3 — ·95 ohms
147	8·2	$\frac{147}{8·2}$ =17·9 ohms	2·9 ohms	3 & 4 — 1·1 ohms
146	7·7	$\frac{146}{7\,7}$ =18·96 ohms	3·96 ohms	4 & 5 — 1·06 ohms
145	7·25	$\frac{145}{7\,25}$ =20·0 ohms	5·0 ohms	5 & 6 — 1·04 ohms
130	4·75	$\frac{130}{4\,75}$ =27·3 ohms	12·3 ohms	—
129	4 675	$\frac{129}{4\,675}$ =27·7 ohms	12·7 ohms	21 & 22 — ·4 ohms
128	4·6	$\frac{128}{4·6}$ =28·1 ohms	13·1 ohms	22 & 23 — ·4 ohms
127	4·5	$\frac{127}{4·5}$ =28·4 ohms	13·4 ohms	23 & 24 — ·3 ohms
112	3·5	$\frac{112}{3·5}$ =32 ohms	17 ohms	—
111	3·437	$\frac{111}{3\,4375}$ =32·3 ohms	17·3 ohms	39 & 40 — ·3 ohms
110	3·375	$\frac{110}{3·3375}$ =32·6 ohms	17·6 ohms	40 & 41 — ·3 ohms

It will be noticed that the resistances in each step are getting very small at the lower voltages, and the machine is approaching a state of instability. If the machine be separately excited, the quotient in column 3 is always 150, and the resistance required is much larger, the total being $\frac{150}{3·3375}$ = 44·5 ohms, and the regulating resistance being 29·5 ohms. A second curve in Fig. 2 shows the regulating resistance for various voltages with separate excitation.—J. W.

LEGAL INTELLIGENCE.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY v. KILLARNEY ELECTRIC LIGHT COMPANY AND GOODMAN.

On Tuesday the Master of the Rolls heard an action brought by debenture holders of the Killarney Electric Light Company to raise the amount of their debentures. The defendant company was incorporated under a provisional order in 1891, by which the undertakers were bound to continue the supply of electricity, and if they failed to so supply electricity they were liable to a penalty of 40s. for each day. Although the assets of the company were extremely valuable, and would ultimately realise a considerable sum, yet, owing to the manner in which the company had been worked for some years, the machinery had become defective, and the result was that a portion of the town of Killarney was left in darkness in consequence of the breakdown of the machinery. The plaintiffs entered into an arrangement to repair the machines, and at the present time the machinery was going, the town being kept fully supplied with light. The defendant company had a contract with the Killarney Urban District Council for the electric lighting of the town, which would expire next day (Wednesday), and tenders had been invited for a supply of light for the ensuing two years, the gas company being also invited to tender. The defendant company would not tender without the consent of the Court. In order to carry out such a contract a question arose as to whether it could be done without appointing the receiver as manager pending the action.

Mr. O'Brien, K.C., on behalf of the plaintiffs, also asked that the debenture-holders should be at liberty to advance money to keep the place going, and that such advances should be made salvage payments.

Mr. Teeling (instructed by Mr. J. N. Murphy) appeared on behalf of Mr. Leahy, of Tralee, a shareholder and debenture-holder, and asked that the application should be adjourned. He submitted that the plaintiffs had no authority to appear for the debenture-holders, and that the directors of the defendant company had no knowledge of the present application.

Mr. O'Brien said the plaintiffs represented over £4,000 debentures.

Mr. Teeling said that under the circumstances he could not object to the tender for lighting the town being sent in, but he thought the other parts of the application should stand over.

The Master of the Rolls said he hardly understood how this company had got into such a position, because on the figures in the affidavits it ought certainly, at least, to be able to pay its way. It would be a matter of public regret that an electric lighting company should cease to exist in a place like Killarney, where there were not only streets to be lighted, but also large hotels. He had no jurisdiction or power to interfere further than was necessary to preserve the property which was charged with the plaintiffs' mortgage. His Lordship saw no reason to appoint a manager, and as to the contract for lighting the town he thought steps ought to be taken to send in a tender for the purpose. He would make an order to that effect, and also allow the payment of the rent and the hire of the machine to be made salvage claims. The other matters must stand over.

HAMILTON v. GENERAL ENGINEERING COMPANY, LIMITED.

A motion came before Mr. Justice Joyce last week for the appointment of a receiver and manager. This was a debenture-holders' action, and the application was made on the ground of urgency.

Mr. Manning, for the mover, said a meeting of the directors had been held, at which plaintiff was present, and at which it was decided to at once call a meeting of the shareholders of the Company for the purpose of considering the desirability of winding-up owing to the want of working capital.

Mr. Peterson, for the Company, said that he was instructed to consent to the appointment asked, which his Lordship made accordingly.

GUTTA PERCHA CORPORATION.

An enquiry was held in the Court of Bankruptcy on Monday into the failure of the Gutta Percha Corporation, Limited, against which a winding-up order was made in February, 1900. The accounts showed liabilities £20,305, and assets £5,195, absorbed by the claims of debenture holders. The deficiency as regards contributories is returned at £177,067.

Mr. Hubert Waldron said that he had acted as solicitor to the corporation, which acquired patents relating to an invention for producing guttapercha from the leaves and twigs of guttapercha trees. The patents were acquired from the Isonandra Syndicate,

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of Paris, for £63,000. by Mr. Stanier, a nominee acting for witness, and on the next day resold to Mr. H. Parson Smith, another nominee acting for witness, for £150 000. An agreement was made providing for the incorporation of the present company with a capital of £200 000. The Globe Venture Syndicate agreed to provide £1,000 for the expenses of issuing the prospectus in consideration of subsequently receiving the amount back with a bonus of £1,500 in cash and £8,000 in cash or shares. They also found two directors—Sir Edward Thornton and Sir J. Luther Vaughan—for which a further £2,000 shares were to be allotted to them or their nominees. The prospectus contained favourable reports by Lord Kelvin, Prof. Ramsay, and Dr. John Hopkinson upon samples produced under the patent produced. After the issue of the prospectus the working capital was reduced to £10,000 by a modifying agreement with the vendor. He understood that the proposed profit of £86,500, the difference between the £63 500 to be paid by Mr. Stanier and the £150,000 to be paid by the company, would belong to Mr. G. Shenton. Witness had advanced some £4,500 to Mr. Shenton and had received shares as security, but no cash; the shares were now unsaleable. In February, 1898, the company bought from Prof. Ramsay his patents for a similar invention for £1,000 in cash and £10 000 in shares. In September, 1898, the company spent over £4,600 in erecting premises and machinery at Belvedere, but its products found no sale.

Sir Edward Thornton, P.C., stated that he was chairman of the corporation, and admitted that with a working capital of £50 000 the company might have succeeded, but there were other causes for the failure besides want of capital. He thought the directors were entitled to use the working capital of a company for any purpose of that company, and that under certain circumstances vendors might be paid out of it. He had received nothing whatever from the company, and was, in fact, a loser to the extent of £4,000.

Sir J. Luther Vaughan, K.C.B., said he became a director at the instance of the Globe Venture Syndicate. The reduction of the working capital from £50,000 to £10,000 was done under advice of their chemical experts. He had paid £200 for debentures in the corporation, and had never received a penny from it.

The enquiry was adjourned to Monday next.

MARYLEBONE BOROUGH COUNCIL v. METROPOLITAN ELECTRIC SUPPLY COMPANY.

On Saturday the above-named company answered to eight summonses issued at the instance of the Marylebone Borough Council, for having committed eight breaches of the West London Lighting Order of 1889, by laying down in the district more mains than had been sanctioned and approved by the Council—viz., 44 mains instead of 29. Mr. Muir, on behalf of the company, pleaded "Guilty" to six of the summonses. It was explained that in May last the company were desirous of laying a number of low-tension mains for the transmission of energy from a distant station. The Vestry agreed to the plans, but in November it was discovered that the plans were being violated in several respects; the breaches were made wider than they should be, the mains, instead of being laid under the footway, were carried into the carriageway, and in some cases more mains were being laid than had been sanctioned, and were being laid, not one on top of the other, as agreed upon, but side by side. The Council refused to sanction any deviation from the plan originally submitted. It was argued that the public interest had not suffered; the laying of five extra mains had been done by the engineer under a mistaken idea of the rights of the company, in order to supply without delay a demand for a continuous current of electricity to the premises of two of their customers.

Mr. Curtis Bennett said that he was of opinion that the plan submitted by the company was most misleading, and that nothing would have been heard of the extra mains but for the discovery made by the Council. The case was a bad one. He fined the defendants the full penalty of £10, with £5. 5s. costs, on one summons, and £5, with £3. 3s. costs, on each of the remaining five, £56 altogether. The other two summonses were withdrawn.

We comment upon the case elsewhere.

TORQUAY TELEPHONES.

At Torquay County Court on Saturday, S. J. Trethewy, builder, claimed £14 of the National Telephone Company as damages for breach of contract. In January last year Trethewy applied to the company to connect his premises with their system. The instruments were fitted up, but he was not connected with the exchange. In January last Trethewy was sued for £15 for rent of the telephone, and without obtaining advice he paid the amount into court. It was not until three weeks later that plaintiff's premises were connected with the telephone.

Mr. Alney showed the regulations of the company provided for payment in advance. The connections would have been made as soon as Trethewy paid the rent, for which several applications were made.

His Honour did not think plaintiff had any case as regarded the main point. He entered into a contract which stipulated that the rent should be paid in advance. For some reason he did not pay, and the company was under no obligation to connect his premises. But when sued in January he paid the rent, and was entitled to be connected. For some reason, however, he was not connected for several weeks, and he was entitled to damages for this period. Judgment would be given for plaintiff for £2. 2s. and costs.

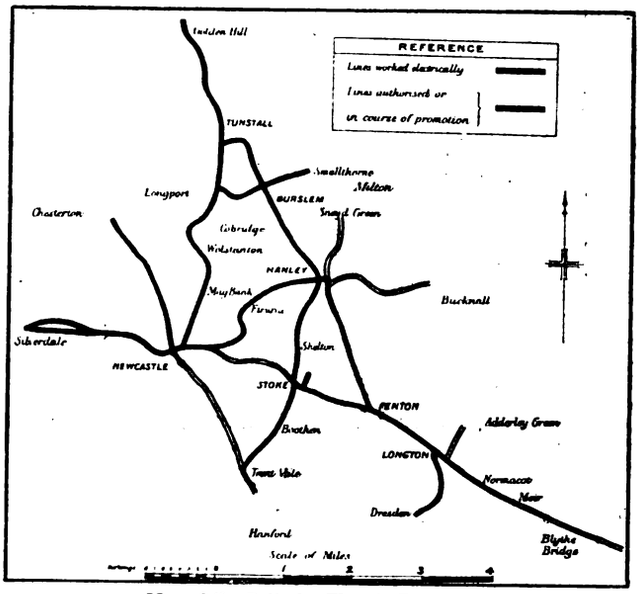
COMPANIES' MEETINGS AND REPORTS.

POTTERIES ELECTRIC TRACTION.

Directors: Emile Garcke (chairman); C. S Drummond; J. V. Kitchener; Stephen Mear; Major Pilkington; J. S. Raworth; S. Sellon. Secretary: B. Kingsford.

Report of the directors (with abstract of accounts) for the year ending Dec. 31, 1900:

The gross profits for the year amount to £64,151. 4s. 7d. After deducting all expenses chargeable to revenue, including all repairs and maintenance and interest on debentures, there remains a net profit of £13 839. 6s. 2d. To this has to be added the amount of £866. 9s. 7d. brought forward from previous account, making an available balance of £14,705. 15s. 9d., which the directors propose should be applied as follows—viz: to provide for dividend for the year on the cumulative preference shares, £10,000; to pay a dividend on the ordinary shares of the Company of 2 per cent. for the year, £4,000; to transfer to the credit of the depreciation fund, £500; to carry forward to next account, £205 15s. 9d. Owing to the strikes of potters and bricklayers throughout the months of April and May the traffic receipts suffered considerably, and the work on the new generating station was seriously delayed, and for some time prevented the opening of the Chesterton and Silverdale lines. It should also be noted that during a large part of the year only a part of the total system has been in operation. During the past year the directors have issued £125 000 4½ per cent. debenture stock, part of a total issue of £200,000. This issue has been guaranteed as regards principal, interest, and premium by the British Electric Company, and the expenses of the issue were paid by that company in consideration of this Company giving them an option to subscribe for the remaing £75,000 debenture stock at par before April 27, 1901. The total capital expenditure at Dec. 31, 1900, was £363 621. 3s. 5d., in addition to £186,311, the cost of the debentures and shares held by this Company in the North Staffordshire Tramways Company, Limited.



Map of the Potteries Electric Tramways.

At the date of the map accompanying the last report about 12½ miles of tramways and light railways had been opened for traffic. Since then the following sections have been opened: Hanley to Etruria, 1 mile 1 furlong; Tunstall and Longport, 6 furlongs; Burslem to Goldenhill, 2 miles 8 furlongs; Etruria and Newcastle, 1 mile 7 furlongs; Wolstanton to Newcastle, 1 mile 1 furlong; Longton to Dresden, 1 mile 2 furlongs; Longton to Normacot, 1 mile 2 furlongs; Newcastle to Chesterton, 2 miles 4 furlongs; Newcastle to Silverdale, 3 miles. The whole of the tramways and light railways of this Company and of the North Staffordshire Tramways Company are now working by electricity, with the exception of the terminal section at Blythebridge, the construction of which is now in hand. In view of the extensions which have been applied for and of other developments of the business, the directors recommend that power be taken to increase the nominal capital of the Company by the creation of 10,000 ordinary shares and 10,000 5 per cent. cumulative preference shares of £10 each, and the necessary resolution which the shareholders will be asked to consider, and, if deemed advisable, to pass, will be found on the first page of the notice convening the meeting. The directors have applied to the Light Railway Commissioners for an order to extend the lines of the Company along the routes indicated on the accompanying plan. The local enquiry in respect of this application was held on Feb. 21 last, and the Commissioners decided to recommend the Board of Trade to grant the order. The directors have taken steps to introduce a service for the conveyance of goods and parcels by electric cars over the Company's entire system, supplemented by horse and hand vehicles, for the purpose

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of local distribution throughout the Potteries district, and they hope that this service will be in operation before the summer. The directors have decided to establish an experimental service of steam omnibuses in order to provide traffic facilities for the outlying villages, and two of these conveyances will shortly be run between Burslem and Milton, a distance of about three miles. If the experiment gives satisfactory results, the directors propose to extend the system in other outlying parts of the Potteries district. The directors are in negotiation with some of the local authorities for the transfer to this Company of their electric lighting orders. The directors propose to take the opportunity of the general meeting to ask the shareholders to alter the articles of association in accordance with the requirements of the Companies' Act, 1900, and the resolution to this effect is contained in the notice convening the extraordinary general meeting. The directors retiring this year are Mr. C. S. Drummond and Mr. J. V. Kitchener, who are eligible for re-election. Messrs. Bourner, Bullock, and Co., the auditors, also retire, and offer themselves for re-election.

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Share capital: 20,000 5 per cent. cumulative preference shares of £10 each, fully paid, £200,000; 20,000 ordinary shares of £10 each, fully paid, £200,000 ...	400,000	0	0
4½ per cent. debenture stock (authorised, £200,000) issued ...	125,000	0	0
Temporary loans: Lloyds Bank, Limited, £30,000; British Electric Traction Company, Limited, £3,000 ...	33,000	0	0
Sundry creditors ...	24,692	5	10
Depreciation fund ...	500	0	0
Profit and loss account: balance carried forward at Dec. 31, 1899, £866. 9s. 7d; net profit for the year 1900, £13,839. 6s 2d.; deduct preference dividends paid to Aug. 15, 1900, £6,250 ...	8,455	15	9
	£591,648	1	7

Cr. Assets.	£	s.	d.
Construction of the permanent way and electrical equipment of the extension tramways and light railways, parliamentary powers, and preliminary expenditure: as per last balance-sheet, £275,085. 18s. 9d.; expenditure during 1900, £88,535. 4s. 8d. ...	363,621	3	5
Debentures of the North Staffordshire Tramways Company, Limited: 734 first mortgage bonds of £100 each, £73,400; 301 second mortgage bonds of £100 each, £30,100 ...	103,500	0	0
Shares of the North Staffordshire Tramways Company, Limited: 1,933 £10 preference shares at par, £19,330; 11,542 £6 ordinary shares at £5. 10s. per share, £63,481 ...	82,811	0	0
Deposits—Consols lodged with the Paymaster-General, at cost ...	6,221	0	0
National war loan bonds ...	591	0	0
Stores and material ...	6,979	0	9
Sundry debtors: the North Staffordshire Tramways Company, Limited, £22,252. 19s. 10d.; other accounts, £1,947. 19s. 11d. ...	24,200	19	9
Cash at bankers and in hand ...	3,723	17	8
	£591,648	1	7

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Power and running expenses ...	24,933	17	4
Repairs and maintenance ...	4,164	11	8
Administration and general expenses ...	4,767	16	11
	33,866	5	11
North Staffordshire Tramways Company, Limited, amount payable under working agreement ...	11,425	0	0
Interest on loans and discounts on debenture instalments, £1,999. 4s. 5d.; debenture interest, £3,021. 8s. 1d. ...	5,020	12	6
Balance carried to balance-sheet ...	13,839	6	2
	£64,151	4	7

Cr.	£	s.	d.
Traffic receipts ...	53,291	10	8
Advertising receipts ...	350	0	0
Sundry receipts ...	709	17	11
	54,351	8	7
Dividends on shares and interest on debentures of the North Staffordshire Tramways Company, Limited ...	9,799	16	0
	£64,151	4	7

OXFORD ELECTRIC.

The annual report for the year ended Dec. 31 last states that the revenue account shows a profit (including £73. 10s. brought forward from last year) of £5,125. 3s. 8d. After providing £1,965. 10s. 11d. for debenture and other interest, and writing off £254. 0s. 11d. on account of hire-purchase installations, the available net profit is £2,905. 11s. 10d., which the directors propose to appropriate as follows: in payment of a dividend at the rate of 5 per cent. per annum on the share capital, £2,500, and in adding £250 to the reserve and the renewal of plant account, which will then amount to £2,000, leaving £155. 11s. 10d. to be carried forward to next year's account. Since the last report, 3,722 8 c.p. lamps or their equivalent have been connected to the mains. This increase compares favourably with the average progress in previous years. The exceptional cost of coal and the increase in the price of materials generally have acted unfavourably on the cost of production. Notwithstanding the reduction in the price of electricity from 7d. to 6d. per Board of Trade unit, which took effect from Dec. 25, 1899, the revenue from the sale of the current shows an increase of £338. 4s. 2d. over that of the preceding year. The number of units sold had been 13 per cent. more than in 1899, and in view of the number of lamps recently installed and the applications from new customers, there is every reason to anticipate that the rate of increase during the current year will exceed that of 1900. The capacity of the sub-station at North-parade has been doubled to meet the increased demand in the north of Oxford, and the distribution mains of the Company have been extended in Farndon, Woodstock, Banbury, St. Margaret's, and Cowley roads. The plant has been maintained in thoroughly efficient order. To provide for the cost of new plant to meet the growing demands, and other capital expenditure which may be expected during the present year, the directors propose issuing 2,500 shares at par. The retiring directors are Sir Henry C. Mance and Mr. Alderman Robert Buckell, who are eligible for re-election. The auditor, Mr. W. S. Carver, offers himself for re-election.

WOLVERHAMPTON TRAMWAY.

At the annual meeting of this Company, held at the London offices on Monday, the **Chairman** (Mr. E. Garcke) stated that for the lines purchased by the Corporation of Wolverhampton they had received £22,500. The remaining lines had been handed over to the British Electric Traction Company under an agreement for £10,020, so that they might work them with their other systems and relieve the Company of the loss of working the fragmentary portions of the lines. These two matters having been completed, there was no further need for the existence of the Company. He might mention that it was believed by the directors that the receipts would represent £5. 10s. per share.

An extraordinary meeting was then held for the purpose of the winding-up of the Company and the appointment of a liquidator, when resolutions to this effect were adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Zagazig (Egypt).—The Local Commission will receive tenders for the electric lighting of the town up to April 15.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the electric lighting of the town for 30 years. Tenders by April 25.

Sunderland.—The Corporation invite tenders for indiarubber-covered cables, etc. Tenders by March 29. Details in our advertisement columns.

Ploesti (Roumania).—The Municipality invite tenders for the laying down and working of electric tramways for 30 years. The provisional deposit is £2,000. Tenders by April 3.

Kirkcaldy.—The Corporation invite tenders for engines and dynamos, storage battery, and overhead travelling crane. Tenders by April 15. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for the supply and erection of various plant for electricity works. Full details in our advertisement columns. Tenders by April 11.

Colwyn Bay.—The Urban District Council invite tenders for the supply of one 120-kw. steam dynamo and switchboard extensions. Tenders by March 22. Details in our advertisement columns.

Leith.—The Town Council invite tenders for the supply, delivery, and erection of a 350-kw. steam dynamo, suitable for either private or traction supply. Details in our advertisement columns.

Shipley.—The Urban District Council invite tenders for the supply of house terminal boxes and switch gear, motors, wiring installations, &c. Tenders by March 19. Details in our advertisement columns.

Cheltenham.—Tenders are invited for the electric lighting of St. John's Church, Cheltenham. Specifications, etc., can be had from Mr. Weaver, Carlton-place, Hewlett-street, Cheltenham. Tenders by March 25.

Greenock.—Tenders are invited for electric wiring and fitting up the free library, Wallace-square. Specification, etc., may be obtained from Mr. W. M. Nelson, burgh electrical engineer, Hunter-place. Tenders by March 18.

Fulham.—The Borough Council invite tenders for wiring the Central Library, 592, Fulham-road, S.W. Specifications, etc., may be seen on application to the librarian, Mr. F. T. Barrett, at the Central Library. Tenders by March 20.

Darwen.—The Corporation invite tenders for the supply and delivery of feeder cables, pillars, and overhead electrical equipment in connection with the electric tramways. Tenders by March 25. Details in our advertisement columns.

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Cardiff.—The Corporation invite tenders for steam-pipes, exhaust pipes, injection and overflow pipes, feed pipes, drain pipes, engine-house flooring, and switchboard gallery and central service gangway. Tenders by March 18. Details in our advertisement columns.

Dundee.—The Town Council invite tenders for the supply and delivery of about 1,540 tons of steel girder rails and 60 tons of fishplates. Specification, etc., on application to Mr. Wm. Mackison, C.E., Municipal Offices, 91, Commercial-street, Dundee. Tenders by March 28.

Wolverhampton.—The Tramways Committee invite tenders for the complete overhead equipment of about five miles of tramway route, and the supplying and laying of feeders, conduits, and switch pillars for the same. Tenders by March 22. Details in our advertisement columns.

Bilbao (Spain).—Tenders are invited for the electric lighting of the new prison. The installation must provide for 1,000 5-c.p. lamps. Particulars may be seen at this office. Tenders are to be addressed to the Office of Civil Construction, Plaza de San Lorenzo, 2, Cajo, Bilbao.

Burnley.—The Corporation invite tenders for the supply and delivery of steel rails, fishplates, soleplates, tiebars, and bolts and nuts required in the construction of about seven miles of double tramway track. Specification, etc., may be obtained at the office of the Borough Surveyor. Tenders by 26th inst.

Burnley.—The Tramways Committee invite tenders for the supply of the necessary materials for the overhead equipment in connection with the trunk line. Specification, etc., may be obtained from Mr. R. Birkett, borough electrical engineer, Aqueduct-street, Burnley. Tenders by March 23.

Ayr.—The Corporation invite tenders for the supply, delivery, and erection of (Section 5) water-tube boilers, stokers, etc.; (6) condenser and pumps; (7) accumulators, etc.; (8) balancers and boosters. Specification, etc., may be obtained from Mr. Arthur J. Fuller, burgh electrical engineer, Electricity Works, Ayr. Tenders by March 20.

Wolverhampton.—The Tramways Committee invite tenders for (A) the complete overhead equipment of about five miles of tramway route; (B) the supply and laying of feeders, conduits, and switch pillars for the same. Specification, etc., may be obtained upon application to Mr. C. E. C. Shawfield, borough electrical engineer, Commercial-road, Wolverhampton. Tenders by 23rd inst.

Colne (Lancs.).—Tenders are invited for the excavator, mason, bricklayer, carpenter, joiner, slater, plasterer, plumber, glazier, and ironfounder's work in connection with the proposed electric lighting station and chimney at Phillips-lane, within the borough. Specifications, etc., may be obtained at the office of Mr. T. H. Hartley, borough surveyor, Town Hall, Colne. Tenders by March 20.

Christiana (Norway).—The Government Railways Department are inviting tenders for 12,000 kilos of 4mm. galvanised iron wire, 4,500 kilos of 2½mm. copper wire, and 5,000 insulators complete. Conditions may be obtained from the Telegraph Inspector at Stenersgade 8, III, and tenders inscribed "Telegraf-og Telefon-material," addressed to Jernbanetorvet 8—9, both at Christiana. Tenders by March 20.

Warrington.—The Corporation invite tenders for (Section 1) supply, delivery, and laying of steel rails, paving, etc., forming permanent way; (2) supply, delivery, and erection of steel poles, brackets, trolley wire, insulators, etc., forming a complete overhead equipment; (3) electric tramcars. Specifications, etc., can be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Tenders by March 27.

West Ham.—The Town Council invite tenders for the supply of (1) high and low tension paper-insulated cables, boxes, etc.; (2) double-pole house cut-out boxes; (3) recording wattmeters; (4) transformers and transformer tanks; (5) house wire and wiring accessories; (6) engine-room stores. Particulars may be obtained at the Borough Electrical Engineer's Office, Central Electricity Station, Abbey Mills, West Ham. Tenders by March 22.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Bloom-street generating station of (a) switchboard for connecting four 1,800-kw. generators to the lighting and traction systems; (b) four continuous current motors for driving mechanical stokers and economisers. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall. Tenders by March 25.

Newport (Mon.).—The Corporation invite tenders for the supply and erection of: (Section 4) constructional steelwork, bunkers, etc.; (5) steel flue; (6) coal and ash conveyor; (8) overhead travelling crane; (9) steam-boilers; (10) mechanical stokers; (11) fuel economiser; (12) water-storage tanks; (13) compound condensing vertical engines; (14) electric generators; (15) condensing plant with cooling towers; (16) feed pumps. Specifications, etc., may be obtained from Mr. H. F. Parshall, 8, Princes-street, Bank, London, E.C. Tenders by March 25.

London, W.C.—The British Electric Traction Company, Limited, on behalf of the Gravesend and Northfleet Electric Tramways Company, invite tenders for the construction of new tramways in Gravesend and Northfleet, and the reconstruction of the existing tramways in Gravesend; for the supply and construction of the necessary electrical equipment for working the overhead system. Copies of the specifications and schedules can be obtained on payment of £10, returnable upon receipt of a bona fide tender, from the secretary, Mr. Charles Dade, Donington House, Norfolk-street, Strand, London, W.C. Tenders by 25th inst.

RESULTS OF TENDERS.

Salford.—The tender of W. H. Bailey and Co., Limited, for providing Jackson's electrically-driven motors with double reduction gearing at an extra cost of £1,972 has been accepted.

Ayr.—The following tenders for the car station have been accepted: D. J. Meikle, Main-street, carpenter and joiner-work, £308. 13s.; Wm. Watson, 18, Mill-street, excavator, mason, and brickwork, £1,415. 8s.

Brighton.—The Electric Lighting Committee have accepted the tender of the Brockie Pell Arc Lamp, Limited, at £1,753. 7s. 6d., for the supply of 115 double-carbon arc lamps and fixing 107 of such lamps on standards erected by the Corporation.

Islington.—The Electric Lighting Committee have accepted the tender of Messrs. J. Grover and Son, Wilton Works, New North road, at £5,782, for the erection of a water tower, tanks, and sundry additions at the electric lighting station.

London.—The London School Board have received the following tenders for wiring, etc., for electric lighting at Offord-road School:

G. Weston and Co.	£370	0	0
Drake and Gorham	365	5	0
Peto and Radford, Limited	331	0	0
Comyn Ching and Co.*	324	0	0

* Recommended for acceptance.

Sheffield.—The contract has been given to Hadfield's Steel Foundry Company to provide the necessary points, crossing blocks, curved and other rails, made of their special manganese steel, at the Post Office corner, in the Haymarket, for the sum of £1,160. The following tenders have been accepted for the construction of 25 new cars: G. F. Milnes and Co., double-deck car bodies, £253. 10s. per car; the Brill Truck Company, trucks, £56. 11s. per truck; the British Thomson-Houston Company, G.E. 56 double-motor equipments, at £330 each. The tender of the Leeds Steel Company for the supply of rails and fishplates, at a sum of £24 156 is to be accepted, subject to their agreeing to a bending test to be defined by the city surveyor.

BUSINESS NOTES.

TRACTION.

Middlesbrough.—On Monday a commencement was made with the tramways extension.

Ramsgate.—The Isle of Thanet Railway Company hope to start the service of electric tramways at Easter.

Southampton.—Mr. G. B. Carnon has resigned his position under the Corporation of tramways manager.

Kinver.—The tramway from Stourbridge to Kinver is now complete and awaiting inspection by the Board of Trade.

Warrington.—The Corporation have decided to present a petition against the South Lancashire Tramways Bill.

Wigan.—The question of providing workmen's cars on the new electric tramways is occupying the attention of the committee.

Leyton.—The Urban District Council will oppose the City and North-East Suburban Electric Railway and North-East London Railway Bills.

Paisley.—The Town Council on Tuesday confirmed their resolution to present a memorial in Parliament against the Paisley and District Tramways Bill.

Private Bills.—In the House of Commons on Monday the Bexley Tramways and the South Yorkshire Electric Power Bills were read a second time.

Blackburn.—The question of proceeding with the construction of the Audley tramways will be brought before the Tramways Committee at an early date.

Scarborough.—The Town Council have rejected the offer of the electric tramway company to hand over its Bill to the Corporation on payment of the expenses to date.

Perth.—The resident electrical engineer has been requested to report upon the Corporation's offer of £20,000 for the purchase of the tramway company's undertaking.

Cleator Moor.—The Urban District Council have resolved to oppose the West Cumberland Tramways Bill. A ratepayers' meeting has confirmed the Council's decision.

Liverpool.—The Tramways Committee has decided to stop the sale of scholars' tickets in consequence of their determination not to grant favours to any class or section of classes.

Manchester.—A consequence of the Liverpool accident will be the formation of a special sub-committee to consider the question of the removal of overhead wires in Manchester.

Proposed Electric Ferry.—The latest project for improving the means of communication between the parishes on the banks of the Medway below Aylesford is an electric ferry.

Farnworth.—The Urban District Council have instructed Messrs. Lacey, Clirehugh, and Sillar to prepare specifications for their tramway extensions, which consists of about five miles.

Darlington.—The Town Council have approved the resolution of the General Purposes Committee, recommending the Corporation to conclude the purchase of the tramway company's undertaking for £7,500.

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Middleton.—At the monthly meeting of the Town Council it was stated that the arrangements with the British Electric Traction Company with regard to the laying of tramrails were now complete.

Hyde.—The Corporation have refused to allow the tramway company to open up the footpaths for the purpose of repairing the cables until a satisfactory settlement of the question in dispute has been come to.

Hoole.—At the monthly meeting of the Urban District Council on Monday, general regret was expressed at the action of the Chester Corporation in withdrawing the scheme for extending the tramways to Hoole.

Aberdeen.—At a recent meeting of the Tramways Committee the Convener submitted a proposal for supplying a service of late cars on the different routes, but consideration of the matter was deferred until May 1.

Belgium.—The much-talked-of project for an electric railway between Brussels and Antwerp is still to the fore. A commission, provided with complete plans by the Department of the Interior, is now examining the ground.

Wandsworth.—The Borough Council have resolved to present a petition against the London County Council (Tramway and Street Widenings) Bill, and have confirmed their decision to oppose the London United Tramways Bill.

Gomersal.—The District Council have agreed to accept Mr. Stephen Sellon to negotiate for the purchase of the Gomersal portion of the Dewsbury, Batley, and Birstall Tramway Company's undertaking by the British Electric Traction Company.

Hull.—The Watch Committee have decided to purchase india-rubber gloves for the use of the police on point duty, so that they may handle without fear of injury any telephone or telegraph wires that may fall across the electric tram trolley wires.

Portslade.—The Urban District Council have appointed delegates to confer with representatives from Shoreham, Kingston, and Southwick on the proposal of the Shoreham and Hove Tramway Company to introduce electric trams into these districts.

Hornsey.—The District Council have approved the engineer's suggestion that clauses should be pressed upon the promoters of the Charing Cross and Hampstead Railway Bill for the protection of the district regarding various matters, including vibration.

Halifax.—On the question of the tramway extensions coming before the monthly meeting of the Town Council, a motion that the recommendation of the committee, that the line to Wheatley be laid as early as possible, should be referred back, was defeated.

Southport.—The agreement between the Corporation and the tramways company for the reconstruction and electrical equipment of the Cambridge-road and Roe-lane routes has been sealed. Work will soon be commenced, the Cambridge-road route being altered first.

Hampstead and Charing Cross Railway.—The Opposition Committee has issued a memorandum setting forth the objections to the route at present proposed for the extension to Golder's-green, and indicating an alternative route free from such objections.

Walker.—The District Council have rescinded their resolution respecting the Tyneside Tramways and Tramroads Bill on the ground that the Newcastle scheme would come into the heart of the town and the other company only to the outskirts of the place.

Blackpool.—The Town Council have approved the decision of the committee to increase the tramway manager's salary by £100. From Whit-week to the end of the season the tram fare will be 2d. from Victoria Pier, to or from Cocker-street, or 3d. for the whole journey to the Gynn.

Coventry.—On the question of the steps which had been taken to prevent any accident from falling electric wires coming before the City Council on Tuesday, it was stated that the Telephone Company had applied for a great additional number of their wires to be laid underground in the town.

Batley.—The Tramways Committee recommend that the engineers be instructed to prepare estimates of the cost of laying and equipping the tramways authorised by the Tramway Order, 1900 and that the town clerk be authorised to apply for sanction to borrow the amount of such estimate.

London United Tramways.—The directors recommend a final dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year ending Dec. 31 last the interim dividend to June 30 having been at the same rate. The reserve funds will be increased from £36,190 to £39,467.

Dundee.—Mr. A. P. Trotter, of the Board of Trade, conducted the official inspection on Wednesday week of the electric equipment of the new east end route and of the Perth-road extension of the Corporation tramways. Some time ago Colonel Dunop examined the permanent way and found everything satisfactory.

Proposed Berlin Underground Railway.—The Berlin Press states that the Traffic Committee of the Corporation have decided that the city shall undertake the construction of the proposed underground railway according to its own plans. The north to south line, the plans for which are being drawn up, is to be laid first.

Proposed Public Motorcar Service.—A movement is on foot to run a service of light motorcars between Streatham, Upper Tooting, and Clapham Junction, *vid* Tooting Bec and Trinity-roads. The cars would complete the distance in 25 minutes, carrying from 10 to 12 persons each. A speed of 14 miles an hour is suggested.

Plymouth.—By the end of the present financial year the electric trams will be running to Compton. A ratepayers' poll is to be taken on the question of the Sunday trams. The Tramways Committee have reduced the hours of their employés from 62½ to 58 per week.

Watford.—On the undertaking of the promoters that the Tramways Bill will not be considered in committee by the first House unless and until terms are arranged between the District Council and the promoters to the satisfaction of the Council, the latter have withdrawn their opposition and given their unconditional consent to the Bill.

Barrow.—It is stated that the British Electric Traction Company have asked for a 28 years' lease of the tramways, and have promised to spend about £65,000 in converting the system to electric traction. At the Town Council meeting on Monday no definite decision was arrived at, but as we go to press we learn that the Corporation have accepted these terms.

Imperial Tramways Co.—The accounts of this Company for the year ending Dec. 31, 1900, will enable the directors to recommend a final dividend for the half-year on the ordinary shares at the rate of 8½ per cent. per annum, making with the interim dividend paid to June 30, 8 per cent. for the whole year. The reserve fund is to be increased from £69,203 to £72,789.

Leigh.—The town clerk has been instructed to take steps to watch the South Lancashire Tramways Bill through Parliament, with the view of opposing the authorisation of the additional lines proposed to be laid within the borough. Plans, sections, and estimates for the laying within the borough of the tramways already decided upon are being prepared by the borough surveyor.

Whitehaven.—The Town Council have passed a resolution in favour of lodging a watching petition in the matter of the West Cumberland Electric Tramway Bill. One of the principal objections is that with regard to the purchase clause, which in its present form is quite prohibitive, and would make the ultimate acquirement of the tramways by the local authorities practically impossible.

Brompton and Piccadilly Railway.—In compliance with the decision of the Standing Orders Committee of the House of Lords, the company have withdrawn from their Bill the whole of the proposed extensions with the exception of about six furlongs between Piccadilly and Bloomsbury-square. The estimated expenditure by the company on extensions is thus reduced from £1,569,689 to £334,944.

Thornaby.—At the monthly meeting of the Corporation the tramway company was instructed to consider how the efficiency of the guard wires on the overhead system might be increased so as to ensure public safety as far as possible from falling telephone wires. The Imperial Tramways Company wrote refusing to entertain the claim of the Corporation to participate in the alleged surplus profits of the company.

Cambridge.—At the half-yearly meeting of the Street Tramways Company it was stated that the whole question of the introduction of electric traction hung upon the question of electrical disturbance. The directors did not consider it advisable, in the face of difficulties of that kind arising, to at once proceed with the question of electrical traction in Cambridge, but to await the result of the Board of Trade enquiry into this matter in the case of the London United Tramways Company.

Cardiff.—At the meeting of the Tramways Committee on Friday last the Borough Engineer presented a report on the construction of the tramways, in which he expressed himself as perfectly satisfied with the progress made. In all, 15 miles of single track and eight miles of double track have to be constructed. A sub-committee to continue the discussion with Mr. Glenn, of the tramway company, with reference to the preparing of the existing track for electric traction, was appointed.

Manchester and Liverpool Electric Railway.—The total number of opposing petitions which have been deposited against this Bill is 15. The petitioners include the Liverpool and Salford Corporations, Manchester Ship Canal Company, London and North-Western Railway, Cheshire Lines Committee, Lancashire and Yorkshire Railway, Great Central and Wigan Junction Railways, and the Eccles Corporation. The time for presenting such petitions in the House of Lords has now expired.

Wolverhampton.—At the Town Council meeting on Monday it was stated that the Corporation were prepared to purchase the tramway lines to Bilston and Willenhall from the District Councils, to lay down new lines for electric cars similar to those which would be made in Wolverhampton, and provide a good service of cars at cheaper fares, but that Bilston and Willenhall had decided not to purchase the lines in their districts, and they thus deliberately cut themselves off from Wolverhampton.

Merthyr Tydvil.—Trial trips have been made on sections of the electric tramways which have been constructed by the British Electric Traction Company. The new lines connecting Merthyr with Dowlais and Cefn will serve localities immediately occupied by a population of 50,000 people. The company, who have adopted the overhead trolley system, propose at the outset to put on 13 cars, each accommodating 24 passengers, and to establish a five or seven minutes' service. Colonel Dewitt made an inspection of the lines on behalf of the Board of Trade on Tuesday.

Folkestone.—The Board of Trade enquiry into the application of the Corporation to apply for a tramways provisional order is announced for to-day. The Town Council have resolved that tramway No. 3 in the draft order be withdrawn on the understanding that powers shall be sought in the next session of Parliament to construct tramways along Guildhall-street and

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Broadmead-road to Cheriton-road, and also subject to the West Ward Tramways Committee and Lord Radnor supporting the present application of the Corporation as amended.

Surbiton.—In his annual report to the Urban District Council, the surveyor says that, acting on the Council's instructions, he prepared plans, sections, and other particulars for a 4ft. 8½in. gauge tramway at Brighton-road and other streets, in all four miles odd in length, and estimated to cost £33,977, exclusive of power station and plant. He concludes: "The whole of this work necessitated a considerable amount of time and attention . . . and it was somewhat unfortunate that the application for the provisional order was refused in consequence of a very slight informality."

Glasgow.—In connection with the proposed introduction of an improved seat for the tops of the tramcars, it was stated at the monthly meeting of the Corporation that the Tramways Committee were trying seats of various kinds on the new cars, and were ready to hear suggestions. If any inventor in the West of Scotland or any other place could show them a better seat than they had yet seen, they were open to consider it. It was further stated that the first portion of the electric tramways, especially that leading towards the exhibition, would be open and in operation by the end of next month.

"Tube" Vibration.—The Board of Trade enquiry into the question of damage to property alleged to be due to this cause is to be reopened next week. The fullest investigation is to be made, and additional witnesses will be called. The committee's course of procedure necessitates the postponement of the sittings of the Joint Committee of both Houses of Parliament to consider the London Electric Railway Bills to an indefinite date. Speaking in the House of Commons a few days back, Mr. J. W. Lowther said the probability was that none of the 14 Bills dealing with underground electric lines in London would be proceeded with this session.

Workington.—The three most important conditions which the Electricity Committee recommend should be inserted in the West Cumberland Tramways Bill are: (1) that the Corporation shall have absolute right to put down trams in the borough; (2) shall have running powers over all lines laid down by the company in the borough; and (3) that the Corporation shall supply electric energy to the company for all purposes of working within the borough, and that no generating stations of the company be within three miles of the borough boundary for the time being, and that the company do not supply or sell any electricity for light or power within the borough.

Bradford.—An agreement has been come to between the Corporation and the Bradford and Shelf Tramway Company for the withdrawal of the opposition of that company to the Bill now before Parliament in regard to the extension of the Corporation tramway system. In connection with the Corporation tramways, the accounts for the year ended March 31, 1900, show on trading lines a profit of £1,349 on the Bolton-road section, but against this is charged interest on loans and sinking fund, turning it into a net loss of £177. For the Great Horton section there is a profit of £3,469, against which is charged interest on loans and sinking fund, leaving a net profit of £495.

Central London Railway.—Owing to the breakdown of the brake gear on one of the trains at the Post Office Station on Monday, a temporary block in the traffic occurred. The company are appealing to the Divisional Court on a special case from the decision of Mr. Rose, at the West London Police Court, imposing fines amounting to £25 and costs for smoke nuisance at their station in Wood-lane. The ground of appeal is that the company's special Act exempts them from all prosecutions for nuisance which they may commit at their generating station, unless it can be proved that they have been guilty of negligence. The proceedings, reported in a recent issue, were taken at the instance of the Hammersmith Borough Council.

Sheffield.—A recreation club for the tramway employés is to be provided. The work on the Broomhill section of tramways is rapidly nearing completion, and probably cars will be running as far as Manchester-road within a few days. Numerous tests of the guard wires in various parts of the city have been made, which show that they are efficiently connected to the rails, so that in the event of a telephone or telegraph wire dropping and making connection between the guard wire and trolley wire the current will be put directly to the rails through the guard wire, and cause the circuit breakers to immediately act and cut off the current at the power station. These tests have been repeated in the presence of the Board of Trade, Post Office, and Telephone Company's officials, and have been quite satisfactory. At the half-yearly meeting of the Sheffield United Gaslight Company on Monday the Chairman referred to the question of electrolysis of gas-mains by electric tramways. He stated that the directors were trying to obtain the insertion of a clause in the Corporation's Bill providing for compensation in this event.

LIGHTING AND GENERAL.

Fareham.—Sanction has been obtained to a loan of £460 for electric lighting.

Montrose.—The Harbour Board have decided not to change their present system of lighting.

Wigan.—Another instalment of £20,000 is being raised in connection with the electric undertaking.

Stafford.—The Council have resolved to lay electric cables along St. Patrick-street at a cost of £98. 16s.

Mansfield.—The Town Council are petitioning against the Derbyshire and Nottinghamshire Electric Power Bill.

Luton Bute Hospital.—The Management Committee are discussing the advisability of an electric light installation.

Leith.—The question of electric lighting of quays is engaging the attention of the Works Committee of the Docks Commission.

Sleaford.—The Urban District Council are about to take over the electric lighting provisional order from the syndicate holding the same.

Keighley.—The Town Council have decided to petition against the Electric Power (Yorkshire) and the South Yorkshire Electric Power Bills.

Newcastle-under-Lyme.—The Town Council have instructed Messrs. Lacey, Clirehugh, and Sillar to prepare a report on the electric lighting of their district.

Burnley.—The Guardians have decided to inform the Local Government Board that they would be able to produce the electric light cheaper than they could buy it.

Mexborough.—The Urban District Council's application for sanction to borrow £18,000 for an electric lighting installation and refuse destructor has been acceded to.

Share Market.—Electric shares kept steady and without much change during the week. County Electric and Citys hardened to 8; Dublin Trams were dealt in at 13.

Bristol.—Six small motor switchboards have been ordered for the Avonbank works. The continuous-current main is to be extended to Dighton-street and John-street.

Acton.—The electric lighting is still delayed owing to the Council not having been able to obtain a site for the works, but they hope soon to solve the difficulty and to proceed with the works.

Hammersmith.—The engineer is preparing the necessary plans for an application to be made to the Board of Trade for sanction to increase the capacity of the sub-stations from 75 kw. to 100 kw.

Morecambe.—The Urban District Council have confirmed the appointment of Mr. Richard Pape of Hull, as electrical engineer at a salary of £200 per annum. There were over 70 applicants for the post.

Hornsey.—The District Council have decided to send to the Local Government Board a strongly-worded request for a decision as to their application for sanction to borrow £80,000 for electric lighting.

Direct Spanish Telegraph Co.—The directors have decided to pay a dividend at the rate of 4 per cent., tax free, on the ordinary shares for the half-year ended December 31, payable on April 1.

Morley.—The estimates of proposed extension of electricity cables have been approved by the Town Council, and application is to be made for sanction to borrow the sum of £7,050 to carry out the works.

Clayton.—The maximum charge for electricity under the electric lighting order will be 7d. per unit. The Council are urging the National Telephone Company to establish a central call office at Clayton.

Keswick.—The Urban District Council have accepted the electric light company's offer to erect 20 lamps and to provide standards, energy, maintenance, etc., for the sum of 35s. per 1,000 hours per lamp.

Whitby.—The appointment of clerk of the works of the electric lighting station has been left in the hands of the Electric Lighting Committee, who are to be guided by the suggestions of the engineer, Mr. Preece.

Dewsbury.—Formerly the Corporation supplied the theatre with electricity. After that the theatre company put down a plant of their own, but negotiations have been opened again for a supply from the Corporation.

Seaford.—A committee has been appointed to confer with the Eastbourne Town Council in connection with the establishment of a municipal telephone exchange. The Eastbourne parliamentary division included the Seaford urban district.

Arbroath.—The Electric Lighting Committee have decided to recommend to the Corporation that Messrs. Matthew, Buchan, and Hogarth should be appointed the Corporation's engineers to carry out the installation of electric light in the burgh.

Winding-Up.—The following final meetings are announced in the *Gazette*: the Crowdus Accumulator Syndicate, Limited, April 15; the "Perfect" Arc Lamp and Accessories Company, Limited, April 18; St. Stephens Electrical Syndicate, Limited, April 10.

Bolton.—The electricity fund revenue account of the Corporation for the last year shows an income of £32,830 and an expenditure of £15,068, giving a trade profit of £17,762, against which is charged interest on loans and sinking fund of £12,988, leaving a net profit of £4,774.

Sudbury.—At Tuesday's meeting of the Town Council the motion that the Local Government Board be immediately informed that the Council proposed to withdraw their application for a loan of £20,880 for electric lighting works and construction of a refuse destructor was carried unopposed.

Bedford.—The Public Works Loan Commissioners having informed the Town Council that they are not able to entertain any application for a loan for electric lighting purposes, the terms already arranged with the Prudential Assurance Company are to be carried out as soon as possible.

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The Institution Journal.—Parts 147 and 148 of the *Journal* of the Institution of Electrical Engineers edited by Mr. W. G. McMillan, the secretary, are now ready. They contain the report of the proceedings of the joint meeting in Paris, and a number of other papers, with the discussions thereon.

Crewe.—The borough electrical engineer's last monthly report states that 72 consumers are connected with the mains, representing about 4,000 8-c.p. lamps. The number of units sold registered by meter was 6,581. The maximum load reached at the works on Jan. 26 was 95 kw., and the supply had been maintained continuously.

Nuneaton.—The surveyor (Mr. J. S. Pickering) in his last report on work executed in connection with the electric lighting station, says the work is making good progress. The contract for the new chimney shaft is proceeding satisfactorily. The shaft is now about 15ft. in height. A new main about 140 yards in length has been laid in Seymour-road.

Penge.—The Urban District Council have decided to engage an expert to advise them in their negotiations with the Lewisham Electric Supply Company, Limited. It appears that they have obtained good terms from the company, who propose to charge 3d. per unit for public lighting in the streets, 3½d. for public lighting, and 4½d. for private consumers.

Leicester.—The accounts of the electric lighting undertaking for the half-year ending Dec. 31 last show, after paying interest on capital and £1,068 3s. 1d. on account of sinking fund, a profit of £1,287. 5s. 8d. The profit for the half-year ended June 30 last, as reported to the Council on Sept. 25 last, was £862. 5s. 4d., making a total profit for the year of £1,649. 11s.

Wireless Telegraphy.—The Admiralty have decided to establish wireless telegraphy stations at Dover, Portland Bill, Rame Head, Scilly, and other places. Sir R. Penrose Fitzgerald has given notice to ask the President of the Board of Trade in the House of Commons whether he can hold out hopes that the Government will apply the same system without delay for life-saving purposes.

Tunbridge Wells.—The electrical engineer has submitted a report on the system of incandescent electric light in other towns. Reports have also been received from Blackburn, Starling, and Co., Limited, and from the borough surveyor, borough electrical engineer, and Mr. T. E. W. Mellor, late borough surveyor, upon the suggested heightening of the chimney shaft at the central station.

Swansea.—The Electric Lighting Committee last week was again occupied with the delay in completing the installation. The engineers stated that they were now awaiting the erection of the battery. The British Schuckert Company wrote disclaiming responsibility for delays, and stated that much of the delay had been caused by the station not being ready to receive machinery.

Manchester.—The annual conference of the Postal Telegraph Clerks' Association was opened on the 7th inst. A resolution protesting against the inadequacy of pay in the telegraph department, and urging upon the Postmaster-General the necessity of a general increase in pay, and other resolutions protesting against the stagnancy of promotion and employment of temporary labour, were adopted.

Durham.—At the annual meeting of the County Council on Wednesday, the Clerk reported that the promoters of the Cleveland and Durham County Electric Power Company's Bill had agreed to insert satisfactory clauses for protection of the county's interests, with respect to the main roads under which ducts and cables were to be laid. It is understood that the Council will remain neutral in the matter.

Scotch Power Bills.—In view of the heavy opposition to the Caledonian Electric Power Bill and the Clyde Valley Electrical Power Bill, the authorities of the House of Commons have constituted the two measures as a group by themselves for consideration by one of the committees of the House. The opposition to the former is represented by 48 and to the latter by 30 petitions. Neither of the Bills will be taken before the Easter recess.

Commercial Cable Co.—The accounts for the year 1900 show that after transferring 150 000dol. to reserve for insurance of stations, apparatus, and repair steamer, and 350 000dol. to the general reserve fund, the profit, including 228,063dol. brought forward, was 2,007,730dol. Payment of debenture interest absorbed 720,000dol., and dividends amounting to 8 per cent. have been declared and paid, leaving 221,066dol. to be carried forward.

Southampton.—With regard to the sanction recently received to the borrowing of £12 000 for the purposes of electric lighting, the Town Council have applied to the Local Government Board to extend the term for the repayment of the amount from 22 to 25 years, being the period granted in respect of previous loans. The Tramways Committee are to be charged at the rate of £2. 2s. per annum for each 8-c.p. incandescent lamp on the tramways columns.

Dublin.—A special meeting of the Municipal Council will be held to-day, when a report of the Lighting Committee will come up recommending the acceptance by the Municipal Council of the tender of Messrs. J. and W. Stewart, of Belfast, for building a chimney shaft at the Pigeon House Fort; also giving particulars of the contracts already arranged and of the works in connection with the electric lighting scheme, for which tenders have not yet been invited.

Claret and Soda.—A peculiar claim came before the Tunbridge Wells Lighting Committee recently in the shape of a letter from a consumer asking the committee to repay him the cost of a bottle of claret and a siphon—namely, 6s. 6d.—which was smashed by an employé of the electric light department when attending to the meter at his house. In appreciation of the fact that the applicant was a consumer of current as well as of claret and soda, the committee agreed to meet the claim.

Brush Electrical Engineering Co.—The directors have decided, after placing £5,000 to reserve, to recommend payment of a dividend to the preference shareholders at the rate of 6 per cent. per annum for the half year ended December 31, 1900 (making the full dividend of 6 per cent. on the preference shares for the year), and a dividend at the rate of 5 per cent. on the ordinary shares for the year. The share transfer books of the company will be closed until after March 27.

Warrington.—The Corporation have taken possession of the plant, and completed the work undertaken by the Clayton Engineering Company, Limited, Mr. Preece having reported that, in view of the probable early introduction of electrical tramways, it was desirable that additions should be made to the plant at the works. The engineers have been requested to prepare estimates of the cost of such additional plant, and Mr. Grimsdale is preparing an estimate of the cost of the probable extension of mains.

Aylesbury.—The Urban District Council have decided to negotiate with companies for the execution and maintenance for a term of years of the works needed for the supply of electricity within the urban district of Aylesbury, and for the supply of electricity within such district, on the basis of the site of the electric lighting station being the property of the Council. A site for such station, which is to be utilised in addition as a depôt wharf, paddock, and stables, has been selected on the banks of the Grand Junction Canal.

Hamilton.—At the last meeting of the Town Council a report was submitted from the Electric Light Committee recommending that the report of the engineers should be approved of, and that the Secretary for Scotland be asked to sanction under the Act borrowing powers for £40,000. An amendment to the effect that the Council should agree to the proposal to apply for borrowing powers, but also instruct the committee to proceed with the negotiations for the purchase of power from wholesale electric supply companies, was carried.

Stock Exchange.—The Stock Exchange Committee have appointed March 21 as a special settling day for the Electric and General Investment Company's 19,900 6 per cent cumulative preference shares of £5 each, fully paid, Nos. 20,101 to 40 000. The committee have also ordered the said securities to be quoted in the official list. Application has been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to the Central London Railway Company's scrip certificate for 4 per cent. debenture stock.

Cleveland.—A serious accident took place at the Saltburn electric power generating station, which resulted in much damage being wrought, whilst one employé had a miraculous escape. It appears that a bolt on one of the working parts of a 37-b.h.p. gas-engine snapped in two, and the next moment the room was full of flying pieces of metal. An engineer named Matson promptly turned off the gas supply and retreated by the door. No sooner had the latter closed than a piece of heavy metal struck it with tremendous force. Had he been a second later he might have been killed on the spot.—*Northern Echo.*

Newport.—At the Council meeting on Tuesday the Mayor said there had been no blunder, not even of seven farthings, much less £70,000. Mr. Parshall's original report was for £85 030, and the Corporation went to Parliament with a scheme for £130,000. Then they joined Cardiff, Swansea, and other boroughs to resist the inroads of the South Wales Electricity Company, and Parliament had given them four years in which to provide facilities for selling power to the various large industrial works in the district. Thus they would be able to provide power instead of steam. He believed the extra £70 000 was an excessive estimate, and that all the money would not be needed.

Middlesbrough.—Mr. Frank Baker, the borough engineer, on Wednesday, was made the recipient of two handsome presents on the occasion of his marriage. The first consisted of a silver salver, which had been subscribed for by the officials of the Corporation. It bears the borough arms and the following inscription: "Presented to Frank Baker, C.E., F.G.S., borough engineer, by the officials of the Corporation of Middlesbrough on the occasion of his marriage, Feb. 7, 1901." The Town Clerk presented the same with some appropriate remarks, after which Mr. Baker made his reply. Mr. T. D. Cooper, the oldest member of the staff, supported by Mr. B. J. Wolfenden, the senior assistant engineer, then presented Mr. Baker with a fine silver cake basket from the members of his staff. This is also suitably inscribed, and bears Mr. Baker's crest.

The Aberdeen Accident.—With regard to the accident at Aberdeen, in consequence of which the electric lighting was totally suspended for a short time on Monday, the 11th inst., for the first time since the starting of the works in 1894, we are informed that the failure of supply was due to the racing of a 420-kw. set which was still in the hands of the contractors, who were then adjusting the governors preparatory to the official test, which was arranged for Wednesday. This racing caused a break in the steam pipe connections, which necessitated steam being shut off at the boilers, thereby cutting off supply. According to the recording instruments, the lighting of the town was affected for 45 minutes, and the electrical tramcars were stopped for 23 minutes. The lighting was off this length of time owing to the fact that upon starting up on the town at nearly maximum load, the armature of one of the sets was burned out.

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Ipswich.—The East Suffolk County Council have decided that all motorcars should carry a number both in front and behind, and should be registered. An application is before a committee from the East Anglia Telephone Contractors, who have asked the Council to grant them facilities for erecting wires in East Suffolk. This company have purchased plant of a firm who started a telephone system at Southwold and the neighbourhood.

Nelson.—Messrs. Gibbings and Baker have been appointed consulting electrical engineers. The electrical engineer's report for the last month gives the quantity of electric current sent out during the month in Board of Trade units as 150,169, an increase of 1·65 per cent. over the corresponding month of last year. The Local Government Board have agreed, in response to the request of the Corporation, to increase the period of loan repayment of £2,500 on works of electric lighting from seven to twelve years.

Lowestoft.—The Electric Lighting Committee's last report states that on March 1 68 private consumers, representing 3,500 c.p., had been connected with the mains. The scheme providing for an extension of street, not private lighting, has been adopted by the Council. Electric lighting mains are to be laid in North-parade (south and east sides), Lyndhurst-road, and back along Corton-road, to a feeding point opposite Royal-avenue. The loan asked for from the Local Government Board will amount to £30,000, making a total of about £60,000.

Carnarvon.—At the last meeting of the Gwyrfai Rural District Council the Chairman said that since the Board of Trade enquiry into the electric lighting scheme a letter had been received from Mr. Peterson, the promoter of the scheme, stating that if the Council wrote to the Board of Trade promising support to the scheme, Mr. Peterson was, on his part, prepared to give a legal undertaking to proceed also with the proposed light railways to Dinas Dinlle and Ebenezer, and the water-supply scheme of Cwmdwythwch. The matter was discussed, but no decision was arrived at.

Kendal.—At the annual meeting of the Chamber of Commerce last week the following resolution was adopted with reference to the telephone service: "That the secretary be instructed to communicate with the secretary of the General Post Office intimating that the trunk facilities and telephone to Kendal and district is, in the opinion of this meeting, insufficient. The chamber would strongly urge that another line between Kendal and Blackburn or Kendal and Manchester be laid immediately. The present delays in getting through are detrimental to the business of the town and district."

Cardiff.—The South Wales Electrical Power Distribution Company held their first meeting here on Monday. It is stated that all the money required at present has been subscribed. The promoters at first designed the establishment of generating stations at Pontypool, Treforest, and other convenient centres in Monmouthshire and Glamorgan, but for the present only one generating station will be set up at Treforest. The Rhondda, Aberdare, and Merthyr valleys, as well as Cardiff, Barry, and Newport, are easily accessible from Treforest, whence the electric mains are to run beside the railways.

Colchester.—The new engine and surface-condensing plant, which Davey, Paxman, and Co., Limited, and the Electrical Power Storage Company, Limited, are preparing, will be delivered and erected within two months from the date on which the battery-room is ready, which will be in about three weeks. The borough electrical engineer's last report states that the output of electricity in units during January, 1901, was 17,957, against 9,279 in January, 1900; the number of equivalent 8-c.p. lamps connected during the month was 200, against 20; the total number of lamps now connected was 9 998, against 4,523; and the number of consumers 170, against 89.

Northfleet.—At the last meeting of the District Council, a letter was read from the National Traction Company to the effect that they were pleased to learn that Northfleet were endeavouring to come to a working arrangement with regard to a generating station for the supply of electricity. As it was necessary for them to make early arrangements for the supply of electricity, and assuming the working arrangement would be come to, they were proceeding to come to agreement with the Gravesend Town Council on the subject. The Council decided to reply that if a working arrangement were not come to with Gravesend, then Northfleet would be able to undertake the electric supply.

Wheatley.—At Tuesday's meeting of the Wheatley Urban District Council a letter was received from the town clerk of Doncaster stating that the Corporation had received applications from builders in Avenue-road for a supply of electricity for the residences there now in progress, and the Corporation were prepared to extend their mains to that point providing that they could get the consent of the Wheatley authority. He asked that they would agree by resolution to the Corporation applying to the Board of Trade for a license under the Electric Lighting Act, 1882, to supply electricity for lighting or power in the urban district of Wheatley. The matter was adjourned.

Monmouth.—The Drainage and Electric Light Committee reported at the last meeting of the Town Council that Messrs. Siemens Bros. had accepted the terms offered by the Town Council in settlement of their claims, which amounted to £4,753. 4s. 5d. The terms are immediate payment of £757. 4s. 5d., and the payment of the balance, £3,996, with interest at 5 per cent., in quarterly instalments to spread over five years. Messrs. Siemens Bros. had also undertaken to investigate the condition of the high-tension mains, and what was necessary to put them in working order. The extra dynamo and engine are to be fixed 6in. higher than those already in place so as to prevent injury from floods.

Canterbury.—The tenders for condensing plant have been deferred for a further report by Mr. R. Hammond. Tenders for a spare armature for the new dynamo are to be obtained, and application made for sanction to a loan of £17,000 for the extension works. The engineer has been empowered to arrange for separate circuits to be made for wiring contractors for testing purposes, the charge for consumption to be 6d. per unit. The Town Council's estimates for the next year include a sum of £1 460 for electric lighting at the following rates: 12 arcs at £25, 320 incandescents at £3. 10s., six ditto at £7.

Eccles.—The Chairman of the Electricity Committee was asked at the last meeting of the Town Council the reason of the deficit in the working of the station. He said it was partly due to the light day load, but now that they had got a small engine to run the day load this would be reduced; and it was partly due to the high price of coal. Now that the new main cable was laid, they were in a position to supply as much again as they had done up to the present time. The committee had taken into consideration the mode of charging, and had adopted a new scale which he thought would prove satisfactory. Some of the customers were satisfied with the indicator system, and in their cases no change would be made.

Islington.—The Council propose to apply to the London County Council for consent to borrow £3,286 for valves, water service, and switch gear in order to complete the electric lighting extension works, which are nearly finished. These works are to be proceeded with as soon as the necessary consent to borrow the amount has been received from the London County Council. Various short lengths of distributing mains are required in order to connect consumers who have already applied for a supply of electricity. The estimated cost of this work, amounting to £388, has already been sanctioned by the London County Council. To-night the Council will be asked to authorise that the work be carried out.

Barrow.—The borough electrical engineer's plan in connection with the proposed application for powers to borrow money to carry out the electric lighting of Vickerstown has been adopted, and application is to be made to borrow £12,340 for the purposes of electric lighting. In addition to the sum of £6,207 required for the first portion of the scheme, the following sums are included in the application: for the completion of the scheme for the lighting by electricity of the houses, £4 243; for the lighting of the streets, in the event of the Highways and Lighting Committee deciding to use electricity for this purpose, £1,500; for the laying of additional conduits and distributing mains in Buccleuch, Duke, and Blake streets, £390—total, £6,133.

Ayr.—The monthly report by the electrical engineer (Mr. A. J. Fuller) states that during the month the cable in Prestwick-road, and also the long service cable from Prestwick-road to the hospital, together with the various connections required for this work, were completed and proved perfectly satisfactory on testing. With regard to extensions for lighting and tramways, Mr. Fuller gives details and concludes as follows: "Everything is well in order to meet the expected completion of the tramway route, and I have no doubt that, provided the contractors are well up to their time, we shall be able to give the necessary supply by June." Negotiations with the railway company have been broken off, as the company required a supply of direct current delivered at various points.

Stepney.—The Borough Council have decided to apply to the London County Council for a loan of the additional capital required during the next two years for the purpose of extending the street electric lighting distributing mains, feeders, and cable ways into the three additional districts of Mile End, Limehouse, and St. George's, and also making provision for the increasing demand in the Whitechapel area. The estimates are: on building account—additions to chimney shaft, economiser chamber, extension of cable culvert, £8,582; on plant—additional machinery and plant, £12,100; mains £68 106; house services, £7,200; arc and incandescent lamps, £16,687; stores, £2 720; tools, £200; stamp duties on loans, £250—which, with £6,355 for contingencies, made a total of £122,200.

Bury St. Edmunds.—The borough surveyor has been directed to give notice to the gas company to cease lighting the gas lamps in the vicinity of the new arc lamps. The gas company asked £750 for the posts and the brackets and for the cost of disconnecting. The Electric Lighting Committee offered £300, the company to disconnect at their own expense, the Council opening the ground. These terms have been accepted. The Electrical Engineer reported on Tuesday that since the last meeting 55 lamps had been connected for private lighting. The arc lamps in the centre of the borough having been completed, it was resolved that a charge of £13 per annum be made as arranged. The National Telephone Company were granted permission to erect overhead wires from their station in Lower Baxter-street to the Post Office to connect with the trunk line.

Woods and Co.—The name of this firm has been changed to Marshall and Woods, the partners being Mr. Alfred W. Marshall, M I Mech.E., A.M.I.E.E., who has been for the past six years electrical engineer and manager of the electrical department of the Crypto Works Company, Limited, Clerkenwell, and Mr. Maurice W. Woods, sole proprietor of Woods and Co., and partner in the late firm of Miller and Woods, established in 1890. We are informed that the firm's electric lighting business will be continued as before, and in connection with this the application and installation of electric motors for driving all kinds of machinery is to be made a speciality. The offices and showroom will remain at 2, Gray's-inn-road, but the workshop has been removed to a new

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factory at Shepherd's Bush, adjoining the terminus station of the Central London Electric Railway.

South Yorkshire Electric Power Bill.—The South Yorkshire Electric Power Bill came before Earl Morley's Committee of the House of Lords on Monday. At the time when the Bill was considered by one of the Examiners of Private Bills a non-compliance was returned on account of certain Standing Orders not having been fulfilled. The company had in their Bill, without stating their intention in the notices, proposed to exempt the Bill from the provisions of Section 81 of the schedule to the Electric Lighting (Clauses) Act, 1899, which fixes the liability of the company for "any nuisance caused or permitted by them." M. Tahourdins (Tahourdins and Hitchcock) represented the promoters, and stated that the clause containing the proposed exemption had been struck out of the Bill, and their lordships dispensed with the Standing Orders and allowed the measure to proceed.

Kirkcaldy.—Satisfactory progress continues to be made in connection with the tramways and electric lighting schemes. The engineer's estimate is £50,000 as the cost of the electric light and power scheme, while the tramways, which will run from Links *vid* High-street to Oswald-road, Sinclairtown—a distance of three miles—are estimated to cost £37,000. The profit in connection with the electric lighting and power scheme is estimated at £544 per annum. The estimated annual expenditure in connection with the tramways is £7,686, and the income £8,502, leaving a balance of £906. A site for a generating station has been secured on the new road, and there is evidence that the preliminaries in connection with both schemes are getting into a more advanced state. The Town Council have resolved to apply to the Secretary for Scotland for consent to borrow £50,000 for the electric lighting of the burgh.

Perth.—In consequence of the very large number of applications for current already received, it has been resolved that one 400-kw. set with corresponding boiler plant be acquired. Mr. Hawtayne has been asked to prepare and submit the necessary specification for this additional plant. The Electric Lighting Committee have decided that the resident electrical engineer, Mr. Lambert, is to have the following staff: one switchboard attendant; two improvers, and one assistant, who would also act as outside inspector; one engine-fitter, to reside on premises; one engine cleaner; two firemen; a clerk and storekeeper; and a jointer and an apprentice jointer. The Special Destructor (Expert) Committee have been empowered to make further enquiries regarding the question of the desirability of erecting a refuse destructor, and to report, and the report is to be circulated amongst the members of the Council before the matter comes up again for consideration.

New Issue.—Crompton and Co., Limited, manufacturers of electrical plant and machinery, Chelmsford, announce the issue of 46,000 shares of £3 each at the price of £3. 5s. per share. The company was incorporated in 1888, and has an authorised share capital of £300,000 in 100,000 shares of £3 each, of which 54,000 have been issued and paid up. The company's works are situated at Chelmsford, and comprise some 22 acres of freehold land, with engineering workshops equipped with modern appliances and instruments for the manufacture of dynamos, motors, arc lamps, locomotives, and all kinds of electrical plant, machinery, and instruments. Notwithstanding a considerable addition to the works at Chelmsford during the past 12 months, further extensions are required to meet the rapid growth of the business. The present issue is being made with this object and to provide additional working capital required to enable the company to deal successfully with the increased business.

Prestbury.—Mr. Hamilton Kilgour attended a recent meeting of the Parish Council with reference to the Cheltenham Town Council's application for permission to lay the electric cable through the village to supply Cleeve Hill with the electric light. Mr. Kilgour explained that cables would be laid to serve the overhead line of the electric tramway, and it was desired, when the trench was open, to put in an additional cable for electric light purposes, several houses on the hill having already been wired. In consideration of the sanction asked for, the Corporation would be prepared to put up a 32 c.p. incandescent lamp at each of the three principal corners of the road in the village. It was decided to interview the Mayor, and to arrange, if possible, to grant the concessions which the Cheltenham authorities asked for, provided (1) that they had power as a parish council to do what was asked; (2) that the concession granted would not be used against them in any subsequent application for taking parts of Prestbury into Cheltenham; and (3) the concession of three lamps be granted to them. This was carried.

Darlington.—The borough electrical engineer, Mr. J. R. P. Lunn, in his last report states that the number of consumers connected during the month was 12, making a total of 53, and the total of 8-c.p. lamps connected 663, making a total of 3,877. Applications had been received from 22 intending consumers, who would require 2,400 8-c.p. lamps, and it was decided to recommend that the mains be extended from Stanhope-road, through Duke-street, as far as the Duke-street Club. The Corporation of Darlington intend to petition against the Cleveland and Durham Electric Power Bill. The electric street-lighting was inaugurated on Monday by the Mayoress of Darlington (Mrs. J. G. Harbottle), who switched on the current to the main streets of the borough. Amongst those present were Alderman Barron (chairman of the Gas and Electric Lighting Works Committee), Mr. Jenkin (partner of Prof. Kennedy), Mr. H. Maw, Mr. J. R. P. Lunn (the Corporation electrical engineer). The present installation comprises 40 arc lamps of the Crompton-Pochin S long type of 2,000 c.p., the arcs being 23ft. from the ground. The standards are by Mackenzie, of Edinburgh; the lamps have been erected and fixed by the Crompton Company, of Chelmsford; and the mains put down by Messrs. Callender and Co., of London.

Plymouth.—In consequence of the resignation of Mr. J. H. Rider, the borough electrical engineer, who has been appointed to a more lucrative position under the London County Council, Mr. E. G. Okell, the assistant electrical engineer, has been promoted to the post of electrical engineer at a salary of £350, increasing by annual increments of £50 to a maximum of £500. He is to have charge of the street lights. Mr. S. T. Allen, charge engineer, has been promoted to assistant electrical engineer at £200 a year, increasing by £25 per annum to a maximum of £300. This is a commendable proceeding on the part of the Corporation as compared with others who at every vacancy throw the post open to competition, instead of giving their men in subordinate positions a chance to rise. On the other hand, where the system which obtains at Plymouth is carried out, a premium is put upon an officer's industry in making himself well acquainted with local conditions, etc., and the Corporation must be the gainer by it. The Electricity and Street Lighting Committee in their last report expressed their high appreciation of the zeal and ability displayed by Mr. Rider during the five years he had held the post of electrical engineer to the Corporation. Negotiations with the telephone company have been concluded and an agreement signed with regard to underground telephone wires.

Walsall.—The annual statement of accounts presented by the Electric Lighting Committee on Monday showed that the amount already borrowed had amounted to £25,450, and that they had power to borrow the further sum of £20,049. The greater part of this is already required for extensions now in progress. The amount at present expended on capital account was £34,309, but of that £1,500 had been repaid. The expenditure on revenue account for the year had been £3,100. 9s. 10d., and the receipts were: for sale of current (less discount), £4,122. 5s. 1d.; public lighting, £488; rent of meters, £83. 1s. 6d.—total, £4,693. 6s. 7d. This left a balance in hand of £1,592. 16s. 9d., but against this there had been a deficiency at the close of the previous year of £394. 11s. 11d., and there had been paid for interest £756 15s. 6d., and for repayment of loans £716. 12s. 10d., making a total of £1,868. 0s. 3d., which left a deficiency of £275. 3s. 6d. still unpaid on the previous year's working, but a balance of profit of £119. 8s. 5d. on this year. The profit in the year 1899 was £61. 13s. 5d., but up to that time there had been a gradually decreasing loss each year. The statement of production showed a make of 404,682 units, which was accounted for as follows: public lighting, 29 280; private customers, 246,363; the works, 17,606—total, 293 249. The total unaccounted for was 111,433. The number of public lamps was 19, and the maximum supply demanded was 301 kw.

Rochdale.—An animated debate ensued at the last Town Council meeting upon the question to confirm the proceedings of the Joint Committee of members of the Health, Gas and Electricity, and Tramways Committees, which included the following resolution: "That this Joint Committee is of opinion that the steam raised by the burning of the refuse at the sanitary works should be utilised for the purpose of generating electricity." Finally it was agreed that the minutes be received, but that no action be taken for the present, but at a further stage of the meeting the following resolutions were carried: (1) "That this Council is of opinion that the refuse at the sanitary works should be utilised for the purpose of generating electricity." (2) "That no further extensions or additions should be made at the Dane-street works except those proposed in the minutes of the Gas and Electricity Committee meeting of Feb. 27, 1901, until the steam raised at the sanitary works has been used for the above purpose." The Council also adopted a resolution of the Gas and Electricity Committee, recommending them to make an order that the extra plant required at the electricity works be obtained. The extra plant was described in the committee's minutes as follows: "By October, 1901.—One 400-kw. steam dynamo, erected in existing building; one boiler, 8ft. by 30ft., together with steam and exhaust pipes; condensing plant and accessories in existing boiler-house. By May, 1902.—One 400-kw. steam dynamo, erected in existing building, including foundations; one boiler, 8ft. 6in. by 30ft., with steam and exhaust pipes, feed pumps, economisers, foundations, seatings, accessories in extension of boiler-house."

Cairo.—The Egyptian Government have given a contract for the installation of electric light in two important towns of Egypt (Cantah and Zeftah) to Messrs. Eug. Nahman and Co., electrical engineers, Cairo. The distance between the two towns is a little over 16 miles. Details of the installation have not yet been definitely fixed. The generating station will be at Zeftah, and will contain large steam-engines and three-phase generators. A pressure of 5,000 volts will be used and transformers will be installed at various points along the line. Current will be supplied for motive power as well as for light. Messrs. Eug. Nahman and Co. have just finished two installations of electric light—one at the National Bank of Cairo, and the other at the sugar factory of the Daira Saineh at Poodah. At the National Bank of Cairo the plant consists of 500 incandescent lamps of 10 c.p. and 16 c.p., an electric passenger lift and an electric goods lift (supplied by Messrs. Waygood and Co., of London), battery of 55 Tudor accumulators of about 900 ampere-hours, Crossley gas-engine, and a Brown dynamo giving 110-160 volts for charging the battery. At the Poodah sugar mill the plant consists of two 25-n.h.p. Robey's locomotive boilers working at 140lb. pressure, two horizontal duplex feed pumps, injectors, and water heaters. There are two Robey compound engines of 25 n.h.p., each capable of giving off 60 effective horse-power, fitted with Richardson's

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patent automatic expansion governors. The two dynamos of the continuous-current system are of 320 amperes 115 volts, and work coupled in parallel for giving light to 500 incandescent lamps and 16 arc lamps of 10 amperes. The two installations have been completed by Mr. R. Levi, C.E., the engineer of Messrs. Eug. Nahman and Co., and we are informed that both are running very satisfactory.

PROVISIONAL PATENTS, 1901.

MARCH 4.

4530. Improvements relating to the jointing or terminating of electric cables or combinations of multiple-core cables. Rollo Appleyard and John Frederic Coote, 139, Church-lane, Charlton, Kent.

4532. Improved safety device for overhead electric wires. Alexander William Gilbody and David Robertson, the Municipal Technical College, Bradford, Yorks.

4533. Improvements in trolley wires and other overhead electric wires. Alexander William Gilbody and David Robertson, the Municipal Technical College, Bradford, Yorks.

4540. Improvements relating to the covering or casing of the electric wires or leads employed in house-lighting and for other purposes. Frederic Lennox Broughton, 18, Southampton-buildings, Chancery lane, London.

4549. An improved incandescent electric lamp. Albert Louis Reinmann, 15, Water-street, Liverpool.

4575. Improvements relating to electric power distribution. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Compagnie de l'Industrie Electrique, Switzerland.)

4578. Improvements in electric furnaces. Rámon Chavarria Contarde, 55, Chancery-lane, London.

4586. Improvements in primary batteries. Charles Nestor Gauzentès, 24, Southampton-buildings, Chancery-lane, London.

4591. Improvements relating to the preparation and treatment of filaments for incandescent electric lamps. Henry Edward Newton, 6, Bream's-buildings, Chancery-lane, London. (Charles Garner, United States.)

4697. Improvements in electric demand indicators. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

MARCH 5.

4631. Improvements in electric stop motions of drawing frames. Thomas Chadwick, Penny Bank-chambers, Halifax.

4642. An improved underground or conduit system for the transmission of electromotive force for traction purposes. Richard Ridgway Harrison, 24, Temple-row, Birmingham.

4675. Improvements in cords for switchboards, telephones, and other electrical instruments. The London Electric Wire Company, Limited, and Burton Hawke, Anchor Works, Playhouse-yard, Golden-lane, London.

4695. Improvements relating to the regulation of dynamos. Frederic Strickland, 70, Chancery-lane, London. (Complete specification.)

4700. Improvements in or relating to trolleys and like current collectors for electric railways and tramways. Frederic William Leevers, 6, Lord-street, Liverpool.

4709. Sound and fireproof walls for use in connection with telephone apparatus. Hans Schäffer, 40, Chancery-lane, London. (Complete specification.)

4714. Improvements in electromagnetic traction. Max Nietzschmann, 45, Southampton-buildings, Chancery-lane, London.

MARCH 6.

4736. Improvements in swivelling trolley heads employed in overhead wire electric traction. Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, Lloyd's Bank-buildings, Bristol.

4751. Process for insulating hollow conductors. Robert Detert, 10, Friedrichstrasse, Berlin.

4760. Improvements in electric measuring instruments. Albert Campbell, 15, Rothwell-street, Primrose Hill, London.

4763. Improvements in insulated electric conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

4765. Improvements in and relating to the transmission of power in the electrical propulsion of railway, tramway, and other vehicles. Edward Walter Whiteman, 55, Chancery-lane, London.

4767. An improved cable for supplying the electric current to electrically-driven ploughs and for like purposes. Conrad Meissner, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4768. An improved electric bell circuit for mechanically-driven ploughs. Conrad Meissner, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4776. Combined engine and air-compressing means for electric railway systems. Reginald Walter Barker, 56, Ludgate-hill, London. (The Murphy Safety Third-Rail Electric Company, United States.) (Complete specification.)

4777. Improvements in switch mechanism for surface-contact railways. Reginald Walter Barker, 56, Ludgate-hill, London. (The Murphy Safety Third-Rail Electric Company, United States.) (Complete specification.)

4810. Improvements in electrolytic interrupters. Frédéric de Mare, 70, Chancery-lane, London. (Complete specification.)

4812. Improvements in coherers for wireless telegraphy. John Robert Milne, 22, Southampton-buildings, Chancery-lane, London.

4813. Improvements in wireless telegraphy. John Robert Milne, 22, Southampton-buildings, Chancery-lane, London.

4814. An improved method of operating an electric chopper switch. Joseph Gershom Childs, 145, Farringdon-road, London.

4815. An improved method of making fuse contacts and holders for my detachable fuse plug, patent No. 18651, 1898. Joseph Gershom Childs, 145, Farringdon-road, London.

MARCH 7.

4819. A new or improved device for connecting the trolley with the trolley wire in electrically-driven vehicles. Henry John Weintz, 4, New-street, Huddersfield.

4820. Improvements in switching apparatus for electric circuits. William du Bois Duddell and Thomas Mather, 47, Hans-place, London.

4822. Improvements in arc lamps. James S. Scott, 2, Wellington-place, Belfast.

4841. Improvements in and relating to swivelling trolley heads employed in the overhead wire system of electric traction. Henry Edwin Frank Brecknell, Lloyd's Bank-buildings, Bristol.

4863. Improvement in combined electromagnetic and carbon microphone. Walter Elliott Rossetter, 14, Elmers End-road, Anerley, London.

4868. Improvements in electric switches. Charles Wesley Scott, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 16, 1900, being date of application in United States.) (Complete specification.)

4870. Electric coupling for railway cars. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

4892. Improvements relating to electrical interrupters. James Mackenzie Davidson, 323, High Holborn, London.

4899. Improvements in and relating to overhead wires and guard wires for electric traction and other purposes. Henry Ridley Burnett, 18, Southampton-buildings, Chancery-lane, London.

4902. Improvements in electrical cables. Mervyn Joseph Pius O'Gorman, 24, Southampton buildings, Chancery-lane, London.

MARCH 8.

4928. Improvements in fuses for distribution boxes, the same being applicable for single fuses of electric light installation. Peter Mushet and David Buchanan Selkirk, 154, St. Vincent street, Glasgow.

4940. Improved coupling joint or connection for electric wires and fittings. Max Railing and George Henry Ide, 165, Queen Victoria-street, London.

4967. Improvements in electrical measuring instruments for use as power indicators and the like. Kenelm Edgcumbe and Edgar Isaac Everett, 22, Charterhouse-square, London.

4986. Improvements in and relating to electric switches and cut-outs. Frederick Hagger Headley, 322, High Holborn, London.

MARCH 9.

5007. Improvements in the manufacture of electrical switches. Alfred Watson, 180, Hockley-street, Birmingham.

5017. Improvements in batteries. Gustavos Heidel, 154, St. Vincent-street, Glasgow. (Complete specification.)

5038. Improvements in incandescent electric lamps. Henry Christopher Mance and Nernst Electric Light, Limited, 82, Victoria street, London.

5039. Improvements in preparation of Nernst conductors for electric lamps. Charles Cornfield Garrard and Nernst Electric Light, Limited, 82, Victoria-street, London.

5040. Improvements in Nernst incandescent electric lamps. Charles Cornfield Garrard and Nernst Electric Light, Limited, 82, Victoria-street, London.

5041. Improvements in incandescent electric lamps. James Swinburne and Nernst Electric Light, Limited, 82, Victoria-street, London.

5042. Improvements in glow bodies for Nernst incandescent electric lamps. Bernard Mervyn Drake, Maurice Solomon, and Nernst Electric Light, Limited, 82, Victoria-street, London.

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5043. Improvements in rods for Nernst incandescent electric lamps. Legh Sylvester Powell and Nernst Electric Light, Limited, 82, Victoria-street, London.

5055. Improvements in alternating electric current induction motors. David Leonard Lindqvist, 322, High Holborn, London.

5062. Improvements in cord-controlled switches for electrical purposes. Arthur Thomas Milnor Thomson and the Thomson-Davis Telephone System, Limited, 22, Southampton buildings, Chancery-lane, London.

5063. Improvements in accumulators for secondary batteries. Thorvald Tage Agathon Hansen and Carl Christian Frederik Ferdinand Petersen, 22, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on March 30.

1900.

4198. Time apparatus for making and breaking telephonic and telegraphic circuits. De Lamprecht.

4383. Electric controlling apparatus. Lincoln.

4500. Self-locking elbow joint for electrical fittings. Hirst and Collings.

4561. Bearings and lubricants applicable to electric trolleys and other electrically conducting bearings. Cothias.

5389. Electrically-operated railway signals. Shoecraft and Gardiner.

6499. Electric meter depending on electrolytic transport of mercury. Lehfeldt.

6727. Electric contacts. Halford.

6768. Construction of vehicle or car wheels and electric motors therefor. Isbills.

7861. Electrical reciprocating apparatus. Brown.

8123. Electric light wall plugs. Oppenheimer. (Actiengesellschaft Mix und Genest.

8234. Electric rail bonds. British Westinghouse Electric and Manufacturing Company, Limited. (Redou.)

8427. Electrical presses. Kammerer.

9971 Method of utilising electrical earth currents. Jahr.

14139. Electric railways on the closed-conduit system. Purvis.

14568. Toll-collecting machines for telephones. Haddan. (American Toll Telephone Company.)

17453. Electric perforating and recording machines, more particularly applicable for use with musical instruments. Davis.

19394. Lampholder switches for electric lighting. Chard.

23417. Galvanometers. Blondel. (Date applied for under International Convention, June 6, 1900.)

1901.

2474. Transmitters for telephones. Mellett and Henderson.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Mar. 2	559	549	+ 10	26,409*c*	22,994
Birmingham Trams.	,, 7	4,215	4,158	+ 57	39,329	—
Blackburn Corp'rat'n	,, 8	414	382	+ 32	3,808	3,431*b*
Blackpool Corporatn.	,, 7	209	162	+ 47	29 919	22,046
Blackpool-Fleetwood	,, 9	166	182	- 16	1,394	1 472
Bolton Corporation..	,, 11	1,331	—	—	14,028	7,497
Bradford City Trams	,, 3	797	385	+ 412	6,699	3,088
Bristol Tramways Co.	,, 8	3,753	2,569	+1,184	—	—
Carlisle Tr'mw'ys Co	,, 9	120	—	—	1,095	—
Central London Ry.	,, 9	5,855	—	—	60 662	—
City & South London	,, 10	2,060	1,303	+ 757	20,133	11,775
Cork E. T. and L. Co.	,, 7	343	311	+ 32	3,190	2 854
Dover Tramways ...	,, 9	159	141	+ 18	1,533	1,451
Dublin & Lucan E.R	,, 9	67	70	- 3	703	541
Dublin U.T., elec. cars	,, 8	3,184	2,784	+ 400	—	—
Dublin S.D. Electric	,, 8	647	643	+ 4	—	—
Dundee Tram Co. ...	Feb. 27	435	359	+ 76	—	—
Glasgow Corporation	Mar. 9	8,239	8,360	- 121	—	—
Halifax Corporation	,, 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	,, 9	747	579	+ 167	33,748*b*	31,194
Hull Corporat'n E.S.	,, 9	1,555	716	+ 839	67,243*b*	—
Liverpool Corporat'n	,, 2	7,789	7,063	+ 726	69,889	59,651
Liverpool Overhead	,, 10	1,507	1,369	+ 138	14,695	14,301
Portsmouth Corpn...	,, 9	559	—	+ 54	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 10	2,954	—	—	—	—
Southampton Trams	,, 7	625	327	+ 298	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

b Since April 1, 1900. *c* From June 1, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	10 11
——— 40,001-70,000	5	..	10½-10¾
——— 6 per cent. Cum. Pref., 1-40,000	5	..	5¼-6¼
——— 5 per cent. Mortgage Debentures	100	—	100-105
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
——— 6 per cent. Cum. Pref., 1-50,000	1	—	3/16-5/16
——— 4½ per cent. First Mortgage Debentures	100	—	85-90
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¼-5
Brush Electrical Engineering, Ordinary	2	—	1⅝-1⅞
——— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2⅜
——— 4½ per cent. Debenture Stock	100	..	103-106
——— 4½ per cent. 2nd Debenture Stock	100	—	101-106
Callender's Cable, Debentures	100	—	109-112
——— Ordinary	5	—	15-16
——— 5 per cent. Pref.	5	—	5¼-6
Crompton and Co.	2	—	2⅛-2⅜
——— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	3	—	1¼-2
——— 5 per cent. Debentures	5	—	2¾-4¼
——— 4 per cent. Deb. Stock, Red.	100	—	88-90
——— 5 per cent. Second Deb. Stk., Prov. Certs.	—	—	98-100
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1⅝-2⅛
——— 7 per cent. Cumulative Pref.	2	—	2¼-3
——— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
W. T. Henley's Telegraph Works, Ordinary	5	—	16-17
——— 4½ per cent. Preference	5	—	5¼-6
——— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
——— 4 per cent. Debentures	100	—	102-105
Telegraph Construction and Maintenance	12	—	38-42
——— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	11-12
——— 5 per cent. Cum. Pref.	5	—	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	—	11¼-12½
——— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7½
——— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅞-1
——— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	..	70-75
Bournemouth and Poole, Ordinary	10	—	12½-13½
——— 4½ per cent. Cum. Pref.	10	—	10-11
——— Debenture Stock, Red.	100	..	101-106
Brompton and Kensington, Ordinary	5	—	7-8
——— 7 per cent. Preference	5	—	8-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¾-7½
Charing Cross and Strand	5	..	9½-10½
——— 4½ per cent. Cum. Pref.	5	—	5¼-5¾
Chelsea Electricity Supply	5	—	6-6¼
——— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	7-8
——— 6 per cent. Cumulative Pref.	10	—	13-14
——— 5 per cent. Debenture Stock	100	—	122-127
——— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	—	101-103
County of London and Brush Provincial, Ordinary	10	—	7-8
——— 6 per cent. Cum. Pref.	10	—	11½-12½
——— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¾-5¼
——— 4½ per cent. First Mort. Deb.	100	—	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5¼-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7¼-8¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¼-10½
London Electric, Ordinary	2	—	1½-2
——— 6 per cent. Pref.	5	—	4-5
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	12½-13½
——— ,, 85,001-98,769	5	—	7-8
——— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
——— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1½-1⅝
——— £5 Shares	5	—	7-7½
——— £4½ Shares, New	4½	—	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	200-220
——— 4½ per cent. First Shares Mortgage Debentures	$100	—	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
——— 4 per cent. Debenture Stock	100	—	80-90
South London, Ordinary	5	—	2¼-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15
——— 7 per cent. Pref.	5	—	8¼-9¼
——— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
——— 80,001-109,487	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	8¾-9¼
——— Pref. Half-Shares	5	—	4¾-5¼
——— ,, ,, deferred	5	—	4-4¼
City and South London, Consolidated Ordinary	100	—	46-50
——— Ordinary	10	—	4-5
——— 4 per cent. Debenture Stock	100	—	115-120
——— 5 per cent. Pref. Stock '91	100	—	132-137
——— ,, ,, ,, '96	100	—	123-127
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway	100	—	99-101
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9¾-10½
British Electric Traction, Ordinary	10	—	14-15
——— 6 per cent. Cm. Pf. 30,001-60,000	10	—	11½-12½
——— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5¼
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4¼-5
——— 5 per cent. Deb. Stock, Red.	100	—	104-107
——— Prov. Cert., all paid	100	—	96-99
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
New General Traction, Ordinary	5	—	3¾-4
——— 6 per cent. Cum. Pref.	10	—	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10¼-10¾
——— 5 per cent. Cum. Pref.	10	—	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
——— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
——— 4½ per cent. Debenture Stock	100	..	107-109
Telephones.—			
National Telephone, Ordinary	5	—	3¼-3½
——— 6 per cent. Cum. First Pref.	10	..	11-13
——— 6 per cent. Cum. Second Pref.	10	..	11-13
——— 5 per cent. Non. Cum. Third Pref.	5	..	4¼-4¾
——— 4 per cent. Deb. Stock, Red.	100	—	98-101
——— 3½ per cent. Deb. Stock, Red.	100	—	92-95
Oriental Telephone and Electric Company	1	—	⅜-½

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Supplement to "The Electrical Engineer,"

MARCH 15 1901.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Electrical Power Bills of 1900—Before and After.

BY WM L. MADGEN, MEMBER.

The introductory part of this paper consisted largely of extracts from daily papers, showing the views expressed in them concerning the business of this country. The author went on to say:

There may be some of us who find amusement in the comments of the daily papers on technical subjects, but it should be remembered that the articles we scoff at are read by thousands of those of our fellow-countrymen who make up those sentiments and influences which affect us seriously, and it seems full time that steps should be taken to place the responsibility for our backwardness where it belongs. We shall have to take our own part, or we shall find the public ordering German plant with the same complacency as they purchase German pianos.

There were then references to visits and to the value of such visits to works in other countries, after which came the real matter of the paper as follows:

What is the reason, then, that our electrical industry is behind that of nearly every important country in the world? It is due in the first place to silly legislation by Parliament and to obstruction by the numerous local authorities entrusted with arbitrary powers. In the second place, it is due to a class of quasi-officials and their associates, to whose direct monetary advantage it is that an opposition should be entered to every project in which they are not employed. There may be contributory causes, but to these and others that flow from them our chief difficulties may be assigned. Ere this Institution was founded an obstacle had been prepared for us. In 1870 was passed the Tramways Act to which I have referred, and these are some of its leading provisions. A tramway cannot be authorised by provisional order without the consent of the local authority of the district. If the proposed tramway is to run through two or more districts, and consents have been obtained in respect of two-thirds of the length, the Board of Trade may upon enquiry dispense with consents for the remainder. When the procedure is by provisional order the construction of the line can be absolutely blocked by notice given in the prescribed manner by one-third of the owners, or of the occupiers, of the premises abutting upon the road where, for so short a distance as 30ft. or upwards, there would be less than 9ft. 6in. between the outside of the footpath on either side of the road and the nearest rail of the tramway. The most onerous condition is provided in the notorious Section 43, by virtue of which the local authority can purchase a tramway at the expiration of 21 years from the date of the order, or of any subsequent period of seven years, on the terms of paying the then value of the tramway, exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatsoever. We shall agree with Mr. Granville C. Cunningham, general manager of the Central London Railway, that "there is perhaps nothing that has done so much to prevent the relief of overcrowding and congestion as the Tramways Act of 1870. Its provisions in rigidly limiting the term of the concession to 21 years, and practically fixing the price at which the municipality may take over the undertaking at something far below its value, have effectually checked the growth of electric systems." If procedure by special Act is resorted to, the Standing Orders of the two Houses require in like manner the consent of the local authority, so that the undertaking is not furthered in that respect, and is equally liable to be bled for the purpose. The frontagers are given a *locus* to oppose, so that a small number of them are not so well able, through caprice or other motive, to prevent the construction of an important line; but the expense and risk of procedure by special Act have been sufficiently serious deterrent. I think the net results will justify us in agreeing with Mr. Balfour Browne that this same Tramways Act was "a very silly contrivance indeed."

Consider the waste of energy and of enterprise in battling against such conditions, and whether it is any wonder our countrymen have to complain that we are lamentably behind the rest of the world in the cheap and rapid transport facilities afforded by electric traction. We have pleaded that there is no country in the world which would benefit more than our own by the provision of comprehensive electric tramway systems, or that stands more in need of them to relieve overcrowding, yet their introduction has been slow and halting, and carried out in the face of bitter opposition. Instead of lending a helping hand, governing bodies seem to have thought they were doing the public a service by narrowing enterprise down to the scantiest possible outlets, and in some cases by establishing an effective blockade against it. Twenty-six years elapsed—near upon a generation—and it was not until 1895 that the repose of the Board of Trade was disturbed—a body curiously constituted and still more curiously named—and it was found that something really must be done. A commission was then appointed to consider the question of tramways and light railways, and as a result of their report the Light Railways Act was passed in 1896, only four years ago. But this was only a tentative provision—it expires this year, and unless some measure of enfranchisement is passed, we shall be thrown back upon the Act of 1870, which remains effective upon the Statute-book.

The other great department of our domain, the general supply of electrical energy for industrial and domestic purposes, is even yet almost entirely governed by the Act of 1882, which was passed at a time when "the state of the art" was such that electrical energy could only be supplied economically for a distance of a mile to a mile and a half from the generating station. In effect the legislation was made to match the fact that at least one separate station was then required for each town, and the town council was constituted the authority which could either undertake the work itself, or consent to the acquirement of the necessary powers by a company. In either case the Act contemplated the local authority being the ultimate owner of the local undertaking. The clauses as to consent, the period and the terms of purchase, were inspired by the spirit of the Tramways Act of 1870, and the effect upon electrical engineering as a national industry has been equally disastrous. The result was a fiasco. What did Parliament then do? Nothing until 1888, when it climbed down in a half-hearted way—analogous to its performance in connection with the Light Railways Act—and passed another measure extending the purchase period from 21 to 42 years, but leaving the onerous consent clause and the ridiculous terms of purchase as they were.

Until after the Act of 1888 we could do practically nothing in the way of establishing electrical supply undertakings. Circumstances were more favourable in America and Germany during those six valuable years, and, encouraged by the home demand, which is an essential condition of enterprise abroad, the manufacturing trades of those countries laid the foundation of their great export business in electrical plant and accessories, the consequences of which we are feeling to-day. America and Germany now hold the great bulk of the export trade of this character, not only to the countries of Europe, and to South America where this country has heavy financial interests, but also to our own colonies and the United Kingdom itself. You will remember that the whole of the steam-engines, dynamos, electric lifts, etc., for the Central London Railway were supplied from America, and many other examples will occur to you. As I have said, the legislation was in effect made to match the fact that in 1882 it was necessary to put down at least one generating station for each town, and the conception of the situation by many local authorities is shown by their persistent endeavours to wall themselves in, so to speak, against the improvements by means of which the area of economic supply has vastly outgrown such limits.

The Acts of 1882-88 and their administration have proved entirely congenial to the narrow exclusiveness of these bodies, who are endeavouring even now, in their opposition to the Power Bills, to ensure themselves against the developments of science and a cheap supply rather than impair the prospect of their being able to have an isolated municipal plant all to themselves some day or other. The statistics available afford us the following figures for 1901: Electricity works in operation—local authority, 130; company, 68. Undertakings for which orders have been obtained, but works not yet carried out—local authority, 212; company, 55. Of the 55 undertakings which have not yet been carried out by companies, only three of the provisional orders (not taken by transfer from the local authority) are two years old yet, and 32 of the remainder only date from last session. Many of the works are now in course of construction, and very few are being hung up in any way that I am aware of. Of the 212 orders not yet carried out

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by local authorities, the works in 89 cases are, I believe, in course of construction or have been more or less decided upon, leaving a balance undecided of no less than 123. Under a provisional order, the time within which a supply should be available is two years from the date of the order, but of the 212 towns referred to a large proportion have exceeded that period, some of the dates tailing back as far as 1891, 1892, and 1893. The figures do not really show the full extent to which business is retarded, because no one has tabulated the local authorities who not only have not applied for a provisional order, but of whom it is known that they would have blocked any application; but the state of affairs is sufficiently shown by the fact that throughout the whole of the United Kingdom electricity supply under the Acts is only available to the public in some 250 districts. Now, we know that the consumer can procure his electrical energy on a more favourable basis for all concerned from an undertaking dealing with a comprehensive area and varied classes of demand than he can get it from a relatively small local station. This being the case, it may be supposed that it could only be a question of time when the obstacles, obstinate though they have been, to the cheap supply and to a large extension of the industry must give way somewhere.

The first break in the clouds was observed in 1898, when a Joint Select Committee of the two Houses was appointed (at the instance of the Lords) to consider and report upon a reference in regard to "Electrical Energy: Generating Stations and Supply." Time does not serve to detail the circumstances which led up to the appointment of this committee to describe the Bills then pending in Parliament, in which it was proposed to give effect to the developments of electrical science, nor can I read you the full terms of the reference or of the report,* but I extract the following paragraphs from the latter: "Where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage. The committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing Acts." "The committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade."

It was the feeling of electrical engineers that the report was too moderate considering the attitude maintained by the local authorities and their notorious misuse of the powers conferred upon them by the Acts, but this feeling is turning to one of dismay at finding that during the two or three years which have ensued nothing whatever has been done to carry out the recommendation last mentioned—which is a full justification of much that I have urged—and that their exertions continue to be very largely wasted. It might be gathered from the continued lamentations of the Press that the electrical engineers of this country were likely to be put upon their defence, and this might, indeed, be a consistent involution of the legislation which has already tried us very severely in another sense, but it cannot be said that we have been slow to act upon any measure of encouragement available to us. This was true of the Act of 1888 so far as its provisions would allow, and there has been absolutely no hesitation or delay in turning to practical account the paragraph in the report from which I have just read, with reference to the supply of electrical energy over extensive areas, by means of plant of exceptional dimensions and high voltage. I have referred to the Bills pending in Parliament at the time of the report, and we must acknowledge the valuable pioneer work of some of our members in connection with them.

The Bill which affected our prospects most strongly, although it did not pass, was promoted by the General Power Distributing Company in 1898-9, and was familiarly known as the Warsop scheme, the project being to distribute electrical energy over an area comprised within a radius of 26 miles from Warsop, in Nottinghamshire. This district includes such populous centres as Sheffield, Rotherham, Nottingham, Lincoln, Doncaster, Derby, and Chesterfield. The powers sought were to lay trunk mains throughout the area, to give a supply of electrical energy except where the local authority was itself empowered to supply under an order or Act and agreed to take a supply in bulk from the company on arbitration terms. To supply direct in all cases to consumers taking 10,000 units per annum and upwards. The conditions in regard to district, etc., were favourable, and large quantities of coal slack were available at 2s. per ton in the neighbourhood of the proposed power station. The Bill, as we know, did not then pass, but the powers which it sought to obtain have a considerable interest from the point of view of to-day, as in varying degrees they are reflected in the four Power Bills which were passed last session.

Before summarising the considerations relating to the supply of electrical energy over extensive areas, it will be convenient to follow the course of events. Public opinion became gradually informed on the subject, and, it is to be hoped, a little moved at the sense of national backwardness, and in the session of 1900 four Electric Power Bills, each for supply over important English areas, passed through Parliament. These were:

The County of Durham Electric Power Supply.—This area, about 250 square miles in extent, comprises the main portion of the Durham coalfields and one of the leading manufacturing and shipbuilding districts of the north-east coast. Provisional orders had been obtained authorising the retail supply to consumers in the chief towns—viz., Gateshead, Jarrow, and Durham City. The British Electric Traction Company had undertaken an extensive system of electric tramways in Gateshead and district, and have since obtained powers for lines in the Jarrow and Durham city districts. The Power Act authorises the laying of trunk mains throughout the area, and the supply of electrical energy in bulk to undertakers authorised to supply, and also to undertakers authorised to use it for prescribed purposes. Thus the supply may be given at once for general use in Gateshead, Jarrow, and Durham City, and for electric tramways and light railways in Gateshead, Jarrow, and other parts of the county. The first portion of the main power station on the River Tyne at Gateshead is rapidly approaching completion, and will be available this spring for a comprehensive system of supply which is being prepared in readiness for it.

The North Metropolitan Electric Power Supply.—This area, about 325 square miles, includes the great suburbs to the North of London, from Tottenham on the east to Harrow on the west, and the growing manufacturing districts along the River Lea. It covers the area within which the extensive North Metropolitan electric light railway has been carried through by interests friendly to those of the Act. The provisions and general considerations are the same as in the County of Durham Bill, and the same general policy was followed.

The Lancashire Electric Power.—This Act takes in the whole of Lancashire south of the River Ribble (except Manchester, Salford, Bootle, and Stockport), an area of about 1,000 square miles. The district may appear somewhat large, but a great part of it is undoubtedly very suitable, since it comprises a large number of collieries, engineering works, cotton mills, and a variety of other industries. The Act contains powers to lay trunk mains throughout the area, and to furnish electrical energy in bulk to undertakers authorised to supply, the promoters having relied upon the cheapness of production at large generating stations as sufficient to secure holders of electric lighting provisional orders as customers for bulk supply.

The South Wales Electric Power Distribution.—This includes the whole of the county of Glamorgan and extends into Monmouth as far as the River Usk (also including Newport), an area of about 1,050 square miles. The principal towns are Cardiff, Swansea, Newport, Barry, Merthyr, Pontypridd, and Neath, and the district thus comprises the great colliery, shipping, and manufacturing districts of South Wales. The provisions of this Act are similar to those of the Lancashire Act, with one important difference. The South Wales Company were given powers to supply direct to *any* person for power purposes, and for lighting any premises on some part of which the power is utilised, provided only that in a local area where an electric lighting provisional order exists, the consent of the authorised distributor in such area is first obtained. If such consent is withheld, the Board of Trade may dispense with it if, in the opinion of that body, the authorised distributor under the provisional order is not willing and in a position to give the requisite supply to the power user upon reasonable terms and within a reasonable time.

All these Acts contain a sliding-scale clause as regards prices and dividends, also powers for the revision of the scale every 10 years by the Board of Trade, 8 per cent. being taken as the normal maximum dividend. The general clauses follow pretty closely the usual electric supply practice; for details reference should be made to the Acts themselves. There are a few examples of groups of provisional orders having been obtained for adjoining districts by arduous negotiations extending over several sessions. These undertakings typify many of the difficulties with which electrical engineers have had to contend, but they are not more fully referred to here as the form of procedure was not by Power Bill. There is, however, an important Northumbrian undertaking dealing with the north bank of the

* In the House of Commons, July, 1898, Mr. Ritchie, replying to Mr. Kimber, said that the report of the Joint Committee would be carefully considered by the Board of Trade, but legislation would be required to give effect to some of the committee's recommendations, and he was afraid that the prospect of passing a Bill through that session was very small. The prospect must have been small indeed, for the process of official consideration has extended not only over 1898, but also beyond 1899 and 1900.

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Tyne from Newcastle to North Shields (excluding the latter) with part of the hinterland, which belongs to both classes and should not be omitted from the list, especially as it has been one of the first to get to work. The main purpose of the Power Acts is to keep the number of power stations within economical limits, and by the selection of suitable sites and the equipment of works of considerable magnitude to enable electrical energy to be transmitted in such a manner that the retail price to the consumer will be reduced to a figure which will compare with, and in many cases be far lower than, that of any other form of power, whether gas, steam, oil, or other agent. The enormous development of electricity in the United States and Canada and on the Continent of Europe, and the numerous great electrical power distributions over large areas in those countries, are in themselves practical evidence in favour of the principles we are advocating. It cannot be urged that the requirements of this country, so far as trade and cheap production are concerned, are different to those obtaining in the countries mentioned.

The absence of undertakings of the kind in the United Kingdom has not been on account of any difficulty or impossibility on the engineering side, or from lack of suitable conditions. We have few large water powers it is true, but there is an equally good source of power available, and coal in this country can replace, on favourable terms, the water power available elsewhere for the generation of electrical energy. Moreover, even in those parts of the country where coal is more expensive than in the coal districts themselves, relatively cheap electricity may be available if it is generated in sufficient quantity at large power stations, and the supply from such stations is distributed over a suitable area. Capital charges, management, rent, rates, and taxes usually form a larger proportion of power station costs than fuel, but the greater the importance we have to attach to the fuel item, the more necessary it is to adopt the most comprehensive methods and to concentrate and economise its use. Under the Electric Lighting Acts and the conditions heretofore existing, the scarcity of the electricity supply in this country has been due to the high cost of production. Even in the more developed areas the cost has been too high, as a general rule, to admit of its being freely used by the consumer on terms more advantageous than those upon which he can employ steam or gas for industrial purposes, or gas or oil for domestic service. Statistics have shown us that the average cost of production and supply to consumers becomes lower as the output of the power station increases, but the difference between stations supplying one million and four million units per annum is less, and not in proportion to that obtaining between smaller stations with much less difference of output. Without an increasing "diversity factor" this difference would tend to disappear as stations increased in size. A good "diversity factor' can only be achieved by combining with electric lighting the supply of energy for as many and as various other purposes as possible, and, so far as lighting is concerned, the supply to every class of consumer. As the area of supply is extended, the "diversity factor" tends to improve owing to the difference in the incidence of the demand in different districts.

I shall not attempt to follow the more technical aspects of the subject just now, as they afford scope for many papers, and certainly for more discussion than you can give to them this evening; but it may be well to summarise the points for and against the old system and the new—*i.e.*, the supply from small local stations and the supply from main power stations.

Supply over Comprehensive Areas from Main Power Stations in Selected Positions.

Advantages.—(1) Comparatively large field for development; (2) high load factor obtainable, all the plant being used to the best advantage; (3) cost of fuel and handling can be reduced to a minimum, as the power station can be located where fuel is cheapest, fuel handling most economical, and water is available for condensing; (4) low running costs, management expenses, and maintenance per unit sold, as the result of a very large and regular output; (5) the low cost of plant per kilowatt installed, and the increased economy in running with very large sets; (6) low rents, rates, and taxes (the difference between town and country); (7) economical provisions for extensions to plant and buildings; (8) low costs and charges for electrical energy for all purposes possible in consequence of above advantages; (9) removal of the power station with its chimneys, etc., outside the residential district.

Disadvantages (from point of view of local authority).—(1) The transmission mains must pass through their area whether supply be taken or not; (2) sentimental preference for complete independent plant of their own.

Supply in Small Local Areas from Separate Stations.

Disadvantages.—(1) Small field for development; (2) relatively low load factor; (3) cost of fuel, handling it, and water supply depend on immediate local conditions, favourable or unfavourable; (4) high running costs, management expenses, and maintenance, the costs per unit sold being generally higher the smaller the station; (5) higher relative cost of machinery per kilowatt installed, and lower economy in running; (6) rents, rates, and taxes relatively higher; (7) the extension of buildings is frequently very expensive, owing to disturbance and other difficulties incidental to town sites; (8) high charges for electrical energy for all purposes as result of these disadvantages.

The story of George Stephenson and the cow on the line has come down to us as typical of the prejudice and the ignorance with which* railways had to contend in their early days; and so, too, when the early history of the electrical industry comes to be written, the part played by the local authorities in their strenuous opposition to the Power Bills will be a record of reproach to them. For the purposes of this opposition there was a conference of local authorities in Manchester in January and a meeting of the Association of Municipal Corporations in May. The object of the first meeting was to prevent the second reading, and that of the second to influence the decision of the Parliamentary Committee. The methods adopted by those who endeavoured to wreck the Power Bills were strongly condemned in the course of the second reading debate, and the President of the Board of Trade found it necessary to repudiate a garbled report which had been circulated as to his remarks upon the Bill for the Warsop project in the previous session. Everyone interested in the welfare of the industry should read and think over that debate. True, the Bills were read a second time and committed, but what a curious light is thrown by the discussion upon the difficulties with which we have to contend! Perhaps there is time to mention two examples. Mr. Ritchie said: ". . . I hope the House will give its attention to the very important considerations in this case before they decide to reject on second reading a Bill that, it is fraught with so many possibilities. It is true, I think, that the electrical enterprise of this country is in an exceedingly backward condition; it is inferior with regard to light, and certainly with regard to the conveyance of power, to many European countries, and it is greatly inferior to North America and Canada. It may almost be said that there are villages in North America which are in possession of advantages in connection with electricity which some of our largest towns do not possess. It cannot be doubted that there is a demand for something to be done. At present electric light matters are governed largely by the legislation of 1882, and it has been said that this Bill is largely in opposition to many of the enactments in the Act of 1882. If no other charge or argument could be brought against this proposal, the argument of the opponents to this Bill would indeed be weak. It must be remembered that it was the Act of 1882 which more than anything else had delayed and hampered the development of electrical supply, and in so far as this Bill departs from that Act, I think its departure is amply justified by the condition of things at present existing in the electrical world." Here we have a member of one of the strongest Governments of modern times, the Minister entrusted with legislation affecting the trades of the country, who has realised the extent and cause of our backward condition in relation to a great industry, and ingenuously confessing that during five long years of office one of the main causes of the trouble has remained effective upon the Statute-book. Sir William Harcourt said, ". . . I do not altogether share my hon. friend's (Mr. Broadhurst) objections to great enterprises being carried on through private sources. That was a question which occupied 50 or 60 years ago the attention of this country, and that was at the time of the commencement of the great railway interest. That question was decided by the wisdom of the great statesman Sir Robert Peel. We know that Sir Robert Peel was much attacked at that time for throwing the railway enterprise of this country into private hands, and not adopting the system so largely followed on the Continent. I look forward to this question of electricity and electric supply as the great question of the future, and it is from that point of view that I wish to refer to the subject. If this company is prepared upon proper conditions to supply electricity to any part of the country, I am not opposed to that. No man can say to-day what part electricity may not play in the industry of the country, and that is a point which the House of Commons should keep in view. But what are the conditions which ought to be imposed? What was the policy which was pursued with regard to the railway companies? Parliament did not leave it altogether to particular promoters of Bills; Parliament did not leave it to the discretion of individual committees. They placed the whole of that great enterprise, upon which more than a thousand millions of private money has been expended, greatly to the benefit of the country—a sum larger than the National Debt, and now paying interest

* In 1801 we had no railways in the sense we now use the term. To-day the railways of the United Kingdom extend to about 22 000 miles of line, constructed at a cost of about 1 300 millions of pounds. The annual gross receipts now exceed 100 millions, and of the expenditure, which amounts to over 60 millions, fully one half is distributed in wages to over half a million employés.

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at least of 4 per cent., and one of the greatest investments for the savings of the country—under general legislation. I think that a model which we ought to follow in this instance. But what was the method which Parliament in those days adopted in dealing with the railways? They did not allow particular promoters to take their chance in individual committees. They placed the whole of that great enterprise, as I have said, under general legislation. . . ." This statement of Sir William Harcourt goes to justify the charge that the Legislature has neglected an industry the importance of which he describes in suitable terms, and it also leads us to the economic aspect of the question. Comparisons have been drawn between the benefits first derived by every class of our community from the applications of steam power and of railways, and those which have accrued to other nations in larger measure than to ourselves from the uses of electrical energy. The United Kingdom itself has not yet lost any material part of its natural advantages for the manufacture of engineering material, or of scope for their employment. In what way has destructive legislation acted so as to place us in the position of inferiority we are reproached with to-day? It has, among other things, tended to destroy cumulative investment effect. Savings out of the profits of a business tend to go back, as an additional investment, into that business or some department of trade allied with it. Part of the profits derived from railway enterprise undoubtedly went in again, and attracting new capital to it, provided means for building new lines and for equipping rolling mills, foundries, engine works, and other undertakings which have provided employment for thousands of our fellow-countrymen. No influence has done so much during the past 100 years to stimulate enterprise, to encourage commerce, and to develop the resources of any country.

In our own time legislation has not only deprived the great mass of the people of the direct benefits of electric science, but it has made much of what little has been done indistinguishable to the investor from local government loans for drainage, refuse destructors, slaughter-houses, and other purposes most necessary in themselves, but somewhat in the backyard of civilisation. It may be replied that Sunderland, for instance, has just declared a profit out of its municipal tramways, but what advantage has this been to anyone? The fares have been substantially the same as would have been charged by private enterprise or the amount would not have been earned. The local rates we may be sure will not go down, and if they are a trifle lower than they otherwise would have been, those to benefit most will be the railway company and other large ratepayers who have contributed least to the tramway revenue. The banks, insurance companies, and such institutions which provide much of the local government loan capital will get their 3½ per cent., and part of it may be reinvested in colourless loans elsewhere, but of that great encouraging influence towards the growth of healthy industry which I have imperfectly described as the cumulative investment effect, there will be little or nothing. And the money for the purpose has been deflected elsewhere. The subject is a complicated one, and it may not be in place to follow it here, but it is a significant fact that, *exclusive* of foreign loans, the yearly increase of capital from this country invested abroad averages at present about £30,000,000. One tendency of this has been to set more people to work abroad instead of at home, and to increase the competition against home industries. In the interests of which class of the community the enactments I have referred to were passed and have been administered by the various authorities, it is difficult to say. They have not benefited the general public, the complaint made on their behalf is that they are debarred from the advantages of electricity; and least of all have they benefited the working-man, who finds that while the electric light and comprehensive electric tramways are not for him, hundreds of thousands of pounds' worth of foreign-made plant and accessories are landed on our shores. The working classes have suffered in another and, perhaps, a more serious way from the division of the country under innumerable local authorities endowed with powers such as I have described. The more or less arbitrary boundaries of these authorities, derived in some cases from the Middle Ages, are not and cannot be adapted to one and all the various means by which science and enterprise can be brought to the aid of the general community, and it can be shown that in practice the system tends to aggravate some of the grievous social and industrial problems of our own times. These authorities number among them men of great ability and benevolence, but their collective action is frequently controlled by traders, property owners, and others who act upon the view that the best interests of their several districts lie in the direction of increase of ratable value and of population. Add to this a large official class alive to the advantage of increasing the importance of its own environment, and there need be little wonder that each district shows a tendency to "cuddle up" all it can attract, and that there should be grave reason for our being urged "to get rid of that which is really a scandal to our civilisation, the suffering which many of the working classes have to undergo in order to obtain even the most moderate, the most pitiable accommodation." There may be many fibres to the scandal of the housing of the poor, but the conditions most favourable to its growth are to be found in our system of local government and its administration.

The future of the electrical profession is so interwoven with social questions that we cannot escape their consideration. Mr. Balfour has said, "I believe that electrical traction is going to play a far larger part in the solution of this difficulty"—the housing of the working classes—"than any of the strange schemes I have analysed"; Mr. Lough that "It has been agreed by everybody that the chief means of improving housing accommodation is to spread out the city and destroy congestion, and it is agreed that there is no way of doing this effectually except by providing better facilities for traffic." No one can question the advantages of improved traffic facilities, but if the direction morning and evening is to and from a congested trade centre the problem is only half solved. It is to electric power distribution on a sufficiently comprehensive scale to adapt the country districts to manufacturing purposes, in company with inter-urban connection by means of electric traction, that we must look for the greatest agency in ameliorating the conditions of the working classes in all their surroundings. It can scarcely be asked what has all this to do with the Institution of Electrical Engineers, for we have seen that the community is conscious of the backwardness of our work, and faced by social phenomena such as those to which I have referred, we are called upon to perform our part in counteracting them. Electrical science is ripe for the occasion, and it therefore appears to be our duty and to our interest to convince the Legislature as to the means it should take to enable us to carry on the services assigned to us. As some technical objection might possibly be raised to any action we may take in this direction, we shall find, on consulting the memorandum and articles of association, which describe the scope and general organisation of the Institution, that (among allied objects) it was established "To promote the general advancement of electrical and telegraphic science and its applications, . . ." (Section 3 B), and "To do all such other lawful things as are incidental or conducive to the attainment of the above objects" (Section 3 D). Article 53 says that "It shall be the duty of the Council to adopt all due means for the advancement of the Institution; to provide for properly conducting its business in all cases of emergency . . ."; and a preceding Article 49 provides that ". . . the Council may appoint committees chosen from their own body, and committees for special purposes, consisting of members of Council and members, associate members, or associates of the Institution and others, with such powers as the Council may prescribe."

Thus the terms of our constitution not only authorise action being taken, but they also appear to intimate the course to be followed in dealing with any obstacles with which we may have to contend, and I trust that the discussion will give the Council an indication as to the desirability of appointing a special committee, as provided by Article 49, to consider what steps should be taken to remove the restrictions upon us, some of the effects of which I have endeavoured to describe.

Discussion.

Prof Perry (the president) read a letter from Mr. Vesey Knox regretting his inability to accept the invitation of the Council to be present that night. He had read Mr. Madgen's paper, he wrote, and the question involved seemed to him to be altogether one of price. In the case of tramways no doubt other considerations operated, but so far as mere electrical supply was concerned, Parliament had now in principle decided that any company offering economical advantages should be encouraged, of course with due regard to vested interest. In his opinion it was in the power of companies practically to force local authorities to take current by offering it at a cheap price. Capital expenditure on the part of such authorities would thus be saved. It was in the interest of companies to supply the current cheaply, because the cost of supply at a high rate was much greater than the cost of supply at a low figure. In some ways it was a pity that the sliding-scale clauses were not applied to electric lighting undertakings, instead of the clauses giving the Board of Trade power to alter the scale of charges after seven years. The sliding scale had now been applied in the case of the Power Bills, and it was to be hoped that this would have a natural commercial effect upon the undertakings.

Mr. R. Percy Sellon said so much of the time of the Institution was taken up in the discussion of subjects of a purely scientific character, that it was seldom they had before them a paper of the kind Mr. Madgen had read, which dealt with electrical engineering questions from their political and industrial aspects. The paper went into details and touched the very foundation of the issues upon which the life or death, the success or failure, of electrical engineering depended. In his opinion, therefore, the paper was one of great importance, and its chief interests fell under two heads. First of all, there were the intrinsic interests attaching to it, and then there was the matter viewed from the collectivist or political standpoint. With regard to the first, Mr. Madgen had

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drawn up fully and fairly the *pros* and *cons.* of these large power distribution schemes which depended upon that question. Was it in the interest of the public as a whole that there should be a few large distributing stations distributing over large areas, or a great number of small stations distributing over small areas? Having regard to the fact that at the present time everything was making for the consolidation of industries in all directions, he thought the intrinsic merits of the large power-distributing schemes over the small stations located from town to town were clearly established. It was a reproach to the Institution that they should debate over the question as to whether these schemes were possible while countries which were far behind England in point of industrial progress had solved it, and were still solving it by such stations as Niagara in America, and other. Why was it that they were in that backward state? It was because the progress of the electrical industry in England was not being determined by its intrinsic merits, but from the political standpoint. The industry had come to be the plaything of politicians, and of those who were advocates of municipalisation in the interests of the democracy. That was the real explanation of the fact that in that country they were quite without those large distributing stations, while abroad they were already in existence. In the case of electric lighting, the Legislature retarded the growth there; and with regard to tramways, the Act of 1870 was only after great difficulty amended by the Light Railways Act, which had really given electrical tramways the possibility of existing. Parliament had banded about electrical concessions in such a way that it was very small wonder that the investor could not be got to believe that there was for him a commercial advantage, at least, in going in for electrical enterprise. They in England possessed all the advantages—materials, finance, technics—which their great rivals in America, Germany, and Switzerland had, and the theory that the matter would in the end muddle itself out was one which he contended must be dismissed. The practical question was, what could their Institution do in its own sphere to add its quota towards the removal of the disability under which the industry suffered? He contended it was open to the Institution to take a more active interest in the support of those bodies, associations, and individuals who were engaged in trying to better the conditions in which they worked. Of course, there was the legislative question which just now was menacing the development of the tramway industry and the electric lighting and power distribution schemes. He trusted that the reception which the Institution would give to the paper before them would strengthen the hands of the Council in feeling that the body of the members was behind them in lending the weight of authority of the Institution in the support of any measures which would help to remove the disabilities which the industry was subject to.

Mr. J. S. Raworth agreed as to the great importance of the subject. The two main points were: were electrical engineers behind the position which they ought to have achieved? and, secondly, what were the causes which had brought that lagging into existence? He would compare the position of the gas companies with that of the electrical undertakings in this country. The total revenue of all the electric light and power undertakings in Great Britain and Ireland was £1,606,000 per annum. It would perhaps astonish the meeting when he told them that the revenue of the gas companies in the two years from 1896 to 1898 had increased from 19 millions to 21 millions odd, the exact increase being £1,600,110 All that ought to have gone into electrical engineers' pockets. In the face of all the electric light stations in the country, it was the fact that the gas companies had been able to steal that amount of money from electrical engineers and put it into their revenue account. Further, the profit which the three large gas companies in London made per annum was £1,630,000, which was greater than the revenue of all the electric light undertakings put together. Who could say, then, that their industry had not been choked. His objection to municipal trading was based on the ground that corporations did not manage business as well as companies. Besides, the companies could supply the article at a lower price than could municipalities. It was only on account of the growth of tramways and electric lighting that the new principle was introduced of giving the advantage to the corporation as against the company. In the great industry of gas there was no advantage to the municipality that the company did not enjoy. There were two or three provisions of the Act of Parliament which brought about the present state of affairs from which they were suffering. In 1882 the Legislature made it almost impossible for any electric lighting stations to be established, because the necessary capital could not be raised. That matter was somewhat mended by the purchasing clause being altered from 21 years to 42 years, but even now it was a difficult matter to get capital for these undertakings. If the legislative restrictions were removed, and private undertakings were put on the same terms with municipalities, he foresaw there would be no further trouble.

Mr. A. A. Campbell Swinton deplored the fact that they did not have more discussions like the present at the Institution. Mr. Madgen had given the reasons for the backwardness of the electrical industry in this country, but until only a very short time ago engineers would not have agreed with these. They would have said it was due to the speculation which took place in 1882 There was no doubt at all now, however, that the primary reason why the industry was so backward was because of the Tramway and Electric Lighting Acts, and the administration of those Acts by the Board of Trade. He had been led to look into the constitution of the Board of Trade. He had consulted several books on the subject, one of which told him that the Board of Trade had been in existence for some centuries, and after leading a chequered career was entirely suppressed. This, however, he did not believe. The "Encyclopædia Britannica" explained that the Board of Trade was formed of high officers of State, including the Lord Great Chamberlain and, *ex officio*, the Archbishop of Canterbury. This work went on to state that the Board of Trade was seldom called together, and existed merely in name. That really went, to some extent, to the root of the present state of affairs. If they would follow the example of Oliver Cromwell, and appoint to the Board of Trade a number of citizens who would be representative of the industries of this country, it would be a good thing. Placing any new industry in the hands of municipalities must necessarily lead to that particular business proceeding very slowly. Corporations could not speculate with the ratepayers' money, and, therefore, could only go in for a business the success of which was absolutely assured. That was one great objection to municipalisation. Private enterprise was the only legitimate way of trying new work. Speakers had alluded to the fact that it was not easy at the present time to raise money for electrical schemes and, again, he thought the reason was largely because the larger portion of the electrical industry was in the hands of municipalities. In Newcastle, a town with which he was familiar, there were two companies, both of which were prosperous. Both the Scarborough and the Cambridge electric lighting companies were almost entirely capitalised from Newcastle, which showed that the people there found the enterprises in their own town profitable. If the electric lighting undertakings at Edinburgh, Glasgow, Liverpool, etc., were in the hands of companies paying 10 or 12 per cent., there would be no difficulty whatever in getting any amount of money. What was required now was that some body representing the electrical industry should assert themselves. Parliament was pushing all it could for municipalisation, and it wanted someone to push the other way. He thought this Institution might do it to a certain extent.

Mr. Atherley Jones, K.C., M.P., admitted that Parliament had been perhaps remiss in the efforts which it might have successfully made in order to encourage and develop that great enterprise, which, whether it were traction or whether it were lighting, had had such marked success in other countries, but which in this country, through causes which had been traced by Mr. Madgen, had not met with corresponding success. He thought probably they would all agree, however, that within the last few years at any rate there had been a growing tendency on the part of Parliament that the interests of the community could perhaps be better served by deferring to the dictates of private enterprise rather than to municipalities. He was far from saying one word which would reflect on the municipal government, but they had perhaps coddled the municipalities a little too much. One of the greatest hindrances to the development of electrical enterprise had been the veto which could be exercised by local authorities over private undertakings. That, he thought, would be removed before long. Parliament, in passing the Power Bills last session for the county of Durham and a certain portion of Wales, recognised that the effect of municipalities was to over-ride the interests of private bodies. The Bills now before Parliament were likely to meet with as much opposition as those he had just mentioned. He thought even that much-abused body, the Board of Trade, would admit that it was desirable that facilities should be offered—to what length it was impossible to say—for tramway and light railway companies to construct under more favourable conditions, so as to provide a means of communication from the centres of industry to those places outside the large towns, where the working classes could get cheap and healthy homes. If the President of the Board of Trade, who, he thought was desirous of promoting the well-being of the public in this direction, would devote his attention to carrying through the Light Railways Act which was to some extent to succeed the present Light Railways Act, and probably part of the Tramways Act, it would in no small measure lead to the greater development of the electrical industry in this country. He had been able to induce the President of the Board of Trade to receive a deputation and to disclose the precise scope and direction of the new Tramways Act, and these matters which Mr. Madgen had dealt with would undoubtedly be laid before the President before long, and, he hoped, would bring forth good fruit.

Dr. S. P. Thompson thought they were all indebted to Mr. Madgen for his paper, for he doubted whether a more important topic could have been brought before the Institution at the present time. To be able to supply electrical power to their industries was a national question. It was sometimes thrown against them, when they advocated the establishment of these large power stations and adduced practical reasons why they should be encouraged, that all the power stations abroad were worked by water, whereas in this country they had no such driving power. That argument could not be admitted. In the first place, water power was not to be had for nothing, and if they had waterfalls in this country the owners would want payment for the use of them. The price for the same would be estimated on the cost of running the works by some other power. The problem was how to make use of the natural sources they had, whether it were coal or water. The dearer the power was in itself, the more was there to be gained by distributing that power as economically as possible. He would ask Mr. Madgen to give some information as to the relative working of large stations by coal as distinguished from large stations worked by water power. Another thing he would like to know was, what

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was the proper basis for reckoning out a suitable size of unit for a big power station? Up to now, facts as to this had never been stated in a compact and concise manner which could be used for convincing those who could not at present be convinced. Was it true that when they got a station up to the size of 10 000 h.p., it did not pay to go on increasing it to 20 000 h.p.; that it was better to put up another station a short distance away? Was there, in other words, a limit of size where an increased output would decrease the profits? In Bradford, practically all the industries which required electric power were textile, and began and left off work at the same hours. That was certainly not one of the most favourable conditions for the supply of electricity, as everyone knew it was much better to have a variety of industries taking the supply working at different hours of the day. Therefore, in determining the unit, they must consider the different places all over the country, and the circumstances under which the supply was made at each. When one compared the state of things in Italy—comparatively speaking, a poor country—and saw how station after station had been built, one felt perfectly ashamed of what was going on in this country. While in Bradford he found a firm which was supplying looms to the textile industry of Lombardy, each of which was fitted up with a three phase motor, whereas in Bradford itself the firm had not supplied a single loom electrically fitted. They now came to find that a central station was an absurdity. It was far better to have the station outside, which did away with the necessity of carting coal and other materials into the heart of the towns. A few large stations outside the towns would pay a great deal better than a number of small stations inside, each serving its own particular district. He would close with a parable. In Aldgate, in the City, there was the old village pump surviving to this day. The time was not far distant when these pretty little electric stations would be looked upon as being just as useless as the Aldgate pump was to-day for supplying water to London.

Mr. R. Hammond said that during the discussion of the Power Bills last session before Sir James Kitson's Committee, some vital interesting engineering questions arose in connection with the generation of electrical energy at centres of distribution, and of energy for large areas. These questions still awaited decision. They were: (1) what was the limit of distance from the generating works to supply the consumers beyond which the extra cost of distribution counterbalanced the advantages of concentration of plant; (2) what was the limit of kilowatts installed in a central station beyond which economy of centralisation of plant ceased; and (3) what were the means that were going to be adopted in order to preserve, over a large area with various consumers, large and small, pulling at the line, uniformity of pressure so as to be able to give electric light within efficient limits? The paper before them had an excellent title, but not one of the engineering questions which they, as electrical engineers, were interested in was touched upon by the author. The paper might be summed up under about four heads: (1) a lament—a dirge, he might almost say—over the fact that they in this country were terribly behind in electric lighting; (2) an intimation that this backwardness was due to the ignorant Legislature, to the foolish Board of Trade, and to the selfish local authorities; (3) an intimation that what they should do was to copy the Germans and Americans; and (4) an appeal to this Institution to form a committee in order to make the path of the company promoter at all events a little smoother. He was glad to be there that night to say that he distinctly dissented from these four propositions. The real reason why we were behind in this country in electric lighting was that they had to compete with gas at 2s. per 1,000 cubic feet. Throughout America and the Continent gas was abnormally high in price, and that was why the electric lighting undertakings flourished in those countries. Mr. Madgen said the backwardness in this country was due to local authorities. That was an absolutely mistaken idea to nourish. As matter of fact, out of the 25 millions of money spent on electric lighting undertakings in the United Kingdom and Ireland no less than 14 millions had been contributed by local authorities and they, he thought, owed a great debt of gratitude to them. Local authorities could produce electricity at a price hands down below companies. Then as regarded Germany, they heard a lot about the wonderful power schemes there. As a matter of fact, practically all the largest works were owned by municipalities. He also disagreed with the suggestion that a committee should be formed to put these local authorities right and to straighten out the Legislature. It would be better far if some member—he could not because he was a member of the Council—would move an amendment that a committee be formed to consider the engineering questions connected with power supply, and to report to the Institution to what extent the power schemes are likely to overcome the present difficulties.

Mr. S. Morse suggested to the last speaker that his speech was one better undelivered. He regretted that Mr. Hammond had stated that being a member of the Council he could not himself move an amendment. He might have said he did not dare to move it. The present position of the electric lighting industry was largely due to the unreasonable conditions put in the way of its progress by local authorities. He agreed that Parliament was responsible for many of them, but local authorities had gone further, and entered into an alliance by which they exercised an undue influence, which ought not to be permitted, over members of Parliament when these matters came before the House. It was essential for the industries of this country that there should be available to every manufacturer a supply of electric power at rates which would enable him to compete with his foreign competitor. Last session a body of local authorities went to the President of the Board of Trade, and said in effect, "If you sanction these Power Bills, we will vote against you on every question." Whereupon the Bills came out of committee with the decision that nothing should be done affecting local authorities unless they desired it. Local authorities wanted to spend the largest possible amount of money on their electrical schemes, and did not work from the point of view of giving a cheap supply to manufacturers. He was surprised to hear Mr. Hammond make the statement that because 14 millions had been spent by the local authorities on electric lighting schemes we should be grateful. That sum was a very small part of what would have been spent had companies had a free hand. Traders had a right to have their schemes discussed on the merits, and the veto given to local authorities to prevent that being done ought to be abolished.

Mr. G. L. Addenbrooke largely agreed with Mr. Hammond—at any rate, as regarded his facts; but he thought he had drawn wrong inferences from them. The fact was that, while on the Continent electric light and power had been supplied for the last seven or eight years, we in this country had done practically nothing in power supply. If proper regulations putting private enterprises and local authorities on even ground had been passed, instead of the Electric Lighting Acts some years ago, they would have seen the industry in a far more advanced position than it was at present. By the end of this session of Parliament something like £100,000 would have been spent in promoting these Power Bills. It was perfectly true that in Germany and Switzerland practically all the power schemes were in the hands of municipalities. As stated by Mr. Hammond, the engineering question of the subject ought to be discussed by this Institution, but each power scheme must be dealt with on its own merits. Unless local authorities could see absolute detriment to themselves by the passing of the Power Bills, a free hand should be allowed as far as possible.

Mr. E. Garcke said he felt very strongly on this question, and if he had followed Mr. Hammond, as requested, he was sure he would have been discourteous to him. That gentleman was once a company promoter himself—an occupation which he now looked down upon. He much regretted that Mr. Hammond should have put forward statements which were so misleading to the younger members of the Institution, where he had looked for a fair-minded view of that very complex question. Mr. Hammond wanted them to be thankful that the municipalities had spent 14 millions on the industry. As a matter of fact those who were capitalists would have spent that sum five or six years previously had they had the chance. He must say he was strongly in favour of municipal enterprise, but he did think it was not one of the provinces of local authorities to take the profits of trade from private individuals and put them in the pockets of collective capitalists of local authorities. He would undertake to refute any suggestion that gas had been an obstacle to electric light. Another argument Mr. Hammond used was that the local authorities supplied electrical energy at a lower rate than companies. His (Mr. Garcke's) argument was that if the corporation undertook to supply electric light at all, they should do it in the common interests of the community. The lower the price the better they could do their work, and on this ground he contended that the municipalities were able to carry out certain undertakings better than private companies. The backwardness of the electrical industry in this country was due to a plurality of reasons—social and political, among others.

Prof. W. E. Ayrton thought the paper was well worthy of their most careful consideration. The science of electrical engineering comprised the application of correct reasoning of all that appertained to the electrical welfare. He ventured to think that there was a certain obscurity of logic at the beginning of the discussion, for it was endeavoured to be proved that the electrical backwardness in this country arose wholly from the obstruction of local authorities. He was not there as a champion of officialism, but no one had been more anxious to see the wide development of the electrical industry than he. Taking the example of the Metropolitan Railway, why were the trains not run electrically to-day? Was this stagnation not rather due to the lethargy of the chairman and directors of a private company than to any restrictions imposed upon them by the kingdom, Parliament, or the County Council. The Bill to sanction the running of the Inner Circle electrically became an Act of Parliament four years ago, and yet ——. There were endless like examples. Coming to the question of the distribution of electrical energy, was it the fact that in those districts which were under the control of municipalities electrical energy was always so dear, and in other places where private companies ruled it was so cheap? He did not believe it. He knew of an instance where a large private company refused to supply energy in bulk to the local authority at less than 3d. a Board of Trade unit. Needless to say, the offer was not accepted.

Mr. C. B. Clay, of the National Telephone Company, referred to the case of the telephones in this country. He proceeded to read editorial extracts from the *Times* of June 13, 1884, with a view to showing that the Government threw every possible obstacle in the way of the introduction of telephones. One extract ran: "It is much to be wished that Parliament could find time to liberate the telephone from the bonds of red-tape, and allow its future to be shaped by the operation of the ordinary laws of economy," and drew the moral that the practical applications of science could not be prosperously committed to the hands of the Government. This, said Mr. Clay, applied not only to telephones, but to all branches of the science. One of the conditions on which

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the company were allowed to open up call offices was that they should charge 1s., and half of this went to the Government.

General Webber rose to a point of order, complaining that Mr. Clay's remarks were irrelevant to the question before the meeting.

The **President**, however, ruled that the speaker was entitled to proceed.

Mr. Clay said the title of the paper was "The Electrical Power Bills of 1900—Before and After." He was dealing with the "before." Proceeding, he referred to the veto of municipal authorities. In London the County Council had the right to say whether the telephone wires should be placed under the streets or not. Even now there was comparatively a small amount of underground work going on in London, and this was solely due to the County Council, who, after keeping the company waiting a year or two inserted two clauses in the agreement which could not be accepted by the company. He complained that the company were unable to lower their rates owing to the hindrances of the Post Office, and urged upon the Institution the necessity for doing everything possible to get rid of the obstructions of municipal authorities. If competition were allowed on fair grounds, he had nothing to say.

General Webber and **Mr. J. Gavey** both repudiated the statements of the last speaker. The latter was of opinion that the Telephone Company had had an absolutely free hand to charge what rates they liked. It was not right to say that they had been hindered by the Post Office as regarded the reduction of rates. The present state of affairs was rather the result of public pressure than of the action of the Post Office. It was untrue that the Post Office had acted unfairly in preventing the public receiving a proper telephone service either from the company or the Post Office. The company, on the other hand had in certain places resorted to the device of offering to the Post Office subscribers a free service.

Colonel R. E. Crompton, having read the paper with the very greatest interest, was in full sympathy with the author. He agreed that it was not on account of their inefficiency as engineers that they were so behind in the electrical industry in this country. It was due to extraordinary causes, one of which dated from the Tramway Act of 1870, which sought to fetter private enterprise and enabled municipalities to compete by means of the rates. Mr. Hammond must have forgotten that for years after the Electric Lighting Acts came into force municipalities had numbers of provisional orders lying idle. They never lifted a finger until private enterprise showed them that the industry could be made profitable in this country. The question was, Could electrical transmission in this country be made to pay? The municipalities would hang back until this was proved just in the way they did in the days of the electric lighting. But in spite of them the Power Bills would be brought forward, and within a few years municipalities would be applying for parliamentary powers for transmission schemes themselves. There was no doubt that the public opinion was that in England the electrical engineers were to blame—a most shameful and unmerited suggestion. When they remembered what such men as Hopkinson and Swan had done, and when they knew what was done to introduce accumulators and the hundreds of other things in England, they asked themselves what had other countries done that they in this country had not done first? There were no central stations abroad so economical as those in this country. The fact that the machinery for these stations had been very largely made abroad, was mainly due to climatic conditions. The real cause of the backwardness of the electrical industry in England was municipal restriction, and nothing else.

Mr. Madgen, in reply, expressed his regret that the question of municipal trading had necessarily to be brought into the discussion. But it would not have been well had the opinion of this Institution gone forth to the world without some opposition from the apostle of municipal trading. Mr. Hammond attributed the backwardness of the industry to the cheapness of gas. He (the speaker) had never heard such a weak argument addressed to such a body of men before. The engineering and technical questions which arose on this subject might usefully absorb the attention of the Institution for two or three years. With regard to the economical limit of a central station, some five years ago it was put at 5,000 h.p., but now that was much too low a limit. Referring to an article in the *Electrical World* of New York, Mr. Madgen said increasing the size of a central station always caused a continuous increase in the economy of generation. At a certain point, however, it was met by the disadvantage of long feeders, etc. The character of the area to be dealt with went to determine the limit of the station to some extent. Mr. Edgar, the president of the Boston Edison Company, had written him that their plant was so arranged that for all practical purposes it was one station of 20,000 h.p. Mr. Hammond had referred to the value of the work done by local authorities in this country. At the present time throughout the United Kingdom there were only 250 districts where a supply of electricity was made. Mr. Hammond evidently did not recognise the dog-in-the-manger nature of the local authorities, who at the present time had 212 provisional orders outstanding. With regard to Prof. Ayrton's remarks about the Metropolitan District Railway, it was owing to finance that the line was not at present run electrically. Prof. Ayrton also gave an instance of a company refusing to supply the local authority with energy at less than 3d. per unit, but it must be remembered that they only wanted 500 kw. as a maximum demand. He should have charged them 6d. a unit. With regard to telephones, the Telephone Company had been treated in an exceedingly unfair way by the Government. Anyone could realise the difficulties under which they had been carrying on their work. Practically all their business was overhead, and they had to get wayleaves wherever they went. Mr. Gavey had reproached the company with offering the Post Office subscribers a free service, but the Government was itself responsible for any devices which the company might have resorted to in order to carry on their business. He was glad Mr. Crompton had appreciated the purpose of this paper. It was a bread-and-butter question. How could it be in the interest of anyone that local authorities should deal with the industry in the way they were were doing? It was in their interest, as electrical engineers, to see that these legislative hindrances were removed. It had now been discovered that electric tramways were a means of relieving congested districts. Personally, he believed that electric power distribution was going to do more to relieve such districts, as it would assist in the migration of industries into more open country.

A vote of thanks to Mr. Madgen for his valuable paper closed the meeting.

COMPANIES' REPORTS.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY.

Directors: Alderman T. G. Gibson (chairman); J. H. Armstrong; F. W. Dendy; G. B. Hunter; Dr. J. T. Merz; J. H. B. Noble; J. Tennant; Dr. R. Spence Watson; Sir Lindsay Wood, Bart.

Report of the directors (with abstract of accounts) for the year ended December 31, 1900:

The directors, in presenting the balance-sheet and profit and loss account for the year ending Dec. 31, 1900, have pleasure in stating that the total units sold for the year amounted to 1 095,519, as against 967 098 in 1899, and 803 789 in the year 1898. The profits of the year, including the balance of £1,811. 1s. 6d. brought forward from 1899, amount to £10,605. 6s. 11d., out of which interim dividends at the rate of 5 per cent. per annum upon the amount paid up on the preference shares, and at the rate of 8 per cent. per annum upon the ordinary shares, were paid in July last, absorbing £3 680. 2s. 3d. The directors now recommend the payment of further dividends at the rate of 5 per cent. per annum on the amount paid up on the preference shares, and at the rate of 8 per cent. per annum upon the ordinary shares, absorbing £4 537. 13s. 10d.; and that the balance of £2 389. 10s. 10d. be carried to next year. The high price of coal which ruled during the year has increased the cost of production compared with the previous year by about £1,600. At present prices the larger portion of this increased expense will be saved during the current year. The reserve and depreciation account, which at Dec. 31, 1899, stood at £20,000, has been increased during the year by the sum of £20,000, being the premium of £1 per share on 20,000 preference shares issued, and now stands at £40,000. Two sets of plant, with a capacity of 500 kw. each, have been erected at Pandon Dene, so that the continuous-current service referred to in the last report is now supplying current in the city of Newcastle-on-Tyne. The Bills which were promoted in Parliament last year to give powers to the Company outside the area of their original provisional order, and also for the supply of electricity in Gosforth, have been successfully carried through, as reported to the shareholders on Sept. 20 last. Pursuing the policy foreshadowed in that report, the Company is now in possession of an extensive central generating station at Wallsend, having taken over and enlarged a station commenced by the Walker and Wallsend Union Gas Company. A suitable riverside site at Carville, the provisions for the purchase of which were included in the Company's Bill of last year, has also been secured upon satisfactory terms, and is available for future development. The central generating station is under the management of a joint committee of the directors of this Company and of the Walker and Wallsend Union Gas Company. The Company under the above arrangements is in a position to meet the present and growing demand for electricity for both power and other purposes. The purchase price of the riverside site referred to above was settled at £22,500, on the understanding that the vendors received preference shares for their purchase money, and in settlement thereof there were allotted to them in January of the present year 3 750 5 per cent. fully-paid preference shares of £6 per share, £1 of which is premium. This allotment is additional to the 20,000 preference shares issued at a premium of £1 to the shareholders during the year 1900, and there now remains unissued 10 000 ordinary shares and 6,250 preferences shares, which will be offered to the shareholders of the Company on the same terms as the last issue during the forthcoming autumn, by which time it is expected the remaining calls will have been made on all the allotted shares. The directors propose to create 4 per cent. mortgage debentures to the amount of £250,000, which will be issued from time to time as the extended operations of the Company require, the total issue not to exceed one-half of the paid-up capital. Towards this contemplated issue considerable sums have already been received, and are treated in the accounts as loans. The expenditure on capital account during the year has amounted to £127,261. 2s. 9d., the greater portion of which was not productive of revenue during the year. The Board has been increased under Article 74, as amended by special resolution dated Oct. 4, 1900, and the directors have pleasure in stating that they have secured as colleagues Sir Lindsay Wood, Bart., Mr. J. H. B. Noble, Mr. F. W. Denby, and Mr. G. B. Hunter. The confirmation of the appointment of these gentlemen as directors is required under the articles of association at this meeting. The directors regret to have to report the loss of the valued services of Colonel

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F. F. Sheppee, who, owing to his having ceased to reside in the district, has resigned his seat on the Board. Consequent upon this resignation, Dr. J. T. Merz is the only director who retires by rotation. He is eligible, and offers himself for re-election. The auditor, Mr. Thomas Harrison, also retires, and is eligible for re-election.

ELECTROLYTIC PARENT COMPANY.

The report of the directors for the year ended Jan. 31 last shows a net balance at the credit of profit and loss account of £49,536, represented by £62 in cash and 49,474 fully paid up ordinary shares in the Company. The directors recommend that 45,772 of these shares be distributed among the shareholders by way of dividend, at the rate of eight shares for every five shares held in this Company. Satisfactory progress has been made with the construction of the works of the Company at Middlewich, Cheshire.

NOTTING HILL ELECTRIC LIGHTING.

Directors: Sir William Crookes F.R.S. (chairman); Arthur Ellis Franklin, Esq.; Alexander Howden, Esq; James Thomas Jervis, Esq.; Joseph Wilson Swan, Esq., F.R.S. Engineer and manager: Geo. Schultz Secretary: R. G. Rawkins.

Abstract of the eleventh annual report of the directors and statement of accounts for the year ended Dec. 31, 1900:

The expenditure on capital account, which at the date of the last balance-sheet stood at £137,350. 13s. 7d., has been increased during the past year by £27,639. 9s. 4d., of which the principal items are: £12 198. 16s. 11d. for new mains (principally the trunk main from Wood-lane to the distributing stations); £3 336. 15s. 6d. for the freehold property in Lancaster road (bought for the purpose of erecting a subsidiary station to supply the northern portion of Notting Hill); £3 177. 14s. 5d. for the erection of the buildings in Lancaster road and Bulmer-place, to contain the transformer machinery; and £8 282. 2s. 9d. for the necessary machinery for equipping these stations. To provide the capital necessary for this expenditure, the balance of £19 000 debentures was issued, and at a general meeting held on Aug. 1 the capital was increased by £100,000. Of this fresh capital 2 200 £10 shares have been issued to shareholders, at a premium of £2 per share. As it was not possible to carry through the full scheme of extension during the course of the year, the sum of £18,000 remained unspent, and is on deposit to meet instalments due to contractors when they mature. The number of lamps connected is 68 505, and the number of consumers is 1,191, and of these 91 per cent. are supplied at 200 volts. It will be seen that for the first time the net profit of the Company shows a decrease, notwithstanding the fact that the gross revenue showed an increase of 10 per cent. This is accounted for by increase in expenditure for coal (£1,000), and by the expenditure of £1 200 on "repairs to accumulators," which involved the entire renewal of one set of batteries. Moreover, in May the directors found the new works in Wood-lane would not be in working order in time for the winter supply, and, therefore, they were compelled to refuse fresh supply contracts. The result was that the fresh capital expenditure has been unproductive, and the increase in the number of lamps, which promised to be large, amounted to only 9,400. It is expected that early in the current year the Company will resume making fresh connections. From the number of applications already received a large increase may be anticipated. In the south-western portion of the Company's area, bounded on the east by the grounds of Holland Park, and comprising Addison-road and its neighbouring streets, a difficulty has arisen. It is intended to supply this district from a transforming station at the southern end of Addison-road, and a suitable long leasehold site was purchased, subject to the consent of the freeholder to the transfer. This consent has been withheld, and it has become necessary for the directors to apply to Parliament to enable them to acquire this site by compulsory powers, as it is necessary for the proper carrying out of their obligations to supply current in this portion of their area. The Bill which is now before Parliament is confined to this one object. At a special general meeting held on the 27th inst. the shareholders passed a resolution approving it, and a notice of the necessary confirmatory meeting to be held after the annual meeting is sent herewith. In the last report it was stated that in conjunction with the Kensington and Knightsbridge Electric Lighting Company, Limited, a new generating station was to be erected at Wood lane for supplying current wholesale to the two companies, to be distributed through transforming stations in their respective areas. It was estimated that the cost of these joint works would be £100,000, and this estimate has not been exceeded. The capital was obtained by the issue of special debenture stock, amounting to £100 000, and no part of the capital of our Company has been utilised for this purpose. The works are now approaching completion, the machinery is running, and the tests having proved satisfactory some amount of current is already being supplied to the respective companies. The premium arising from the issue of shares and debentures during the year amounted after deducting expenses to £4 257. 17s. 7d. The directors have added to this the sum of £742. 2s. 5d. out of current revenue, making a total of £5,000, which has been transferred to the depreciation, renewal, and reserve fund, bringing that account up to £11,000. Although the expenditure on the renewal of accumulators might have been taken from this fund, the directors preferred to charge it against the revenue for the year. Of the remaining net profit, after paying interest on the debentures and new ordinary shares, depreciation, etc., amounting to £7,444. 14s. 8d., the directors recommend the payment of the usual dividends of 6 per cent. on both the preference and ordinary shares, amounting to £5,670. Of the balance, according to the articles of association, one-half, amounting to £887. 7s. 4d., is credited to the holders of the founders' shares, and the other half to the ordinary and preference shares. This will enable a further 1 per cent. to be paid on both ordinary and preference, with a distribution of £1. 12s. per share on the founders' shares. An interim dividend of 3 per cent. was paid on July 1, and the balance of 4 per cent. will be paid forthwith, together with the distribution on the founders' shares. The preference shares having received their full 6 per cent., the 1 per cent. bonus will be added to the interim dividend on these shares, to be paid on July 1 next. The directors desire to place on record their appreciation of the services of the engineer and manager, secretary, and staff generally; the amount of extra work thrown upon them in connection with the construction of the joint station and of the subsidiary stations has been very large, and has been ably carried out. They desire also to express their satisfaction at the friendly assistance they have received received in all matters connected with the joint station from the directors and staff of the Kensington and Knightsbridge Electric Lighting Company, Limited. The directors retiring in rotation are Messrs. Alexander Howden and J. W. Swan, who, being eligible, offer themselves for re-election. The shareholders will recollect that on the occasion of the last meeting Mr. J. W. Swan, F.R.S., was elected a director to replace the late Mr. Francis Radford. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and, being eligible, offer themselves for re-election. The accounts will be audited in due course on behalf of the Board of Trade.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£2,917	11	7			
Oil, etc., and stores	384	11	0			
Wages and gratuities	692	14	3			
Repairs and maintenance of plant	1,674	0	10			
				5,668	17	8
Electricity supplied from Wood-lane works				111	10	9
Distribution of electricity.						
Repairs, maintenance, etc.	402	10	9			
Wages of meter readers, etc.	113	16	0			
				516	6	9
Rates and taxes				677	17	0
Management Expenses.						
Directors' fees and salaries	2,613	10	0			
Stationery, etc., and general charges	316	3	4			
Auditors of Company	52	10	0			
Auditor appointed by Board of Trade	37	0	0			
				3,019	3	4
Special Charges.						
Insurances	107	5	7			
Law costs	6	5	1			
				113	10	8
				10,107	6	2
Balance carried to net revenue account				9,856	0	0
				£19,963	6	2

Cr.	£	s.	d.
Sale of current (782,215 units) less discounts and bad debts	18,796	18	5
Rental of meters and other apparatus on consumers' premises	798	8	8
Connecting installations, sale of stores, etc.	124	18	10
Rents receivable	235	11	9
Transfer fees, etc.	7	8	6
	£19,963	6	2

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
Capital account—amount received	172,000	0	0
Due from sundry tradesmen and others	5,240	12	0
Sundry creditors	1,005	13	0
Depreciation, renewal, and reserve fund account	11 000	0	0
Founders' shares undivided profit account	19	14	9
Preference and ordinary shares undivided profit account	64	14	9
Balance at credit of net revenue account, £7,444. 14s. 8d.; less interim dividends, £2,835	4,609	14	8
	£193,940	9	2

Cr.	£	s	d.
Capital account—amount expended for works, including cost of provisional order	164,990	2	11
Sundry debtors for current supplied, etc.	6,942	19	7
Other debtors	285	0	2
Stores on hand	479	17	7
Stock (movable plant and tools)	277	17	8
Cash at bankers and in hand	19,964	11	3
Preliminary expenses, compensation, etc	1,000	0	0
	£193,940	9	2

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NOTES.

Canadian Telegraphs.—There are still persistent rumours abroad to the effect that the telegraph system in Canada will soon be under State ownership. The Government is reported to be negotiating for the purchase of the lines with a view to conducting the business, but up to the present no authoritative statement has been made.

Lecture on Electricity.—Mr. E. T. Williams, of King's Lynn, delivered an interesting lecture in the lecture hall of the Union Chapel, Manchester, on the 5th inst. on "Electricity in the Service of Man." Mr. E. W. Hoyle, M.A., of Owens College, presided. The lecture was illustrated by lantern views, and a discussion followed.

The Institution Journal.—The *Journal* of the Institution of Electrical Engineers for February, 1901, contains Mr. W. Langdon's valuable paper "On the Supersession of the Steam by the Electric Locomotive." Mr. W. Duddell's paper "On Rapid Variations in the Current through the Direct-Current Arc," which aroused so much interest among the various members of the Institution, also appears, followed by Lieut.-Colonel Crompton's descriptive lecture "On the Electrical Engineers (R.E.) in South Africa."

Electrical Developments.—Hitherto the primary batteries employed in the central telegraph office in Calcutta have given considerable trouble and inconvenience to the department. These have now been supplanted by an installation that has been set up for the storage in secondary batteries of electricity from the street mains, which is used in the transmission of messages to a number of long-distance lines. The apparatus is most compact, and has shown itself to be a great improvement on the old arrangement.

Cooper's Hill.—It is with great satisfaction we note that the seven professors at Cooper's Hill Engineering College who were recently requested to send in their resignations are to be given a hearing. As a result of urgent representations which have been addressed to the Secretary of State for India, Lord George Hamilton has intimated that these gentlemen are to be permitted to state their cases to the Visiting Committee of the college. After this has been done the matter will be further considered by the Secretary of State in Council.

The Tesla Telegraph.—A short note appears in the issue of the *Scientific American* for March 9 to the effect that Mr. Tesla's agent has left London for Lisbon to establish a receiving station on the Portuguese coast at the fortieth parallel of latitude, which will be in communication with a Tesla transmitter located on the New Jersey coast. We had no idea that an actual experiment was proposed, and trust that our contemporary is correct in the above statement. We, personally, should have thought that to make experiments on a smaller scale over a shorter distance would have been a more reasonable procedure.

The Yorkshire Electrical Power Bill.—It will be remembered that the directors of the syndicate which is promoting the above-mentioned Bill had inserted a clause in it which would allow them to supply energy without the consent of local authorities in certain cases where it was proved to the satisfaction of the Board of Trade that the company would give a cheaper supply than the local authority in question. Owing, however, to the strenuous opposition which has been brought against this clause, it has now been revised, so that the consent of the local authority will in every case have to be obtained. We much regret that this has been the case, as the interest of the consumers and also of the electrical profession would be better served if the Bill were passed in its unamended condition.

Mandalay Tramways.—*Indian Engineering* gives some further particulars regarding this scheme, from which it appears that the Burma Electric Works Syndicate, Limited, propose to lay down and work a double track from the Zegyo Bazar to the Arakan Pagoda, and another from the railway station to the steamer landing stages on the Irrawaddy. It is suggested that the rent payable to the Municipality for the road should be £33. 6s. per mile per annum for the first six miles for the first five years, and for the next five years £5 per mile. For any additional mile up to 12 miles £33. 6s. per annum, and for any extension over 12 miles £13. 6s. per mile.

Wireless Telegraphy in War Time.—The decision of the Admiralty with regard to utilising wireless telegraphy for naval signalling purposes in war time testifies to the fact that the Government has fully recognised the value of this system of signalling. Stations for this purpose are to be established, it has now been decided, at Culver Cliff, Dover, Portland Bill, Rame Head, Roche Point, Scilly Isles, Gibraltar, and Malta. These two latter stations will, of course, be for use in connection with the Mediterranean and Channel fleets. As to the English stations, Culver Cliff is to be in direct communication with Portsmouth and Rame Head with Plymouth. By these means the naval commanders-in-chief at these ports may receive rapid and continuous information of what is happening in the outlying portions of their command. Special staffs for peace and war will be allocated to each station.

The Central London Railway.—The committee of experts which is considering the question of the alleged damage caused by the working of the above railway to houses along the line of route is still taking evidence at the Board of Trade. We understand, unofficially however, that the experiments which the committee are making tend up to the present to show that the vibrations have been exaggerated by the householders, who hoped to obtain damages from the company. In certain cases instruments which have been used elsewhere for similar purposes have failed to reveal appreciable vibrations due to the running of the line. Certain witnesses at the enquiry have stated that the vibration is more at certain times of the day when the rush of traffic is on. Engineering evidence, however, is brought to the effect that this is extremely unlikely, as the weight of the people in the train is such a small proportion of the total weight.

Imperial Telegraphs.—Some important resolutions, mostly originating from the provincial towns, on the question of Imperial telegraphic communication were considered on the last day of the annual meeting of the Associated Chambers of Commerce last week. For convenience these were ultimately consolidated into one resolution, which, while expressing satisfaction with the progress made in the formation of an all-British Pacific cable, urged on the Government the absolute necessity for the construction of all-British lines between all parts of the Empire, and advocating that support be given by the association to the Imperial Telegraph Committee of the House of Commons in their efforts to promote enquiry into the question of charges and increased efficiency and economy. The resolution in this form was agreed to. There was another motion on the agenda paper, urging the Government to establish without delay additional and improved cables between the United Kingdom and the Continent, and to arrange for more direct wires to the principal European centres of commerce and manufacture. This was also adopted, and resolutions drawing attention

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to the need for more efficient telegraphic and telephonic service between the commercial and manufacturing centres of the United Kingdom and for the cheapening of telegrams were next moved and carried.

Personal.—When the question of Mr. J. H. Rider's resignation came before the Plymouth Electric Lighting Committee it was accompanied by a note from him expressing his deep sense of the kindness and support he had experienced at all times from the committee, and adding that he would leave Plymouth with the utmost regret. We are pleased to be able to state that the committee, putting on one side the loss to the town, congratulated Mr. Rider on his new appointment, and expressed their high appreciation of the zeal and the ability displayed by him during the five years that he had acted as electrical engineer to the Corporation. In view of what happened when the tramway engineer of the London County Council resigned his previous position in order to take up work in London, it is exceedingly pleasant to read of the goodwill which exists between Mr. J. H. Rider and the Plymouth Electricity Committee. We are also glad to note that his position at Plymouth is to be filled by his first assistant, Mr. E. G. Okell. Here, again, the committee are to be congratulated in that they have promoted an engineer who has been Mr. Rider's right-hand man in the design and laying down of the plant from the commencement up to the present time, and he will be able to render much more valuable service as chief than any outside man coming into the district.

Motor-Wagon Trials.—As previously stated in these columns, the Liverpool Self-Propelled Traffic Association will hold a series of automobile trials early in June this year. The main object of these trials will be to test the different types of heavy motor-wagons suitable for haulage operations in Lancashire prior to their being taken over by a Lancashire syndicate, which will be formed for the purpose of conducting road transport between Liverpool and manufacturing towns in Lancashire. We are now informed that the entry forms for this competition are ready for issue to intending competitors. Upon representations that a number of vehicles will otherwise be debarred from competing, the Council have decided to add a fourth class, to be known as class D. In this section there are no restrictions upon the tare or platform area, and all the conditions already published apply. The minimum load to be carried is four tons, but an excess may be declared, according to the rules. There is no alteration in classes A, B, and C, the specification for which remain unchanged. The days on which the tests will be made are Monday, June 3, to Friday, June 7 (inclusive). They include hill climbing at Everton Brow, manœuvring at Prince's Dock, and long-distance runs—such as from Liverpool to Manchester *viâ* Warrington, and back *viâ* Bolton. Some important results should be obtained.

Internal Resistance of the Lead Accumulator. In the digest of the *Electrical World* for March, we notice an abstract of a paper by Messrs. Dolezalek and Gahl on this subject, being an account of an experimental investigation of the variation of the lead accumulator during the charge and discharge. This internal resistance, it appears, is very small, and is some ten-thousandths of an ohm in the cells used in practice. The resistance increases gradually during the discharge. It decreases during the charge. In spite of its small value, the internal resistance is greater than it ought to be if calculated from the conductivity of the electrolyte. It must, therefore, exist in certain transition resistance at the plates, due to films of non-conducting lead sulphate on the spongy lead and lead peroxide, or due to variations of concentration of the acid at the plates. The authors find that in practice the increase of the resistance of the negative electrodes during discharge is entirely negligible. There is practically only an increase of resistance of the positive plate during discharge. But of greater importance in practice is the drop of voltage due to variations of the concentrations at the electrodes and to the resistance of the support of the active mass, especially of the negative plates. In comparison to these essential factors, the real internal resistance, which consists of the resistance of the electrolyte and the transition resistance between acid and plate, is negligible.

Electric Light in Johannesburg.—We have just had an opportunity of perusing a copy of the *Johannesburg Gazette* for Feb. 21 last. The major portion of the issue of this paper is taken up with proclamations and notices inserted by the military authorities. Two of these concern the electric lighting of the town. It seems curious to read under the initials "V. R." a municipal notice that consumers of electric light can use the telephone at the fire brigade stations at all hours for the purpose of making complaints to lighting department as to their electric light. This notice, which is dated Nov. 16, 1900, is signed by the acting burgomaster. Under the date of Jan. 24, 1901, the same gentleman, now called the acting mayor, informs the consumers that "as no electric light can be obtained from the Rand Electric Supply Company, the whole supply of current for the Municipality of Johannesburg has now to be generated at the town lighting works. The capacity of the plant at these works being small, the public is particularly requested to limit the number of lamps in use during the early hours of the evening to as few as possible." This last notice, which was issued in consequence of the central electricity works being badly damaged by a band of marauding Boers, reminds us of the notice which certain electric lighting undertakings in the United Kingdom have had to issue at various times to their contractors for electrical plant who had not fulfilled their obligations.

Street Railway Convention.—The twentieth annual meeting of the American Street Railway Association has now been fixed for Oct. 9, 10, and 11 next. On each of the first two days there will be two sessions of the convention, the third and last day being set aside for the inspection of exhibits. With regard to the papers to be read at the meetings, the executive committee have decided that these shall be printed and advance copies sent to the members, in order that the time of the members may not be taken up in hearing the various papers read. Among the subjects which will be considered on this occasion are these: "The Economies resulting from the Use of Four Motors instead of Two on Double-Motor Equipments"; "The Best Form of Car for City Service—a Consideration of the Various Types of Car as to Size of Car and Arrangement of Seats, including the Best Types of Brakes and Wheels"; "The Best Manner and Mode of Conducting the Return Circuit to the Power-House"; "Practical Results obtained from Three-Phase Transmission and Rotary Transformers or Motor-Generators in Transmitting Power on Railway Lines"; and "The Modern Power-House, including the Use of Cooling Towers for Condensing Purposes." Mr. Vreeland, of the Metropolitan Street Railway Company, confidently hopes that all the important new work upon that system will be completed by the time of the convention in October, so that the visitors may be able to witness the largest street railway in the world in full swing.

Permanent Phonograph Records.—In a recent patent Mr. Edison describes a new way of preserving

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phonographic records for indefinite periods. The method is simple, consisting as it does of producing a perfect duplicate made of silver, with a thin plating of gold, from an ordinary wax record. The process followed by Mr. Edison is this: He takes a copper electroplate of a wax record. This copper relief obtained is then electroplated with silver, the surface of which next the copper, of course, has precisely the form of the original wax surface. The copper matrix is then dissolved away with acid. In the electroplating process the wax record is revolved under a bell jar in a Crookes vacuum, through which an electric discharge is passing between electrodes of gold. This causes a discharge of a vapour or infinitesimal particles of gold, which attach themselves to whatever they strike, forming a continuous coating of excessive thinness, and following the outline of the surface with absolute fidelity. Upon this coating the copper matrix is plated, to form the inside surface upon which the silver is deposited when the wax is removed. The gold, like the silver, being unaffected by the acid used, remains as a plating on the silver record when the copper matrix is dissolved away. In giving these details, the *Scientific American* points out that the amount of gold used is scarcely appreciable, and the silver may be a thin shell, backed up by other material, so that the records are not as expensive as might be at first conceived.

Velocity of Ions.—In an article on this subject in the *Physical Review*, Mr. C. D. Child adopts a new method for determining the velocity of ions in a gas which was suggested by Prof. J. J. Thomson in a recent number of the *Philosophical Magazine*. A test was made by applying this method to the determination of the velocity of ions produced by a flame. The author points out that no attempt has been made to secure great accuracy, since the quantity to be measured — *i.e.*, the velocity of the ions — is one depending on a great variety of conditions, and because this work is rather the test of a method than anything else. The accuracy of the result given, however, will compare quite favourably with those hitherto secured in attempting to measure such velocities. There was considerable objection to determining the potential with a wire, and accordingly a water dropper was used in the test carried out by the author. In the first place, application of the method suggested by Prof. Thomson showed that the velocity of the positive ions drawn from a Bunsen burner is approximately 2·2cm. per second for potential gradient of one volt per centimetre, and that for negative ions 2·6cm. In the case of an unlimited supply of ions, if the discharge takes place between two regular surfaces, the velocity may be determined by simply measuring the current per unit area and the difference of potential between these surfaces; and if the surfaces be not at all regular, the relative velocities of the positive and negative ions may be determined by comparing the positive and negative currents.

West London Tramways.—No decision has as yet been arrived at either way as to the running of the electric cars on the West London tramways. The Kew Observatory authorities are still anxious as to the effect which any stray electric currents may have on their recording instruments, and on Friday last the ordinary horse-car traffic on the system was entirely suspended for an hour or two in order to allow of tests with the new electrically-driven cars being made. Some 30 cars were in operation, and at the same time a gentleman was watching the measuring instruments in the generating station at Chiswick in the interest of the Kew Observatory authorities. The particulars thus obtained were for comparison with the readings of the magnetometers at Kew in order to ascertain what effects, if any, were produced by the running of the electrical cars, and whether the latter give rise to any disturbances in the records, in addition to those already noticed as a result of the Central London Railway or of other causes. If it be found that the instruments at Kew were injuriously affected by the running of the electric cars on this occasion, it is expected that an agreement will have to be come to between the authorities and the London United Tramways Company before a start can be made with the public electrical service. Mr. A. P. Trotter, of the Board of Trade, carried out the official inspection of the electrical equipment of the line on the same day, and having regard to the great delay which has already occurred in putting the electric cars on the road for public service, we trust that something definite may be done as soon as possible. In the case of no disturbances at the observatory being discovered, there can be no reason, subject to the sanction of the Board of Trade, for any further delay, but in the other event, of course, arrangements must be made for setting up the observatory instruments in some more suitable locality than Kew.

Bradford's Precautions.—Mr. C. J. Spencer, the tramways manager, and Mr. R. A. Chattock, the electrical engineer to the Corporation of Bradford, have drawn up a list of regulations for the guidance of the police in the event of falling overhead wires making earth contacts on the city tramways. A strict obedience to these regulations should to a large extent reduce to a minimum the risks attending the falling of electric wires. In the first place, it is pointed out that all traffic should at once be stopped. The nearest tramcar driver must then be informed of the occurrence, and he will immediately take steps to cut off the current. Failing this notice, communication with the nearest tramway depôt by telephone or other means should be made, but the drivers of the trams must not be called on to interfere with the wires, except for the purpose of saving life or preventing persons from being injured. Of course, if a fallen wire should encircle any person, it must be immediately removed, and with this in view the following advice is given: (*a*) never touch it with your hands; (*b*) never touch the skin of the person in contact with it; (*c*) use a dry rope, dry stick, or any article of dry clothing to drag the wire away with, or to drag the person away from the wire; (*d*) use indiarubber gloves for pulling the person away from the wire, it being safest not even to touch the wire with them; (*e*) in case it is impossible to get the wire away from the person, the wire should be dragged to the nearest tramway rail and held down upon it in order to discharge the current, or the wire should be cut by means of insulated shears, which can be procured from the cars. Gloves should be worn when these are used. Gloves and insulated shears, referred to above, are provided on each car and also at each tramway depôt, police, and fire station. In conclusion, the regulations point out that animation can often be restored to persons suffering from electric shock by using the methods adapted to resuscitation from drowning.

The Barmen-Vohwinkel Suspended Railway.—The first section of the new suspended railway between Elberfeld, Barmen, and Vohwinkel, officially opened by the German Emperor in October last, was thrown open to the public last week. It will be remembered that we fully described and illustrated this railway in our issues of Dec. 14 and 21 last. Great interest in the event was manifested by the people of Elberfeld and the other inhabitants of the Wupper Valley, although directors of the concern had the foresight to keep the fact and date of opening a secret so as to avoid too great a crush. Final trial runs were made early on the morning of the opening day, and as these came off without the slightest

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hitch, the barriers leading to the stations and waiting-rooms were thrown open shortly after 8 a.m., and the unique railway was opened without special ceremony. The cars were immediately besieged by passengers, and all space, even standing room, was crowded by people anxious to experience the novel sensation of travelling on a monorailway with the car suspended in mid-air. The runs were made without any hitch whatever, the cars travelling quietly and without shock or jarring, as in the preliminary trials. They take the sharpest curve without any appreciable tendency to turn out or to rock, and enter the stations with perfect smoothness and regularity. The entrance and exit of passengers at the stations is effected without loss of time. By pressing a stud the doors may be locked automatically by the guard. Tickets are supplied by automatic machines (10 pf. for first class, two tickets), and are punched by the guards travelling with the cars. At the termini the cars are transferred over loop lines to the return rail in a few minutes. It can already be safely asserted that the question of dealing with the traffic in this district, which had become more and more acute during the last few years, has been most satisfactorily solved by the ingenious scheme carried out by the contractors, the well-known Schuckert Company.

Electrolytic Process of Producing Phosphorus. Dr. F. J. Machalske, having carried out some extensive experiments on the production of phosphorus by electrolytic means at his laboratory in New York City, is stated to have obtained such satisfactory results that a company, known as the Anglo-American Chemical Company, has been formed to produce yellow and red phosphorus on a commercial scale by the process developed from these experiments. The *Electrical World* for the current month gives some valuable details of the system from the inventor himself. In the first place, the raw material consists of the ordinary phosphate rock used generally as a fertiliser. At present two electrical furnaces are installed, each furnace having a chamber 12in. by 18in. in area, with a carbon bottom and sides lined with calcined magnesia, the cover being composed of fireclay and red brick. Further, each furnace has an aperture on top for feeding the phosphate rock, and an aperture for inserting an electrode 8ft. long and 4in. in diameter. The inventor claims that five minutes after current is turned on a temperature of 7,000deg. F. is produced, which will reduce in 15 minutes 150lb. of phosphate rock. The phosphorus vapours thus set free are condensed under water, and the residual slag allowed to run off, the operation being a continuous one. Current for driving the plant is furnished from the circuits of the New York and Queen's Electric and Power Company. It is asserted that yellow phosphorus may be produced by this method at a rate of 3½d. per pound, the cost of electric power being 1½d. per horse-power hour. Dr. Machalske claims to have separated by means of the electric furnaces a new metallic compound which has the appearance of silver, and is not affected by sulphuric or hydrochloric acid, though slightly attackable by concentrated nitric acid. The metal has a specific gravity of 10·02, and is a good conductor of electricity at common temperatures, but a non-conductor at temperatures at 100deg. and above. He also claims that in the course of his experiments he found that by means of an electrical furnace connected with a properly-constructed condensing apparatus chlorides of carbon, and especially carbon tetrachloride, may be produced by treating in an electric furnace a mixture of common salt, carbon, and sand.

Possible Uses for the Manometric Telephone.—Mr. Louis W. Austin, in the *Physical Review* for February, considers a convenient method of showing visually the complex motions of the diaphragm of a telephone receiver. He refers to the great sensibility of the manometric flame to small changes of gas pressure, and this, he points out, suggested the possibility of its use in making visible the sound-waves produced in the telephone. Accordingly, a telephone receiver was connected to an ordinary manometric capsule by means of a rubber tube passing through a cork cemented into the opening in the telephone cap. The telephone having been connected in a shunt from the alternating circuit, about ·01 ampere was sent through it, which caused the flame to dance excitedly. On examination in the revolving mirror, however, the image little resembled the known form of current wave, and the real cause of the inaccuracies was not at first apparent. In a new arrangement, however, the connecting tube was done away with, a jet being inserted directly through the rubber cork in the telephone cap, and another hole drilled in the cap through which the gas was introduced, thus making a manometric capsule of the telephone itself. This turned out to be a great improvement on the former arrangement, which proved that at least a large part of the difficulty lay in the friction and elasticity of the connecting tube. Again, on the gas opening in the cap being constricted to about the size of the opening in the jet, the lower edge of the luminous part of the flame, as seen in the revolving mirror, assumed nearly the sine form. Thus the sensibility of the apparatus was increased in a marked degree. The apparatus in its final form has been tried with a number of different alternators, and the curves from all of these showed their known peculiarities of form, although a certain distortion seemed to be present, due probably in part to the flame itself and its tendency to flare. From the above observations the author draws several suggestions as to the possible lines of usefulness for the manometric telephone. In the first place, it may be used to show in the lecture room the motions of the telephone diaphragm and illustrate the undulations of an alternating current. Again, it may be so developed as to offer a practical and convenient method of tracing alternating-current curves, while in connection with a second manometric flame, actuated by a tuning-fork of known period, it becomes a frequency teller. Two other possible applications of the manometric telephone suggested by Mr. Austin are in studying the distortions in sounds produced by telephone transmission, and in comparing small alternating E.M.F.'s.

Glasgow and its Telegraphic Communication. The chief topic of interest before the meeting of the Glasgow Chamber of Commerce last week was a communication from the Postmaster-General in regard to the interruption of the telegraph service between London and Glasgow, due to storms. This was in reply to a memorial of the directors of the chamber calling attention to the matter, and urging the extension of the underground system of wires. The Postmaster-General was unable to agree that "on the Continent, and especially in Germany, interruptions are now, through the adoption of the underground system of telegraphy, unknown." He pointed out that the international service was frequently interrupted by storms abroad. In fact, whereas the proportion of underground wire to the total of mileage of wire was in Germany 9·8 per cent., it was in this country 14·8 per cent. In the case of Glasgow, in the last 10 years the number of times it had been necessary to issue a notice of delay in the telegraphic service to Scotland had averaged only five a year, the average duration of delay being only 1 hour 24 minutes. Lord Londonderry referred to the London-Birmingham underground line, and

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expressed the hope that within a very short time this line would be extended further northwards. He also anticipated that another section from Preston northwards would be commenced during the next financial year, which would especially add to the stability of the Scottish service. On the question of the respective percentage of underground wires in Germany and in this country, a letter was read from Mr. Paul Rottenburg. He had it, he asserted, on the best authority that "an entire collapse of the telegraph connections, such as is often experienced with overhead wires during severe weather, is entirely excluded in Germany," and expressed the opinion that the Postmaster-General must be under some grave misapprehension as to his figures. It was urged that the underground system should be adopted with the least possible loss of time. A report is now being prepared by the committee which formerly had the subject under consideration. The Postmaster-General has also replied to the memorial of the Bristol Incorporated Chamber of Commerce and Shipping, in which he again held out strong hopes of the London-Birmingham underground line being extended. This experimental section, he mentioned, was due to the introduction of the paper-insulated cable, which was so much better suited to the purpose, both from an electrical and a commercial point of view, than the guttapercha-covered wires. He is not without hope "that some of the difficulties and drawbacks still connected with an underground system will be surmounted, and that the Department will be justified in extending it. But it is necessary to proceed with caution."

The Behr Express.—The particulars given in the paper on the monorail high-speed railway between Liverpool and Manchester by Mr. F. B Behr at the meeting of the Society of Arts on Wednesday week, are not new, inasmuch as the whole details of the scheme were well thrashed out before a committee of the House of Commons last year. Owing to various reasons, the Bill, which was then under consideration, did not get through, but the company are returning to the struggle this year with certain alterations in their plans and equipment, which it is hoped will enable the Bill to be passed by the new committee before whom it will come. The description of the line given before the Society of Arts will be interesting reading to those who are unacquainted with the proposal of the company for the maintenance of a quick and frequent service of trains between the two large towns mentioned. The undertaking will require a capital of nearly three millions, and it is estimated that with 3,500 passengers per day it will be able to pay 5 per cent. on its capital. Dealing with the question of brakes, over which considerable comment arose before the committee, Mr. Behr explained that, besides the Westinghouse brake, the company proposed to have emergency electric brakes. These, it is suggested, will consist of electromagnets energised by the motors on the trains used as dynamos. These electromagnets will act on the guide rails, of which there are four. The magnets are said to be 18in. long, each capable of exerting a pull of 200lb. per square inch. The description, however, of this electric brake in the paper is not sufficient to meet with the usual requirements of a Patent Office specification, in that the brakes could not be constructed from the description given. It was explained by the author, however, that these emergency brakes will practically never be required, in consequence of the long length of line between the various signalling stations. This length will, of course, vary with the number of trains it is proposed to run, but with a six-minute service the sections would be four miles long, and the Westinghouse brakes will be able to stop the train when travelling at 110 miles per hour in 37 seconds, during which time it will have made just under 1,000 yards. This seems to give an ample margin. The discussion which followed was opened by Sir W. H. Preece, who was in the chair. He alluded to the energy of the author in carrying out his scheme. He thought there was no difficulty over the braking of the train, and that the emergency brake proposed was really not so essential as it was on an ordinary line. Another speaker referred to the advantage of the monorail system, in that it kept the centre of gravity below the point of the support of the carriages. The discussion concluded with a vote of thanks to the author.

Electric Railway Patents. — Some important decisions were recently given by the Circuit Court of Appeals in New York on three patents relating to electric railways. All three were declared invalid. The first dealt with was the Knight patent, issued in May 20, 1890, which relates to electric railway controllers having a reverser and regulator manipulated by separate handles, in combination with a stop or lock so constructed and arranged as to leave both the reverser and the regulator free to be operated independently of each other. The question the Court had to decide in this case was whether Knight invented the locking arrangement whereby one device locks the other. From a report of the judgment in the *Electrical World*, we gather that the view taken by the tribunal was that, although the patent was in no sense a pioneer one, it did add a new or locking feature to preceding devices in which the regulator and reverser were operated by different methods. The Court, however, considered that while this locking device was undoubtedly an improvement, it was not an invention of such novelty and importance in motor apparatus as to make a distinct step in the progress of the art as contrasted with mere improvement or perfection of what had gone before. The other questions before the Court were as to the validity of two Thomson patents issued on Aug. 14, 1883, and April 9, 1889, respectively. The first of these covered the magnetic blow-out principle as applied to street railway controllers. The second patent related to the application of a shield of insulating material between the opposed surfaces of the arc-rupturing device and the electrodes between which the arc to be ruptured is formed, thereby preventing an arc from forming at any other portion of the electrodes than is directly subjected to the arc-rupturing force, and permitting a conducting material to be applied, without danger of defect of action, very closely to the electrodes. With regard to the first, the Court referred to the early experiments of Davy and others, stating that the old scientists demonstrated that the magnetic field pulls the arc away from the electrodes and extingnishes it. The theory of the divisibility of the Davy discovery of the effect of a magnetic field upon a voltaic arc which burns, from the alleged discovery of Thomson of the effect of the magnetic field upon the ends of the conductor between which the arc is burning, was held not to be strong enough to bear the weight that the experts placed upon it. The Court concluded that if the patent was to be sustained, it would rather rest in its support upon the declaration that Thomson applied the law which the scientists observed in laboratory experiments upon magnets and electric wires to a switch of commercial use and efficiency, and made the experiments of practical utility. As to the second patent, the Court could not conceive that the effect of the insulation in an arc-rupturing device was anything more than the old effect which had always accompanied insulation, and which was accomplished by the old mechanical means, although it was used to prevent lateral discharges in connection with an arc-rupturing device. This, then, was also declared invalid.

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THE TRAFFORD PARK POWER WORKS.

(Continued from page 371.)

The exhaust steam from the engines is condensed in injector condensers of the Ledward type, which are shown in Fig. 7. The circulating water is obtained from the Bridgwater Canal. This water is drawn up by means of

MR. H. ALCOCK, CHIEF ELECTRICAL ENGINEER OF THE TRAFFORD POWER AND LIGHT SUPPLY COMPANY.

centrifugal pumps, which are placed on a separate foundation below the floor line. The pumps are driven by means of Royce motors, and under ordinary conditions they can each supply 430 gallons per minute when working against a 25ft. head. The maximum output, however, can be carried up to 670 gallons. These pumps, the feed pumps, and the station lighting are all supplied from a separate station board, which is placed at the spot marked "balancers" in Fig. 2. The balancers are placed under the switchboard platform, and can be seen in Fig. 12. The whole of the station circuits are supplied at 250 volts, and are each equipped with a throw-over switch, so that they can be thrown on to either side of the three-wire system. This affords an additional means of balancing the system, and in consequence the size of the balancing machines has been able to be kept down. Two balancing sets have been supplied by the Electric Construction Company, of Wolverhampton, and they are each able to transfer 50 amperes from one side of the system to the other.

SWITCHBOARD.

The main switchboard, of which we give a good number of illustrations, is one of the best low-tension boards we have ever seen. It was manufactured for the company by Messrs. Cowans, Limited, of Salford, to meet the special requirements of Messrs. Lacey, Clirehugh, and Millar's specification. The front and side views of the board are shown respectively in Figs. 13 and 14. In Fig. 15 is given a front elevation of the board, with the details of the instrument filled in in the case of two of the panels only. Cross-sections of the board are shown in Figs. 16 and 17. The great object in the design of the arrangement has been to keep down the over-all dimensions in spite of the large current-carrying capacity which the various parts are required to have. Thus all the main parts of the board are designed to carry safely 1,500 amperes, and in spite of this the width of the panels is only 8½in. The framework used consists entirely of wrought and cast iron, while the back panels carrying the switch gear are of heavy slate. The side panels, which form an insulating mechanical division between the adjacent circuits, are also of slate. As will be seen in Fig. 17, the field regulating resistances are placed on a table in front of the switchboard, while the field resistances come under the same, and can be easily got at by removing the front panels of this table. The substantial plug bars which run along the top of the switch gear and underneath the measuring instruments, are made with exceedingly good contacts. Up to the present there has been no need to run at two different voltages in the station for different parts of the district, but the two plug bars will enable this to be done should the need arise in the future. In the meanwhile the arrangements are exceedingly convenient in the event of a trial being made on one machine, while the other large steam generator is supplying load through the other set of plug bars. In the fuses used in this board there is a novel construction of splitting up the fuse into a number of parallel parts separated the one from the other by means of slate divisions. For this purpose a slate grid is provided, as can be seen in Fig. 15; the fuse is then made up of a number of wires, which are soldered on to the copper end connections of the fuse. Each of these wires, when the fuse is inserted in place, comes in one of the ¼in. gaps of the slate grid. In this way the arc will be divided up, and the cooling effect of the slate is expected to

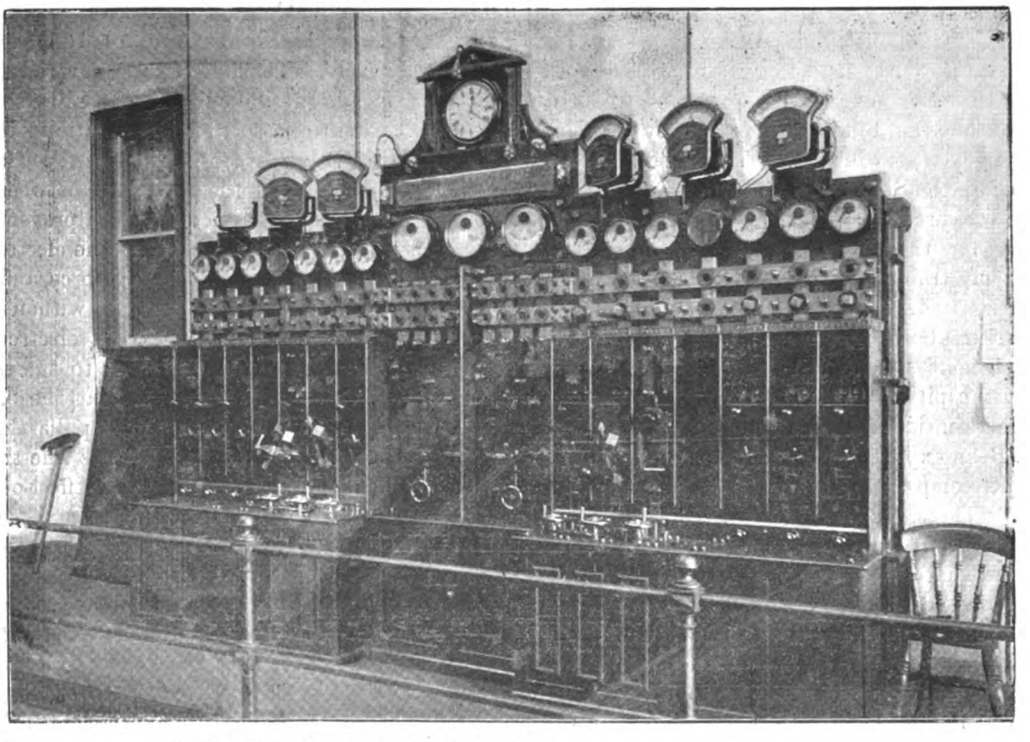

FIG. 13.—View of the Switchboard, taken from the top of the second dynamo.

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materially reduce the ordinarily destructive defect caused by a 500-volt arc with a heavy current. The voltmeters used are of the Weston type, with illuminated dials, which can be read from the engine-room floor level.

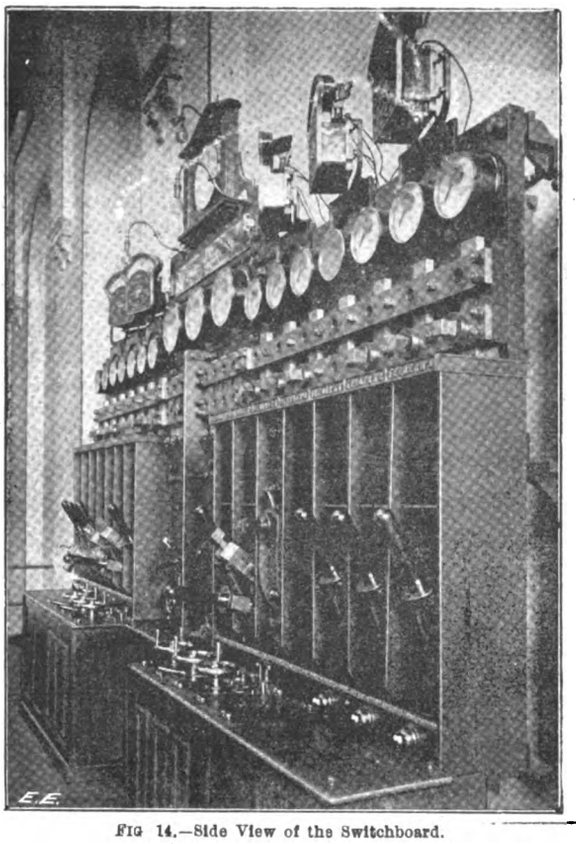
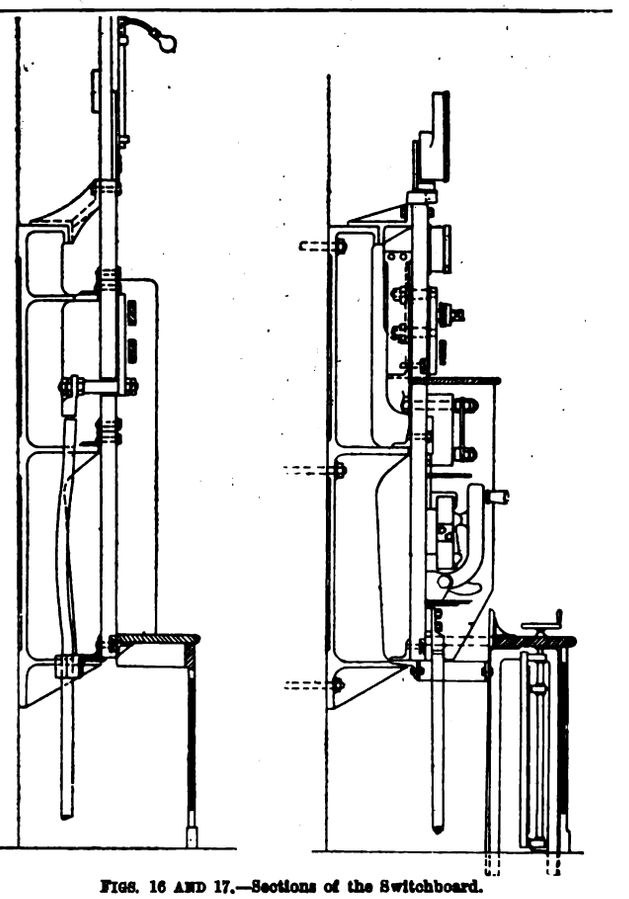


FIG 14.—Side View of the Switchboard.

The ammeters were supplied by Messrs. Nalder Bros. and Thompson, and are of their latest type. Another special feature of the board is the use of the Andrews return-current cut-outs, one of which is placed in one pole of each of the large dynamos. These are interlocked with the field-breaking switch, and as they operate immediately a reverse current passes through them, they avoid the objection to all zero cut-outs—viz., the liability to hold in when there is a very sudden reversal of current. Pilot wires are brought back from the various feeding points, so that the switchboard attendant knows exactly what voltage the consumers are receiving.



FIGS. 16 AND 17.—Sections of the Switchboard.

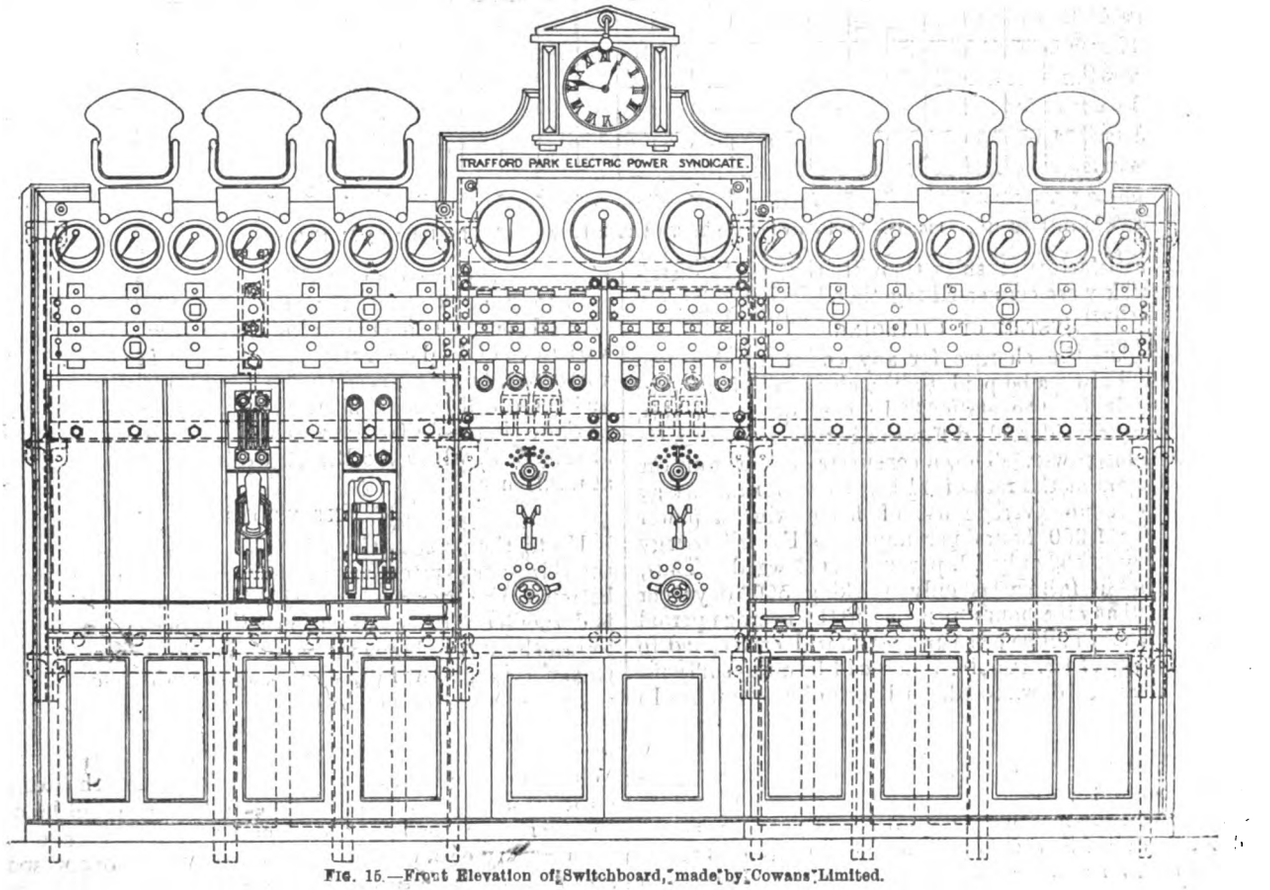


FIG. 15.—Front Elevation of Switchboard, made by Cowans Limited.

DISTRIBUTING SYSTEM

There are at present three distinct feeders laid down by the company for supplying their various consumers. The first of these goes to the main gates of the park, the next

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is laid into the works of Messrs. W. T. Glover and Co., while the third is laid to the workmen's cottages which have been erected by the Trafford Park Dwellings, Limited. These feeders, and also the distributors, were all supplied and laid by Messrs. W. T. Glover and Co. The feeders consist of three separate single cables insulated with diatrine paper and then lead covered. A serving of jute is put on over the lead. The section of the copper is half a square inch in the outside conductors, and one-eighth of a square inch in the zero wires. The whole of the feeders are drawn into 2½in. Doulton conduits, a separate duct being provided for each conductor. The conduits are in each case provided with three ways, and they are laid in a vertical plane in order to economise space. On the extensions which are now being put in hand some Howard bitumen conduits are being used. All the joints are being made in cast-iron split joint-boxes placed in brick pits, which are accessible through manhole frames and covers. The joints are made with copper sleeves, which fit tightly over the conductors, and which, when in place, are sweated up solid. These joint-boxes are then filled with diatrine compound. We understand that it is intended to work the distributing system on independent sections, which will

are all provided with electric light, the charge being included in the rent. Thus, in a seven-roomed house, one light is put in each room, and can be burnt at the will of the occupier for an addition of 9d. per week to his rent. For a four-roomed house the charge is 6d. per week for the four lights. The supply from the company is taken by meter by the Trafford Park Dwellings, Limited, two meters being provided for each large block of dwellings. As between 2,000 and 3,000 houses are being erected by the company, it will be seen that a very considerable power will be required for lighting them. As mentioned in our last article, with respect to the supply of power it is pleasing to note that the consumers have not complained of their bills for electrical energy. This shows that the basis of charges must be correct, and the engineers of the company assure us that the load on the supply station will soon show a profit at these low rates. It would seem thus that the company in attacking the problem boldly will be able to show that it is advantageous to a manufacturer, even though a large one, to take his supply of energy from a distributing centre. We need hardly say that in starting such an undertaking the most unfavourable conditions for supply occur at first before a great variety

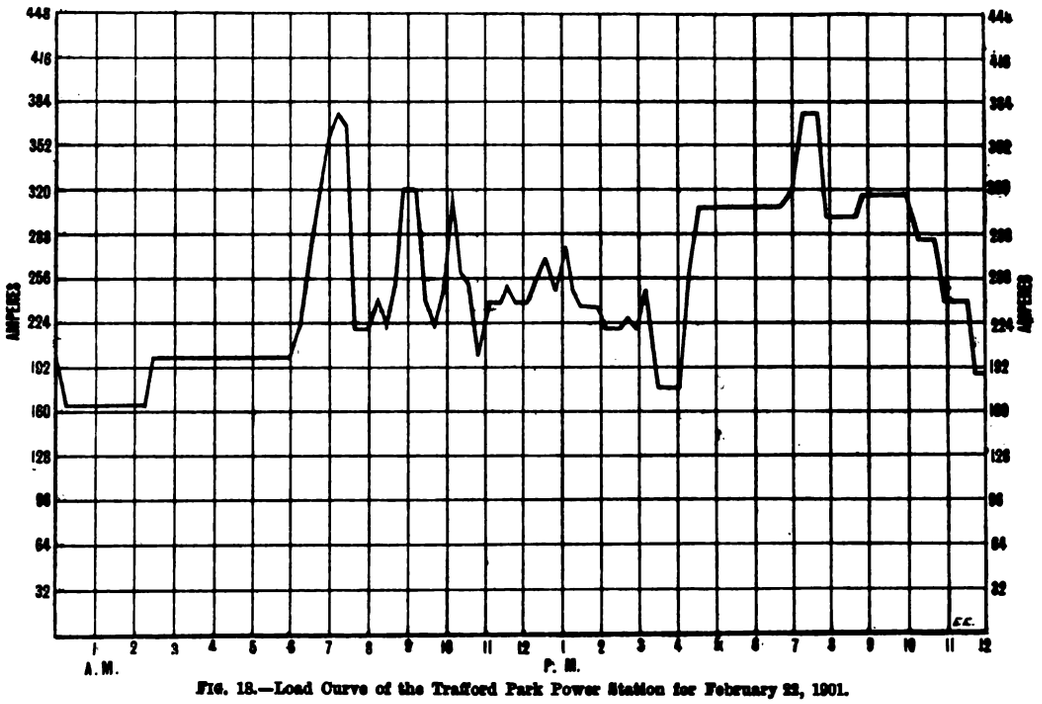

FIG. 18.—Load Curve of the Trafford Park Power Station for February 22, 1901.

give more satisfactory results than if the whole distributing network were connected together.

System of Charging.

In making-up the charges for any consumer, due consideration will always be paid to the character of the load he will provide for the station. In consequence of this, there is a very considerable difference between the cost for lighting and for power. Thus a consumer of power on the estate is charged at the rate of 1½d. per unit for all energy supplied up to an average use of his maximum power demanded for 1,200 hours per annum. For all energy supplied above this, only ½d. per unit is charged. Thus, assuming that a factory is only working 300 days per annum, and that nine hours per day is the average period over which the machinery is running, it will correspond to 2,700 hours' use of the supply, which will be quite sufficient to bring the charge down to 1d. per Board of Trade unit. In this no allowance is made for overtime or for night shift work, from which it will be readily seen that in an ordinary engineering factory the charge per unit will come out considerably below 1d. For lighting purposes the charge is again made on the maximum demand principle at the rate of 4d. per unit for the first 400 hours per annum, and 1½d. per unit for all above this quantity. The supply for lighting is at present given by means of overhead wires for all the main routes on the estate. Another large consumer for lighting is the Trafford Park Dwellings, Limited. The large number of workmen's houses erected by this company

of consumers are connected. The load curve which we give in Fig. 18 shows that the all-night load is already a good one. The curve also shows how sudden are the variations of load on a station supplying factories. These variations, however, occur at well-known periods as a rule, and there will be no difficulty in preparing to meet them at these times—in fact, the curves may be said to show the alacrity with which the British working-man drops his tools at mealtimes.

Extensions.

Up to the present the whole of the supply is given on the three-wire system with direct currents, with 500 volts between the outer conductors. When, however, the current is demanded farther away from the station, it is proposed to use the three-phase system. It is also expected by the engineers that in future gas-engines direct-coupled to dynamos will be employed instead of steam-engines. Tenders have now been received by the company for gas-engines of the large size which would be required. With these engines it is proposed to so arrange the exhaust outlets that the heat in the gases discharged will be used to generate steam for gas-producers. This will result in the recovery of a considerable quantity of heat which is now allowed to go to waste in all gas-engines.

In conclusion, we have to thank the engineers of the company (Messrs. Lacey, Clirehugh, and Sillar) and Mr. L. B. Atkinson for their kindness in placing the information and drawings at our disposal. We gather from the

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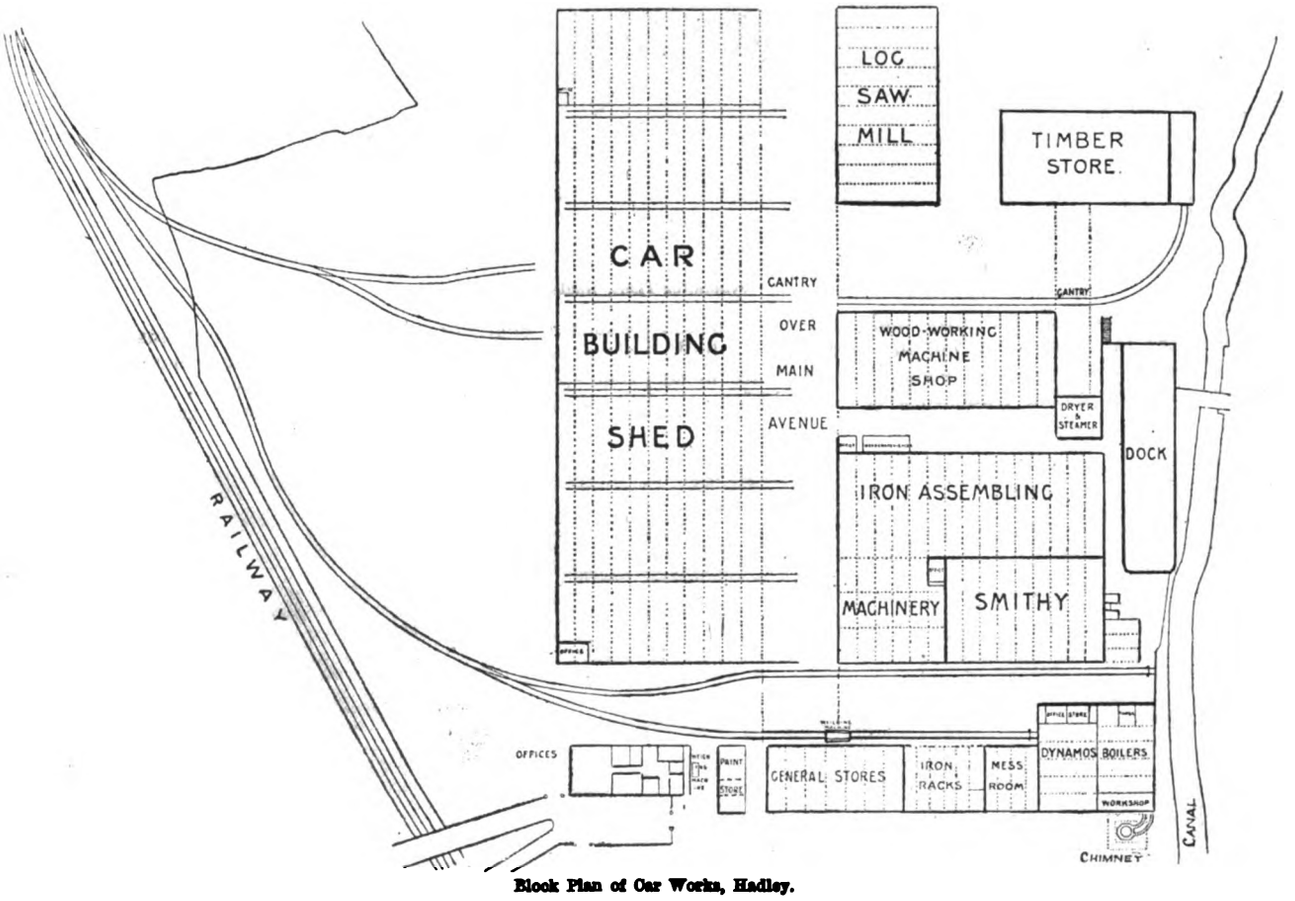
last-named gentleman that from his original calculations, on which Messrs. W. T. Glover and Co. took up the organisation of the undertaking, there is every probability of the cost to consumers coming down even below the present low scales.

TRAMCAR CONSTRUCTION.

Messrs. G. F. Milnes and Co., Limited, who have just issued in book form a comprehensive description of the work carried out by them, may be regarded as the pioneers in the industry of tramcar construction. The issue in question is beautifully illustrated and of a most interesting character. Tracing the history of this industry from its introduction into this country from America some 40 years ago, the descriptive matter deals with every branch of the work done at the main works of the firm at Hadley, Salop. The accompanying plan shows that these works, which have only recently been erected, are completed on the most approved style. The easy accessibility both by rail and waterway is an undeniable advantage. On the one side, there is the Shropshire Union Canal, by which the timber or other material required by the company is conveyed direct from seaports to the dock facing the chief centre of operations; on the other side, a railway which enters the works and is connected with the trunk line of the London and North-Western Railway Company at Hadley Junction. Another impression one readily receives from the plan is the excellent situation of the various workshops and stores with a view to facilitate production by saving time and labour. All the workshops and stores are so arranged that each immediately commands the next in the order of requisition, so that from the moment the raw material out of which the car is evolved is begun to be operated on, till the moment when the vehicle emerges from the company's shed a finished and handsome structure, the work proceeds step by step with extreme regularity and precision. A broad avenue bisects the works almost in the centre, it is a spacious roadway running from the general stores at the one end practically to the log sawmill at the other, and having the car-building shed and the principal workshops on either side. It is furnished with a large gantry crane, worked by electricity, which traverses the entire length of the avenue commanding the entrances to, and the exits from, all the different departments. As before stated, the timber is brought direct into the works by water, and as the logs are required they are conveyed to the sawmills, which department is equipped in a most complete manner. The sawn timber is afterwards taken by trucks to the electric crane in the main avenue, which in turn deposits it in the timber yard. Finally, they are transferred to the stores to undergo the natural drying process. The wood remains here for at least two years. Turning to the wood-working machine shop, the first thing one is impressed by is the extensive nature of the machinery employed for shaping, sawing, mortising, planing, moulding, tenoning, and ornamental work. A particularly noticeable feature about the shop is the total absence of shafting and belting, whereby the risks to the company's employés in this department are considerably reduced. All the machines are worked from the basement. Each of the large ones is independent of the others, the electric current being switched on and off at will—a most important factor in economic production. All shavings and sawdust falling from the machines are carried to a large main beneath the shop, and thence are deposited at the feet of the firemen for consumption in the furnaces. As the woodwork leaves the machine shop it is transferred to the cabinet room, where it undergoes almost its final treatment.



Block Plan of Car Works, Hadley.

Some interesting information is given about the smithy. This is provided with single, double, and quadruple hearths and all the latest plant incidental to the nature of its requirements. At the present time there are at work four steam hammers of varying sizes, and two more are being laid down. The blast to each of the fires is created by means of a powerful fan. In point of rapidity of production the smithy ranks with all the other workshops on the firm's premises. Not less interesting is the shop where the ironwork for the car is made ready for the fitter. It is replete with machinery of the latest construction. Lathes, drills, and numerous other machines of the most approved types, as well as the latest devices for sharpening tools, etc., are everywhere noticeable. As the various sections of the metal portions of the car are here produced, they are immediately transferred to the next department to be

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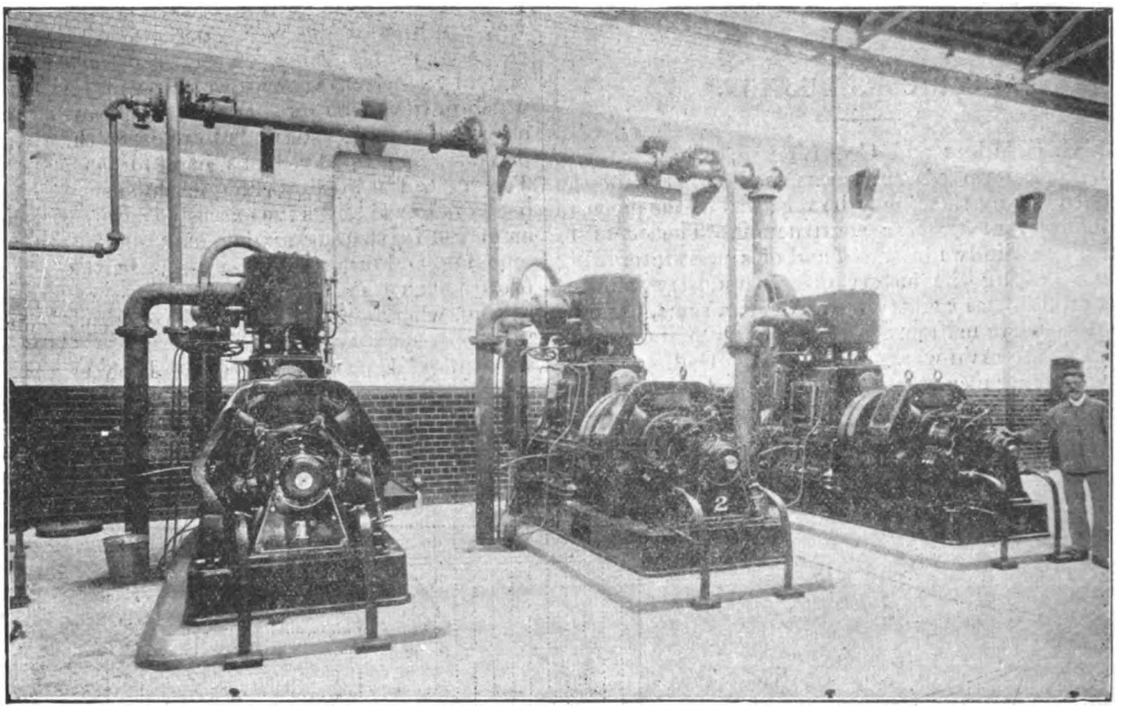
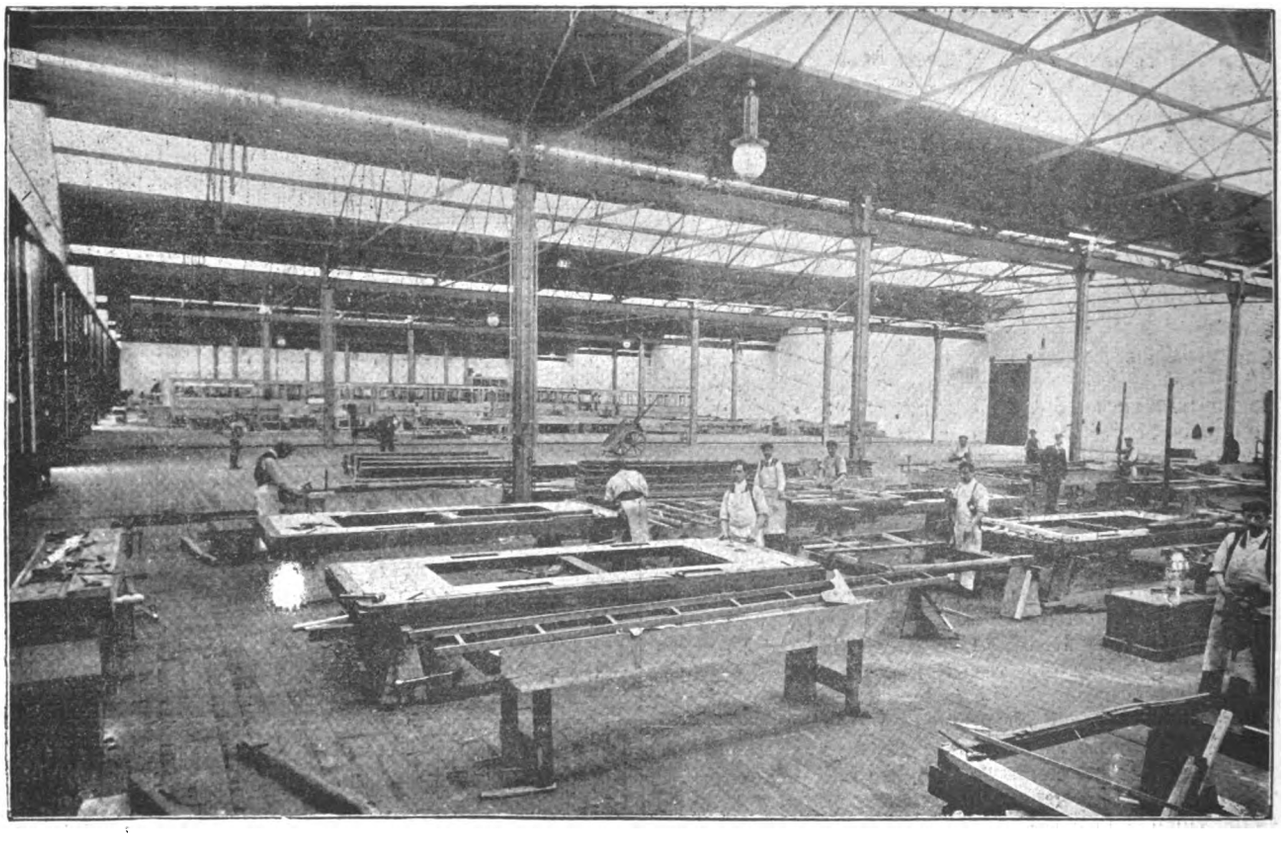
finished and fitted together as the underframe work of the car. Then comes the iron assembling room, which is so named from the fact that here are gathered together, the power is generated by which this complex system of machinery is set and kept continuously in motion is, perhaps, the most interesting part of the works to the



Generating Plant, Hadley.

finished and fitted, all the iron and steel and wooden sections of the car upon which the superstructure is built. All the parts or the sections being completed are fitted together, and the entire framework is dispatched to the electrical engineer. The boiler-house contains three Lancashire boilers, each 30ft. in length, and having an inside diameter of 8ft. As may be inferred, the boilers are designed for the consumption of wood cuttings, shavings,



Corner of Car-Building Shed, Hadley.

car-building shed, where the final processes of construction are carried out.

We may mention at this stage the Busch's lifting jacks employed in the works. They play an important part in the economy of all departments, used as they are for raising both light and heavy weights. The place where sawdust, and other refuse. They have a working pressure of 120lb. to the square inch.

The generating station is equipped with three six-pole continuous-current generators, as will be seen from the accompanying photograph. Each of these generates a current equal to 115 kw. at a voltage of 230. The speed

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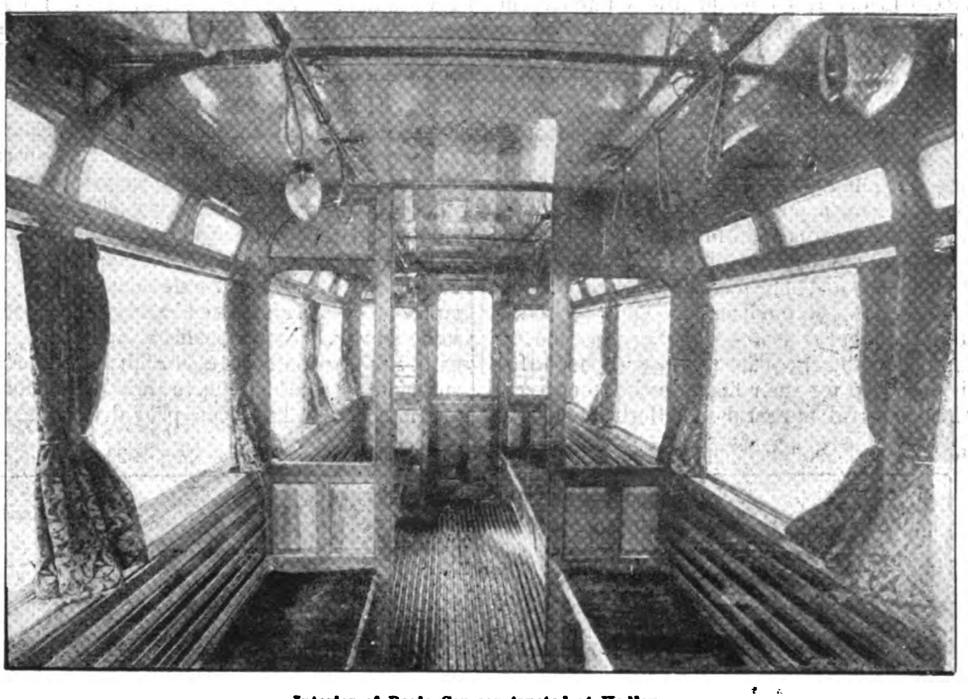
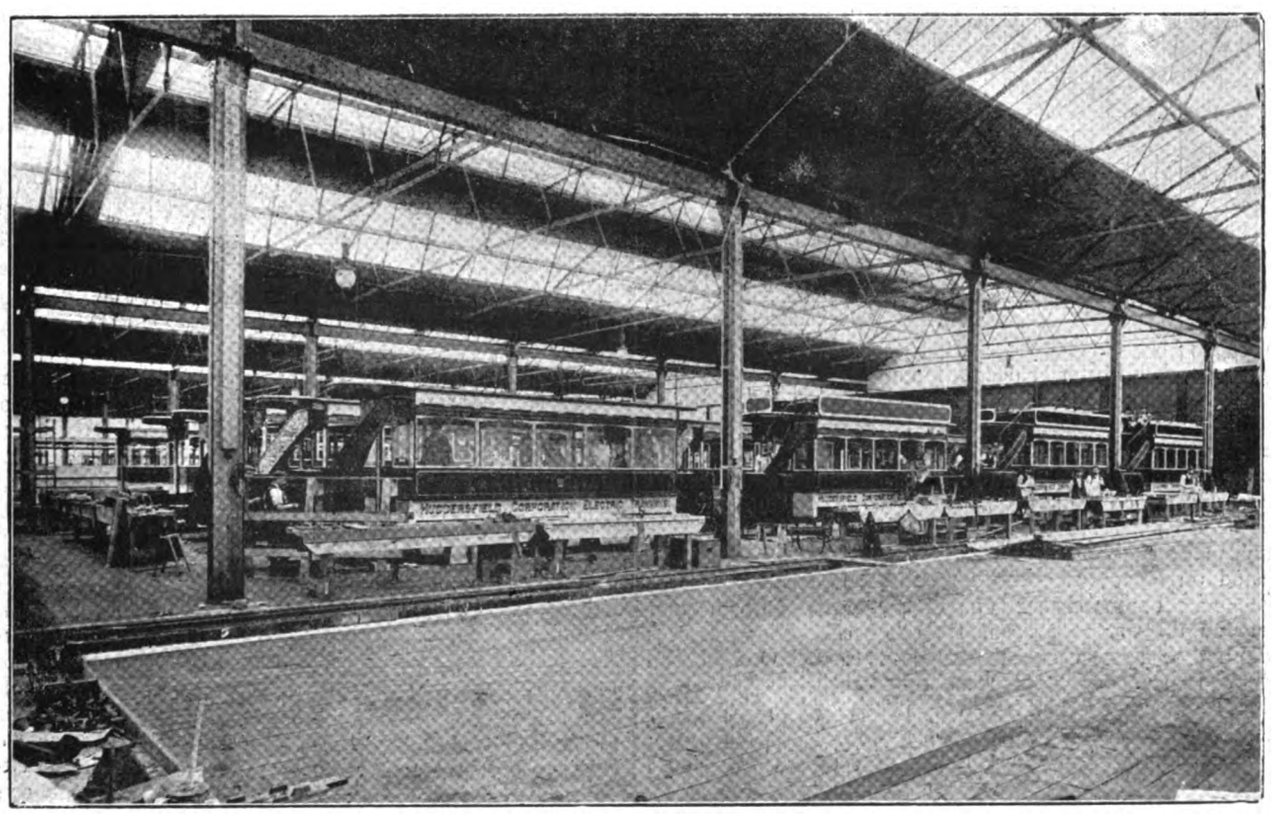
attained to produce this is, as nearly as possible, 400 revolutions per minute. The dynamos are connected direct with three of Browett and Lindley's vertical compound-condensing engines, and are very carefully insulated. The power plant consists altogether of 50 continuous motors of the latest type. They range from 2 h.p. to 60 h.p. each, and were supplied by the British Thomson-Houston Company, Limited. Each motor is supplied with a controlling panel fitted with a double-pole switch, fuse magnetic blow-out, and starting rheostat. On the switchboard there are in all four generating panels, each of which is provided with an automatic circuit breaker, main ammeter, positive and negative main switch, shunt field regulating rheostat, pilot lamp, and discharge resistance. On either side of these panels the feeder panels are fixed. These are supplied with 24 double-pole switches, each of which controls the feeder line of both the light and power plant, with all necessary accessories. The feeders are led to the main distributing boards fixed in each department. Here the boards are furnished with main and sub switches to regulate the different light and power circuits. It may be stated here that the lighting plant is fitted up in the latest style of distribution. There are in all throughout the works nearly 800 incandescent and 100 large arc lamps. The latter are arranged in series of four, controlled by double switches.



Interior of Bogie Car constructed at Hadley.



Car-Finishing Shed, Hadley.

A brief description of the methods adopted in the final stages of the building of a car is then given. The photograph we give of a corner of the car-building shed will indicate the magnitude of the building. When the framework of the body of the car is completed, it is taken here in sections to be fitted. The underframe, as it comes from the

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assembling-room, being first laid down—an operation which occupies only a short space of time—the upper skeleton of the car is fixed upon it ready to be panelled and framed. Whilst the latter process is being carried on outside, the finishers are inside bringing the interior into shape. Very soon afterwards the body of the car becomes almost an accomplished fact. It ought to be mentioned that there are pits in the shed in order to facilitate the fitting of the underneath gearing, such as the brake, etc. The fitters next apply themselves to the construction of the dash-plates, staircase ladders, and top railings. When these are finally adjusted, the car is handed over to the painter, glazier, and upholsterer.

Of course, the foregoing operations constitute only the substantial part of the work put into a car. There are a thousand and one other details that might be enumerated all requiring careful and skilful manipulation. Sufficient, however, has been said to demonstrate that as a modern industry car-building has become an art far beyond the conception of the average person.

The illustration showing the cars as they appear before leaving the finishing shed for their final destination gives a good idea of their general appearance. Both in external appearance and interior decoration and upholstery they are remarkable for their workmanship, elegance, and comfort. The firm claims that the best only of every kind of material required in their construction can find space in the workshops both at Hadley and Birkenhead, and this is a matter which obtains their first consideration. Every car before it leaves the works is subjected to the closest examination by some qualified and responsible person and tested on a tramway line specially constructed for the purpose. The particular type of car most in favour and demand up to the present time is that which is best adapted to the overhead haulage system. One of the latest improvements is that the ventilators are now placed on the sides of the car instead of on the top, thereby leaving for the passengers more headroom in the centre. The windows are fewer in number, but afford quite as bright a light as formerly, and each window is curtained with tapestry. A much better kind of staircase ladder is now constructed, being easier of ascent and descent than that of the old horse cars—an improvement which will be much appreciated. A special design of car is at present in course of construction by this company. Its chief features in the way of novelty are that its entrance and exit platforms are entirely enclosed, so that the driver is sheltered from inclement weather and the passengers derive the benefit whilst entering or leaving the car. As in the case of the Central London Railway, the entrance to the platforms is closed by means of collapsible gates. The cars, of course, are lighted by incandescent electric lamps. In the upholstery department a staff of both male and female employés is maintained. The workroom, as will be seen from the accompanying view, is perfectly equipped with all the appliances needed for furnishing the inside of the cars. Passing the paint-house, the iron stores call for some mention. Hundreds of tons of the metal are stored both in bars and in sheets in and about the building. An obvious advantage in the construction of the cars by the firm is that the whole of the ironwork required in the factory is manufactured on the premises. The general offices of the company speak well in favour of the business done. While, of course, in the first place the aims of the firm are principally directed towards the construction and equipment of the cars, the interests of their employés are by no means lost sight of. Not only do the workpeople perform their duties under the most salubrious conditions, but their more substantial comforts have not been forgotten. Ample accommodation has been provided for the men who wish to take their meals on the premises. There is a large mess-room, where they may be either provided with good substantial food at the lowest possible prices, or where, if they prefer to carry their own provisions with them, these can be reheated and eaten in comparative comfort. This is a privilege highly appreciated by the hands.

Workmen's Cottages, Hadley.

In the matter of local habitation for the employés, provision has to some extent already been made, and is continuing to be made, on model principles. One hundred and fifty cottages have been constructed or are in the course of construction, and the advisability of still adding to that number is under consideration. It is also in contemplation to erect a large concert hall, with billiard-room and library, and to arrange for courses of popular lectures. The firm are, moreover, bringing pressure to bear on the railway company to give cheap fares to the workmen to and from Wellington and the surrounding district, a concession which, it may be remarked, has already been granted in the matter of week-end tickets, by means of which places of interest at some distance may be visited.

Mersey Railway.—The report of the directors for the half-year ended Dec. 31 states that arrangements for working the railway by electricity are receiving the careful consideration of the Board.

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ELECTRIC RAILWAYS.

BY MAJOR P. CARDEW.

In the second Cantor lecture on the above subject, delivered on Monday last at the Society of Arts, Major Cardew commenced with the consideration of gearing. The advantage of gearing was that it allowed a motor to be run faster, and, in consequence, the weight of the motor could be reduced. Another point was that when the motor was built upon the axle, no spring was possible between the weight of the motor and the axle. In consequence of this, at every unevenness of the track the whole weight of the motor had to be suddenly displaced, which caused a great blow on the track, tending to make the inequality worse. By means of gearing the unspring-borne weight could be reduced. Major Cardew then showed a model of the Ganz Company's arrangement for a motor the whole weight of which was spring-borne. This motor, which was of the induction alternating type, had a hollow axle, through which the axle of the wheels passed. The space between the two was sufficient to allow for considerable vertical play without the axles coming into contact. In spite of this, the driving between the rotor and the motor on the wheels was positive in any position. The driving was effected by means of two connecting rods, one of which was always in tension, and the other always in compression. The next division of the subject was that of polyphase systems of traction, such as had been developed in Switzerland by Messrs. Brown and Boveri and by the Oerlikon Company, while Messrs. Ganz and Co. were now equipping a long length of railway line in Italy. Major Cardew proceeded to give a general explanation of the way in which polyphase currents were generated, showing that from an ordinary direct-current machine, by means of slip rings, multiphase currents could be taken. As regards the motors to be used on such polyphase systems, they could be divided into two classes, the first of which was practically a generator reversed. A machine of this class would only act as a motor at a speed which was absolutely in synchronism with the supply. In consequence of this, these motors were of no use for traction purposes. The other class were the asynchronous motors, which gave good starting torque, which could be regulated at will by the insertion of resistance in the rotor circuit. An advantage of this class of motor was that the three-phase currents received from the line were connected to the stator, and high voltages could be used, which was not possible with direct-current motors, in which the high voltage would have to be conveyed by brushes to the revolving armature. He stated that the efficiency of the two classes of motors, polyphase and direct current, was much about the same. He then explained how Messrs. Ganz and Co. have devised what is practically a series-parallel controller for such induction motors. The firm used two motors, the rotor of the first of which is connected up to the stator of the second. As the two axles are coupled together, the first motor and the second are bound to run at the same speed. Thus the speed to which the two motors when so connected tend, is half that of the first motor when used in the ordinary way on the line with a short-circuited rotor. When starting up, the acceleration is effected by means of resistance in the rotor of the second motor. When, then, the locomotive has got to nearly half speed, the second motor is cut out of circuit and the rest of the acceleration done by the first motor. Major Cardew pointed out that in the first condition of starting the whole of the energy taken from the line has to go through the first motor, and that half of this energy in that motor is converted into mechanical energy, whereas the other half is passed on as electrical energy to the second motor. He gave diagrams to show the acceleration which could be obtained in this way, and in one example a locomotive increased in speed up to 11·5 miles per hour in 11·5 seconds, which was an increase in acceleration of one mile per hour per second. When, however, the second motor was switched out the acceleration was slower, it taking 25½ seconds to increase the speed up to 23 miles per hour. The watts consumed in accelerating with the two motors up to half speed were 3,170, while in the other period 2,845 watts were taken to bring the speed up to the maximum. Another advantage of the system was that when it was wished to stop the train, the second motor was again switched in. In consequence of this, the speed of the two motors was over synchronism, and power was returned to the line. In bringing the speed of the train down to 11·5 miles per hour again, some 30 per cent. of the kinetic energy was returned to the line.

As regards the frequency, Messrs. Ganz and Co. found that this should be kept as low as possible, as the maximum torque varied inversely as the square of the frequency. They preferred a frequency of 15 complete cycles per second. With this frequency it was not easy to obtain a good lighting effect, as the pulsations of the light were most noticeable. The firm had overcome this to a certain extent by using incandescent lamps with three filaments, one for each of the three phases. He thought, however, that it would be well to make the lighting independent of the traction circuit, using, perhaps, a small motor-generator on each train. Another feature of the system was that they used compressed air control for all the switch gear, and a liquid resistance for the motor circuit in starting up. The resistance was altered by means of changing the level of a liquid in a tank by compressed air. As the liquid rose it came in contact with peculiarly shaped iron plates, which as the height of the liquid increases offer a greater surface for the current to pass. In this way an absolutely even acceleration could be obtained. With respect to the conductor, there were considerable objections to a third rail along railways in view of the trouble which such a rail caused to platelayers. Owing to the use of high voltages, the Ganz Company were able to revert to an overhead construction in consequence of the small current required. While such high-voltage conductors would not be allowed over public roads, he saw no reason why they should not be for railway lines, which were private property. Major Cardew then described a system of earthing the conductor in the event of fracture which had been adopted by Messrs. Ganz and Co. At each of the poles along the track a wire was connected higher up the pole than the trolley wire, and then on to the trolley wire at a short distance. In the ordinary way there was no weight on this wire, and a ring of earthed guard wire was placed round it. In the event of the trolley wire breaking, this subsidiary wire received the strain and short-circuited on to the earthed ring, which would blow the fuses. As regards the rails as a return, there would be a certain amount of difficulty in adhering to the seven-volt drop allowed by the Board of Trade, owing to the fact that the steel rails were not good conductors for alternating currents. It would either mean laying a good return feeder connected at frequent points of the railway system, or else an insulated return by the side of the main track. It must be remembered that seven volts was a very small percentage of a 3,000-volt working pressure, whereas it was a reasonable percentage when 5,000 volts was the working pressure. An illustration of the trolley used in the Ganz system, in which compressed air is employed for elevating the trolley or for removing it from the wire in case of accident, was then explained by the lecturer. In conclusion, Major Cardew considered that with polyphase working there would be no difficulty in working with a 12,000-volt pressure in the supply, which, with a current density of 600 amperes per square inch and a 5 per cent. drop in the line, would allow the generating stations to be placed 30 miles apart. He thought anything from 30 to 50 miles was a reasonable distance for these generating stations.

The lecture, which was continued until nearly half-past nine, owing to the clock being hidden by a lantern, was mostly devoted, as will be seen above, to a description of the Ganz system, which we suppose is the actual system proposed to be used by that company on the District Railway. We missed, however, that critical comparison between the polyphase system and the ordinary direct-current system of traction which we should have expected from an engineer like Major Cardew. This may be found in the lecture when printed in full, but was obviously lacking in the discourse delivered.

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A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.*

BY MICHAEL B. FIELD, A.M.I.C.E.

(Concluded from page 382.)

Neither Mershon, Crompton and Ashley, nor Heap, however, give any method for obtaining the average voltage at any desired group of feeding points, nor, with one exception referred to later on, is any method given in the above-mentioned patents applicable to case (*b*)—*i.e.*, when unequal currents exist in the go and return feeders, as in the case of three-wire systems and the like. This case, however, is just as important as the foregoing, owing to the extensive use now made of the three-wire system.

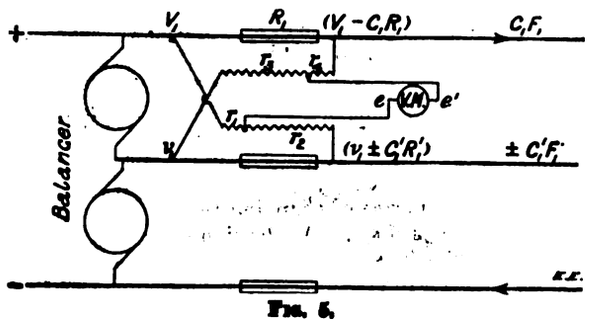


FIG. 5.

In such cases the voltage at the network between the neutral and each outer may be required to be known. The switchboard apparatus needed is very similar to that already described, the difference being that in this case series resistances must be inserted in each main, and the potential resistances are somewhat differently arranged. Fig. 5 shows the arrangement as applied to but one set of feeders. The voltmeter, V, will then be compensated for the combined drop both in the outer and neutral mains with which it is connected. If the average voltage between, say, the positive outer and the neutral at several feeding points be required, the arrangement of multiple-contact switch as in Fig. 2 may be employed. The principle involved in this case is somewhat different to that of case (*a*), and may be best understood by comparison with a Wheatstone's bridge. Fig. 6 may be considered as equivalent to Fig. 5

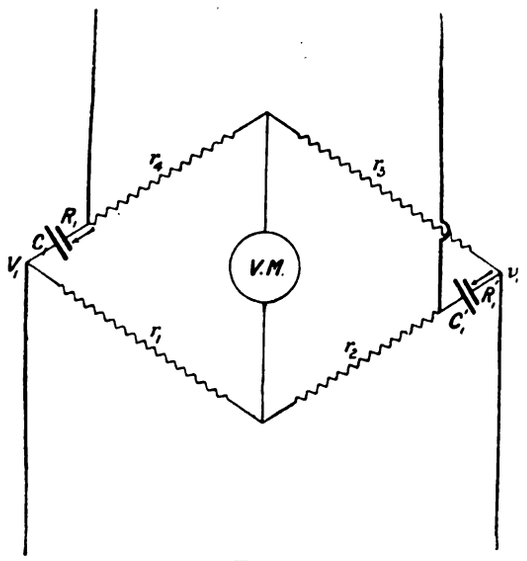


FIG. 6.

if we consider the potential differences called into play by the drop across R_1 and R'_1 as replaced by opposing E.M.F.'s. If, now, the ratio arms of the Wheatstone's bridge be slightly out of balance, it is clear that the current through the voltmeter will be proportional to the expression $\{V_1 - v_1 - (\alpha C_1 R_1 + \beta C'_1 R'_1)\}$, where α and β are numerics, the value of which may be adjusted as desired by merely altering the resistance of the ratio arms. If, therefore, they be adjusted so that αR_1 equals the resistance of the outer, and $\beta R'_1$ the resistance of the neutral, it is clear the voltmeter indications will be proportional to the voltage obtaining at the far end between outer and neutral. With the device just described it is of utmost importance to select as sensitive a voltmeter as possible in order to minimise the losses which take place in the shunt resistances. In the latter portion of this communication this is shown to be the case, the following result being arrived at analytically: If the method be applied to a three-wire system with 400 volts between outers, and if the series resistances in the outer and neutral mains are as large as is at all practicable to make them—

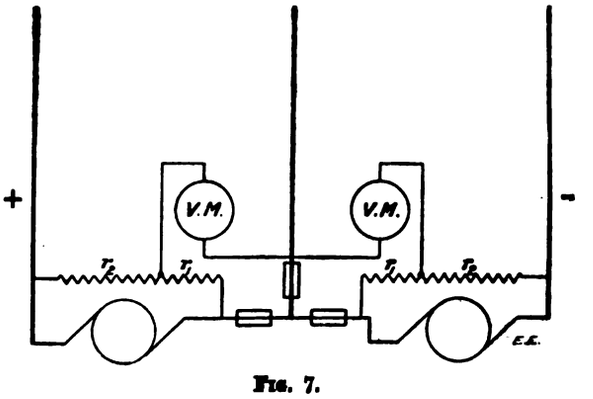
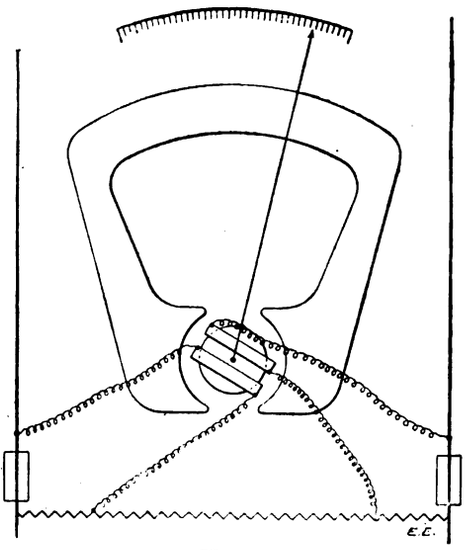


FIG. 7.

e.g., the drop of volts along $R_1 = 0{\cdot}2$ volt and along $R'_1 = 0{\cdot}4$ volt with an average full load—(the drop along the resistance R'_1 may be taken higher than along R_1, since the current in the former case is much less than in the latter, so that a larger drop does not necessarily imply a large loss of power), and if the voltmeter required $\frac{1}{100}$th ampere to give the full scale deflection, then the resistance of $(r_1 + r_2)$ and $(r_3 + r_4)$ could not well be more than 890 ohms. This would involve in them alone a continuous loss of nearly 90 watts. Instruments of the dead-beat suspended-coil D'Arsonval type made up in switchboard form, with a needle swinging in a horizontal plane as in a Kelvin low-tension electrostatic voltmeter, would therefore be best for this purpose, for with suspended-coil voltmeters of this description not only can the values of the resistances $(r_1 + r_2)$ and $(r_3 + r_4)$ be increased to 3,000 or 4,000 ohms, but the maximum drop of volts across R_1 and R'_1 may also



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be greatly reduced. When employing this method for determining the average of several feeding-point voltages, a multiple-contact switch as shown in Fig. 2 is necessary. It is also necessary to shunt the voltmeter by means of the resistance, S. but the resistance, ρ, of the various connecting wires may be made as low as is convenient, since the resistances r_1 r_2 r_3 r_4 will themselves prevent any appreciable interchange of current between the various feeder circuits. Fig. 7 shows a particular case where the voltage at the end of a set of three-wire feeders may be simply arrived at. The figure is a sufficient explanation

* Paper read at a meeting of the Glasgow Local Section of the Institution of Electrical Engineers, Feb. 13, 1901.

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of itself. It is, however, clear that this case is rarely applicable in practice. In Heap's patent 8,348 of 1898, instruments of the Weston type are described for use in three-wire circuits, where the moving member has two distinct coils and four terminals, as shown in Fig. 8. The great disadvantage of this arrangement is, of course, the difficulty of insulating the coils on the movable member from each other, the difference of potential being the full voltage between outer and neutral wire. A further device is described, as shown in Fig. 9, with reference to instruments depending on the attraction of a small piece

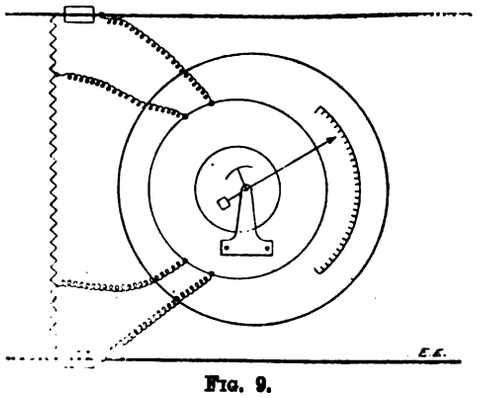

FIG. 9.

of iron. If these instruments be used at all, they may quite as readily be compounded with a few turns in series with the outer and neutral mains in accordance with the original scheme of Dr. Hopkinson. In any case, the device described above of Heap possesses the disadvantage that unless a large drop be allowed in the inserted resistances in the mains, the available voltage across the terminals of the voltmeter is altogether insufficient. For example, on a 250-volt circuit, if the series resistance caused an added drop of, say, 2 per cent. of the feeder drop, the available difference of potential for working the voltmeter would be only about 2·5 volts. With an instrument of the above type to be actuated by only 2 5 volts a comparatively large current would be necessary, causing a relatively large watt loss in the whole arrangement.

Case C.—This case—viz., the compensation for the ohmic and inductive drop in long alternate-current transmission lines—has been very ingeniously handled by Mershon. As already intimated, Fig. 3 gives the pith of Mershon's arrangement, but in his American patents a considerable number of very pretty modifications are shown; but all of these, as he is careful to point out, depend upon the employment of potential or current tranformers, or both. The following method, therefore, which is quite independent of all transformers, not even necessitating one for the voltmeter, may be of interest. In this instance not only must an extra resistance be inserted in the line, but similarly an extra self-induction, unless, indeed, a portion (say a $\frac{1}{100}$th part of resistance and self-induction of the line itself) be employed for the purpose by running back a pilot wire to the station from a point on the line situated at a distance from the power station equal to $\frac{1}{100}$th part of the whole length of the line.

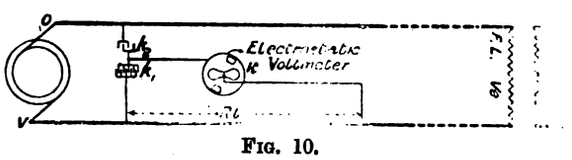

FIG. 10.

To fix our ideas, let us consider a specific case where the line voltage is 30,000 volts, the line being 50 miles from end to end. At the station a 100-volt multicellular electrostatic voltmeter of the Kelvin type is employed, and connected as shown in Fig. 10. It would, of course, have to be thoroughly insulated from earth. k_1 and k_2 are condensers replacing the resistances r_1 and r_2 shown in Fig. 1. The condenser k_2 has a capacity approximately equal to the maximum capacity of the voltmeter—*i.e.*, the capacity between the fixed and movable vanes, the latter being in the position they normally occupy when the voltmeter is indicating its maximum voltage. The capacity of the condenser k_2 is accordingly very small; it must, however, be capable of withstanding practically the full line voltage of 30,000 volts. The writer therefore proposes to employ for this condenser a slab of glass with pieces of tinfoil pasted on the two opposite surfaces, the slab being sufficiently thick to withstand the voltage, and the area of the tinfoil coatings being chosen to give a capacity approximately equal to the maximum capacity of the voltmeter. To prevent leakage and condensation on the edges of the slab, the whole might advantageously be immersed in a bath of special oil or be embedded in a block of paraffin wax or other suitable dielectric. The condenser k_1 must have a capacity nearly 300 times as great as that of k_2; since, however, the voltage across the former will be of the order of 100 volts, it can readily be constructed in the usual way of sheets of tinfoil and mica, and will not be an expensive matter. It is important that the ratio of the capacities of $k_1 : k_2$ be maintained exactly, but it is not of any importance that the capacity of k_2 shall bear any very exact ratio to that of the voltmeter. Thus the voltmeter, if deranged, might be replaced by another of the same pattern, and the latter would indicate correctly. If a portion of the line itself be utilised, instead of inserting extra resistance and inductance, a pilot wire must be run back from a point one-third of a mile distant from the power-house. This wire must be protected, of course, from the inductive action of the current in the line in a manner explained latter on. One advantage in utilising a portion of the feeder itself instead of inserting extra resistances, etc., which may, of course, be done in this or any of the foregoing cases, is that no error is produced by a change of resistance of the line due to changes of atmospheric temperature. We thus have a simple and inexpensive arrangement whereby a 100-volt electrostatic voltmeter may be arranged to measure directly the potential at the far end of a 30,000-volt line, the voltmeter being compensated for both ohmic and inductive effects of the line itself. It is obvious that similar arrangements may be applied to many such useful purposes—*e.g.*, in the last case the voltmeter might be arranged to compensate not only for the line drop, but also for the drop due to both copper resistance and magnetic leakage in the transformer at the far end, and thus indicate the voltage at the low-tension terminals of the transformer irrespective of what kind of load may be connected to the same—*i.e.*, one possessing self-induction capacity or anything else. The drop in the transformer might be exactly imitated by inserting in series in the circuit (now containing a perfect transformer with no drop) a definite self-induction and resistance. These might then be considered as forming part of the transmission line, and therefore by adjusting k_1, k_2, and the inserted resistance and self-induction, or possibly the position at which the pilot wire is connected, the drop due to the extra resistance and self-induction—*i.e.*, the drop in the transformer at the far end of the line—may also be compensated for.

Analytical Investigation.—A simple and straightforward, though possibly a somewhat lengthy, method of dealing with this subject is to consider n feeder circuits (Fig. 11), where F_1, F_2, F_n, etc., represent the total (go and return) feeder resistances of the various circuits. At the station end the positive and negative feeders of each circuit are bridged over by resistances $r_1 + r_2$, and all the points—1, 2, 3, etc.—of these resistances are connected together and to one terminal of the voltmeter. The potential of this terminal is e. The resistance of the voltmeter is r, and the current flowing through it i. It is further shunted by a resistance, s.

Let $V_1\ v_1$, $V_2\ v_2$, etc., be the potentials of the positive and negative feeders of the different circuits respectively, then it is easy to show that

$$e = \frac{r_2}{r_1 + r_2} \cdot \frac{\Sigma (V_1 + V_2 + \ldots V_n)}{n} + \frac{r_1}{r_1 + r_2} \cdot \frac{\Sigma (v_1 + v_2 + \ldots v_n)}{n} + \frac{r_1 r_2}{r_1 + r_2} \cdot \frac{s + r}{s} \cdot \frac{i}{n} \quad \ldots \quad (1)$$

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Let $R_1, R_2, \ldots R_n$ be the series resistances inserted in the feeder circuits, and let the far end of each of these be connected by a wire whose resistance is ρ to the second terminal of the voltmeter. Calling the potential of this terminal e', we may write:

$$e' = \frac{\Sigma(V_1 + V_2 \ldots V_n)}{n} - \frac{\Sigma(C_1 R_1 + C_2 R_2 \ldots C_n R_n)}{n} - \rho \cdot \frac{s+r}{s} \cdot \frac{i}{n} \quad \ldots \ldots \quad (2)$$

where $C_1, C_2, \ldots C_n$ are the various feeder currents, which may be taken as identical with the currents flowing through R_1, R_2, etc., provided ρ be sufficiently large to prevent any appreciable interchange of current between the various feeders.

We have further

$$e' - e = i r \quad \ldots \ldots \quad (3)$$

Hence, eliminating e and e', we have

$$i = \frac{\frac{1}{n}\Sigma\left(V_K - v_K - \frac{r_1+r_2}{r_1} \cdot C_K R_K\right)}{\left(\rho \cdot \frac{r_1+r_2}{r_1} + r_2\right)\frac{s+r}{s n} + s\left(\frac{r_1+r_2}{r_1}\right)} \quad \ldots \quad (4)$$

If $$\frac{r_1+r_2}{r_1} = \frac{R_1+F_1}{R_1} = \frac{R_2+F_2}{R_2} = \text{etc.},$$

the numerator of the above expression is merely the average voltage existing at the far ends of all the feeder circuits. We will call this V_a. It is then clear that the current flowing through the voltmeter is proportional to V_a, if any given number of feeder circuits be connected.

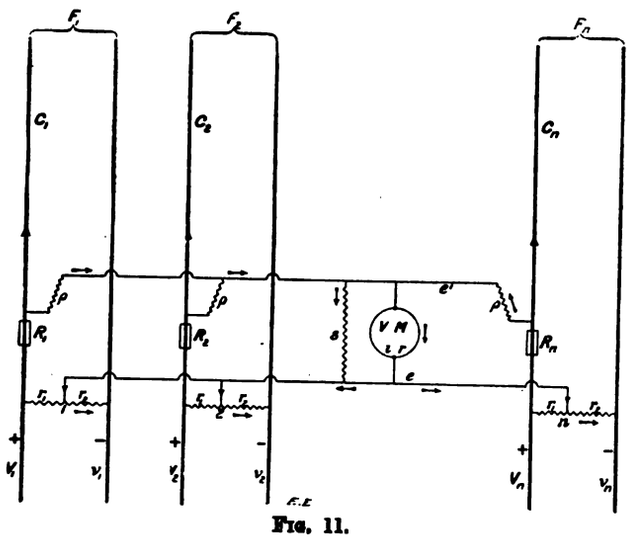

FIG. 11.

The constant of the instrument, however, involves n; in order, therefore, to make the same calibration serve for all values of n, and to obtain the most sensitive arrangement, we must keep $\frac{s+r}{s n}$ equal to unity—in other words, s must always equal $\frac{r}{n-1}$. This therefore is the function of the shunt, s, in Fig. 2, and if by means of the multiple-contact switch s be made to depend on n in the above manner, we have

$$i = \frac{V_a}{r_2 + \frac{(\rho+r)(r_1+r_2)}{r_1}}.$$

If $n = 1$ we may make $\rho = 0$ and $s = \infty$—*i.e.*, no shunt is required. This is the arrangement of Crompton and Ashley, and also of Heap.

The equation holding for the device represented in Fig. 1 is slightly different from the foregoing:

We must insert in equation (1)

$$n = 1, \quad V = \frac{1}{n}\Sigma(V_1 + V_2 \ldots V_n), \quad 0 = \frac{1}{n}\Sigma(v_1 + v_2 + \ldots v_n),$$

and in equation (2) merely

$$V = \frac{1}{n}\Sigma(V_1 + V_2 \ldots V_n).$$

Combining (1) and (2), we have

$$i = \frac{V_a}{\left(\frac{\rho}{n} \cdot \frac{r_1+r_2}{r_1} + r_2\right)\frac{s+r}{s} + \frac{r(r_1+r_2)}{r_1}}.$$

Now in this case, if ρ be very small compared with r, we may say that i does not depend on n, hence s may be made ∞—*i.e.*, no shunt is required—and we have

$$i = \frac{V_a}{r_2 + \frac{r(r_1+r_2)}{r_1}}.$$

Applying the above results to an actual case, let $V = 200$, and let the current required by the voltmeter for maximum scale deflection, corresponding to, say, 220 volts, be 0·01 ampere, the resistance of the voltmeter being 60 ohms.

Let, further

$$\frac{F_1}{R_1} = \frac{F_2}{R_2} = \text{etc.} = 99,$$

then we have $r_2 = 16{,}000$ ohms,

$r_1 = 161\,6$ ohms.

We may take it that the maximum feeder drop will not exceed 10 per cent., hence the maximum volt drop along R_1, R_2, etc., cannot be greater than 0·2 volt. If, therefore, $\rho = 0{\cdot}75$ ohm, we may say that the interchange of current

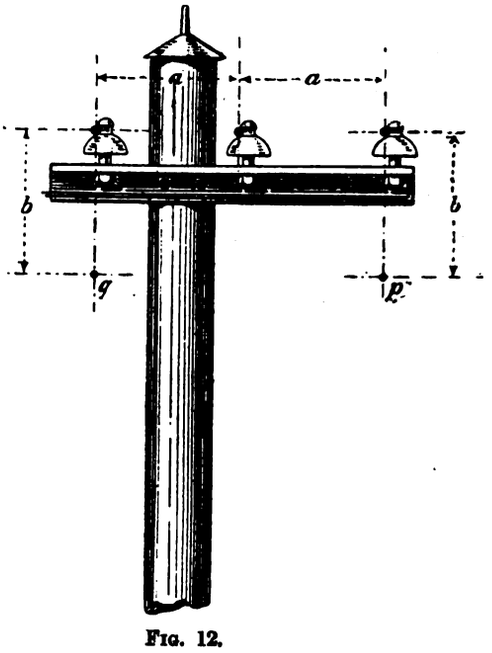

FIG. 12.

between any two feeders cannot be more than 0·13 ampere, or an amount which is quite inappreciable, and at the same time the maximum error introduced by the variation of the value of $\frac{\rho}{n}$ as n is varied cannot exceed one-fifth of 1 per cent.

With the arrangement shown in Fig. 2, ρ must be much greater than heretofore assumed, for if one set of feeders be switched out, the voltage at the near end of the positive of the same might differ by as much as 20 volts from that of neighbouring positive feeders, and a serious interchange of current between them would occur if ρ were not of considerable magnitude. Since, however, from equation (4) it appears that no error whatever is produced by the variation of n, provided s is always equal to $\frac{r}{n-1}$, we may, if we like, take $\rho = 100$ ohms. In this case, taking the same constants for the voltmeter as before, r_2 will come out 6,000 ohms and r_1 60 6 ohms.

It has been assumed throughout the foregoing that the same current returns by the negative feeder as goes by the positive feeder of the same circuit; this will generally be true, unless, indeed, the resistances of the positive and negative feeders are different, or the problem is complicated by the fact that there are faults at different parts of the system. In such cases, however, where the out-

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going current is of different magnitude from the return current, the following arrangement might be employed, which, moreover, is particularly applicable to three-wire systems and such like.

To derive an expression for i in case (b)—see Fig. 5—we have from equation (1):

$$e = \frac{r_2}{r_1+r_2} \cdot \frac{\Sigma V_\kappa}{n} + \frac{r_1}{r_1+r_2} \cdot \frac{\Sigma v_\kappa \pm C'_\kappa R'_\kappa}{n} + \frac{r_1 r_2}{r_1+r_2} \cdot \frac{s+r}{s} \cdot \frac{i}{n} \quad . \quad . \quad . \quad . \quad (5)$$

To obtain e' we must substitute in this same equation:

e' for e	$V_\kappa - C_\kappa R_\kappa$ for V_κ	
r_4 ,, r_1	v_κ	,, $v_\kappa \pm C'_\kappa R'_\kappa$
r_3 ,, r_2	$-i$	,, i

and we may further write $r_1+r_2=r_3+r_4$, hence:

$$e = \frac{r_3}{r_1+r_2} \cdot \frac{\Sigma V_\kappa - C_\kappa R_\kappa}{n} + \frac{r_4}{r_1+r_2} \cdot \frac{\Sigma v_\kappa}{n} - \frac{r_3 r_4}{r_1+r_2} \cdot \frac{s+r}{s} \cdot \frac{i}{n} \quad . \quad . \quad . \quad . \quad (6)$$

Combining (3), (5), and (6) we get

$$i = \frac{\frac{i}{n}\Sigma (V_\kappa - v_\kappa - C_\kappa (R_\kappa + F_\kappa) \mp C'_\kappa (R'_\kappa + F'_\kappa)}{(p r_4 + q r_2)\frac{s+r}{sn} + \frac{r(r_1+r_2)}{r_3 - r_2}} \quad (7)$$

where $$\frac{r_3}{r_3-r_2} = 1 + \frac{F_1}{R_1} = 1 + \frac{F_2}{R_2} = \text{etc.} = p,$$

and $$\frac{r_1}{r_3-r_2} = 1 + \frac{F'_1}{R'_1} + 1\frac{F'_2}{R'_2} = \text{etc.} = q.$$

Now the numerator in (7) is the average voltage obtaining at all the far ends of the feeder circuits between the outers F_1, F_2, etc., and the neutrals F'_1, F'_2, etc. Call this average voltage, as before, V_a.

If, then, we again, by means of the multiple-contact switch, keep $\frac{s+r}{sn}$ equal to unity, we have for case (b)

$$i = \frac{V_a}{p r_4 + q r_2 + \frac{r(r_1+r_2)}{r_3 - r_2}},$$

from which the necessary values for r_1, r_2, r_3, and r_4 are calculable for any given instance.

The last case is that of (c), Fig. 10. We can readily derive the equation for the voltage existing across the voltmeter (which may be designated v') from equation (4), by writing:

$n=1$, $s=\infty$	$R + l\theta$ for R_1	$\frac{1}{k_2\theta}$ for r_2
$\rho=0$, $\nu=0$	$\frac{1}{k_1\theta}$,, r_1	$\frac{1}{\kappa\theta}$,, r;

where R and l are the resistance and self-induction respectively of that portion of the line spanned by the pilot wire, κ is the capacity of the voltmeter (this being a function of the position of the movable vanes), and θ represents the operator $\frac{d}{dt}$. We have then

$$v' = \frac{i}{\kappa\theta} = \frac{V - \frac{k_1+k_2}{k_2} \cdot (R + l\theta) C}{\frac{\kappa + k_1 + k_2}{k_2}}.$$

If $$\frac{k_1+k_2}{k_2} = \frac{F}{R} = \frac{L}{l},$$

the numerator of the above expression represents the voltage obtaining at the end of the line. Call this V_e.

As already explained, k_2 may advantageously be made about equal to the maximum value of κ, in which case, owing to the comparatively large value of k_1, we may write with great accuracy—

$$v' = \frac{k_2}{k_1+k_2} \cdot V_e.$$

It has been pointed out in the previous part of this paper that it is necessary to shield the pilot wire from the inductive action of the line. If the line be a single-phase one carried overhead, it will be simple to place the pilot wire symmetrically with regard to the two-line wires, in which case all inductive effects will be obviated.

If the line be an overhead three-phase one, it is not always possible to place the pilot wire in a symmetrical position with regard to all three-line wires. The inductive action may, however, be neutralised by running the pilot wire for part of the distance nearer the one or other of the lines. Thus, if the three-line wires be carried in a row (see Fig. 12), and a pilot wire be run for a total distance of 500 yards from the station, it might be located for 250 yards in position p, and for the remaining 250 yards in position q. The inductive action of each line wire on the pilot wire depends on the logarithm of the reciprocal of the distance between them plus a constant, which latter is the same for all the line wires.

If, therefore, we adjust matters so that

$$\frac{1}{2}\log.\left(\frac{1}{b}\right) + \frac{1}{2}\log.\left(\frac{1}{\sqrt{4a^2+b^2}}\right) = \log.\left(\frac{1}{\sqrt{a^2+b_2}}\right),$$

or, $$b = \frac{1}{\sqrt{2}}a,$$

the inductive action of each line wire on the pilot wire will be the same, and since the total current flowing in the three-line wires at every instant is zero, the total inductive effect will likewise be zero.

With other arrangements of the line wires corresponding modifications of the positions of the pilot wire will be requisite.

CATALOGUES.

Messrs. Maguire and Baucus, of 5, Warwick-court, Holborn, inform us that they have now taken up the agency for the American-made Cahall water-tube boilers in the United Kingdom. From the illustrations in the list which the firm have forwarded to us, we gather that there are two distinct types of boilers manufactured under this name. In the first of these practically vertical tubes are used to connect the water-drum below the firebar levels, with the water and steam drum at the top. The boilers constructed in this way require exceedingly small ground space for their output, and they have been extensively used in iron and steel works in America. They have in many cases been fired by the furnace gases by means of a burner which is placed inside the ring of vertical tubes referred to above. The circulation of water and steam through these tubes tends to keep the inner surfaces clear of deposit. The other type of boiler has inclined tubes, and is not unlike in form one or two other makes which have obtained a large number of orders for electric lighting stations. The list of repeat orders which is given in the catalogue shows that the firm have a reputation in the States for reliable work.

We have received from Messrs. Geipel and Lange, of Parliament-mansions, Westminster, an interesting specification which has been drawn up by Messrs. Ward Leonard and Co. of the requirements from a well-designed motor starter. This specification we have already reprinted from one of our American contemporaries, and we think it is one which engineers would do well to peruse when specifying what they require from their motor starters in large power installations. The object of the specification is two-fold—first, to secure that the motor shall not be injured in starting, or in consequence of an unexpected interruption in supply; and, next, that the operation of the motor starter shall not in any way injure either the switch contacts or the resistance which is used for regulation. We believe that this specification can be obtained on application to the firm.

The Electrical Company have forwarded to us their latest list of alternating-current electricity meters, which include a large range of meters for various purposes, either with single-phase two-wire supply, single-phase three-wire supply, or for multi-phase working. The mechanism in every case is of the motor type, the motor being constructed on the Ferraris principle, while the armature is of the short-circuited, squirrel-cage type, consisting of a single winding of copper. This moving part is made exceedingly light in order to reduce the bearing friction to a minimum. In fact, the whole weight of the revolving part, including the brake disc, is only 60 grm. The calibration curves which are given in the list, show that good results are obtained with the combination. The accessories at the end of the catalogue for testing meters, and also the model forms of meter cards and reports, will be found of service to electrical engineers.

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ELECTRICAL ENGINEERS IN THE NAVY.

The statement of Mr. Arnold-Forster, when explaining the navy estimates the other day, so far as it referred to the new rating introduced into the navy is of interest to all electrical engineers. Hitherto electrical engineers have been employed, but not recognised as a separate profession. As a matter of fact, however, the organisation has been in the act of evolution for months past, and a department (under the direction of Mr. L. J. Steele) was months ago instituted at Portsmouth. This department was a new departure, and now further development is promised by Mr. Arnold-Forster. If we consider for a moment the extension of electrical work on board ship during the past twenty years, the necessity of a trained scientific staff will be recognised. Starting with the introduction of the electric light, generally finishing, as far as the present is concerned, with the introduction of the wireless telegraphy, every step has necessitated the employment of men trained in the use of such apparatus. Perhaps we ought to have gone even further back to the time of Davy for the useful introduction of electrical methods to maritime purposes. It is well, then, for the electrical engineer to have a recognised position, and not to be any longer merely a man called in to assist. However, we desire more particularly to call attention to the statement that "men will pass through examinations into the navy, and will form, I hope, a valuable contribution to the staff of torpedo lieutenants in ships." It is difficult to suggest an alternative to examinations, nor if examinations were taken as means to an end, rather than the end itself, would the ordinary man desire to get rid of them? The truth, however, needs to be continually emphasised that the examination craze is run to death. There is no certainty that the best men for any position are those who obtain the highest marks by examination, yet these are the men who succeed in obtaining positions, and others not necessarily worse men are "plucked." The passing of men into the army, navy, civil service, etc., has grown to be like that of men going in for a university degree, merely a question of marks. It may at once be admitted that a good electrical engineer for work on board ship, must have a certain amount of general knowledge. Whether he has this or not can be ascertained by a written or a *vivâ voce* examination. We would suggest the abolishment of "marks," and that the examiners' duties be rigidly confined to the ascertaining if a man's general and special knowledge is sufficient for the duties to be undertaken. Besides this there should be other conditions favourable or otherwise to the passing of a man into this special branch. Experience can hardly be expected at the age which will probably ultimately prevail at entrance, and it is very difficult to foretell or to get an indication by examination whether a man is able to grapple with a difficulty when it arises. Hundreds of men can follow, few can lead, and what is wanted on board ship are men who can lead as well as follow. Neither book

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knowledge nor experience will give the best man—he is born, not made—though the ordinary man is made better by reading and thinking—that is, by making himself acquainted with other people's experience, and getting personal experience off his own bat. We candidly confess that we fear the introduction of what this word "examination" forecasts, and trust our impressions may not be borne out by lapse of time.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

OVERHEAD TROLLEY WIRE PROTECTIVE DEVICES.

SIR,—I am much obliged for your reply to my letter of the 11th inst., but I was not aware that the practice of feeding the half-mile trolley sections at one point only was so general as your editorial note would seem to imply. I believe that at Dublin, Bristol, Blackburn, and Leeds, and one or two other places at least, it has been the custom to use the trolley wires as supplementary to the "line feeders," and no less an authority than Mr. Philip Dawson states in his "Electric Traction Pocket Book" (p. 142) that "to ensure the best results being obtained, all main and line feeders, *as well as the overhead line*, should work in parallel."

I cannot help thinking that it is rather the exception than the rule to discard the 0·16 square inch of copper so obtained as a supplement to the feeders.

Mr. Ernest Wilson's book on electric traction also bears out my suggestion; but, of course, I understand that practice may have altered since this book was written.

Having prepared tenders for most of the earlier electric tramways in this country, I may say I do not remember one case in which the number of pillar boxes differed from the number of sectional insulators for a single line of trolley wire, the Bristol line being pretty generally taken as the model. Of course, it may be different now, but it would seem that Mr. Quin's device is inapplicable to those lines at any rate, if not to a good many new ones.—Yours, etc.,

Birmingham, March 18, 1901. PUZZLED.

THE LATE PROF. G. F. FITZGERALD.

At the ordinary general meeting of the Dublin Section of the Institution of Electrical Engineers, held at the Dublin United Tramway Company's Power Station, Ringsend, on March 9, 1901 (Prof. W. F. Barrett in the chair), further reference was made to the death of the above-named scientist.

Prof. W. F. BARRETT, F.R.S, said: We meet to-night under the shadow of a great loss; one of the most eminent and brilliant of physicists, one of the most honoured and beloved of friends, the chairman of our section, has passed away. When on the Saturday morning, a little more than a week ago, I saw the announcement of the death of Prof. Fitzgerald, the fact seemed almost incredible. We knew he was ill, but only a few days before I had a letter telling me how much better he was, and we hoped for a speedy recovery. Alas, it was not to be! A sudden change for the worse occurred, and he passed away a few hours later. When the sad news was known, the uppermost feeling of all of us who had a privilege of knowing and loving him was as if part of our life was taken away. Writing to me a day or two after, Dr. Oliver Lodge said, "I can think of nothing but the death of dear Fitzgerald," and that is just how most of us felt. Not only has science lost one of her most eminent and brilliant sons, but we all have lost a dear, personal friend. It was his genuine goodness, his great sympathy, his ungrudging helpfulness, his unsparing self-sacrifice, his large-heartedness, his beautiful simplicity—in a word, the affectionate regard in which he was held, that was the dominant note in our grief at the news of his death. But beyond this sense of a great personal loss, there comes also the realisation of the great national loss we have sustained. For 20 years past I have seen how incessantly he laboured for the public good: as honorary secretary of the Royal Dublin Society; as one of the Commissioners of National Education; as a member of the consultative board of the new Agriculture and Technical Instruction Department, he brought his great powers to the service of those distinguished bodies. The cause of technical education in this country owed very much to him. From the first he worked incessantly on various committees to forward this object, in quiet and inconspicuous work, generously spending his time and strength; and when we pass to the field of pure science, where his brilliant gifts and immense knowledge are now recognised over the whole world, what an irreparable loss we have had. Not only by his researches and his suggestive papers and his wonderful insight into profound physical problems will he be remembered, but also by his ever-ready helpfulness to other workers, freely giving to them his advice and assistance, yet with a humility and self-forgetfulness all too rare. I myself can testify how often I have benefited by his kindness in this respect. Though I have had the privilege of knowing numbers of scientific men from the time of Faraday onwards, yet I can recall no one, whether of high or low degree, who approached in generous and ever-ready helpfulness our dear friend Fitzgerald. He had a lavish hospitality of mind; not only would he cheerfully lay his own work aside when consulted by a friend, but he would put into his conversation or letters the most valuable and original suggestions, unconcerned whether his ideas were acknowledged or not, so long as truth was advanced or the world was benefited. His was, indeed, one of the most gifted and highly trained yet modest and unselfish of natures, closely resembling both intellectually and in character that great Englishman, Clerk Maxwell, who also passed away at the same age, in the prime of his intellectual power. To quote from the happy eulogy expressed by Prof. Lodge: "A good man Fitzgerald was if ever there was one; devoting himself to public work, free from all petty ambition, caring nothing for himself, throwing out his ideas right and left with splendid prodigality, rejoiced if they were absorbed and utilised by others. How quick he was to seize a point, how keen to criticise, to extend, to illuminate a subject, . . . how willing to enter into the work and the difficulties of others" And when such a loss as this is ours, what must be the inexpressible grief of his wife and family. We pray that God in His mercy may comfort and sustain them, and we now tender to her and to them our deepest and most sincere sympathy.

Dr. F. T. TROUTON, F.R.S., seconded the resolution. He said that all who had had the advantage of knowing Prof. Fitzgerald would feel the appropriateness of what they had just heard Prof. Barrett so beautifully and fittingly express. He, however, had been assistant to Prof. Fitzgerald for a number of years, and had thus had more opportunities than many of judging of the extraordinary enthusiasm for work he was able to evoke in those he came in contact with. He never spared any trouble in assisting those seeking his advice, and the services of the brilliant genius were ever at the service of all serious students of science. The one thing above all, however, that rose up most clearly in the speaker's memory was the infinite sympathy ever evinced with others in all their ideas and plans. Personally, he felt that scientific association with Prof. Fitzgerald had been a great opportunity, but to have had his friendship the privilege of his (the speaker's) life.

Dr. A. TRAILL, S.F.T.C.D., said he had known Prof. Fitzgerald as a personal friend ever since he came to Trinity College, and their relations had been most intimate. Nothing could be more delightful in private life than his simplicity and absolute want of personal ambition. During the experimental work in connection with the Portrush and Giant's Causeway Electric Railway in 1882, a work in which many problems had to be solved and difficulties overcome, when what is now commonplace knowledge was

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then unknown, much interest had been taken in the matter and much assistance given by Prof. Fitzgerald. At that time, and on subsequent occasions, both he and Lord Kelvin had stayed with the speaker at his residence in County Antrim, and many interesting experiments were made on the spot. It was a perfect treat to hear Fitzgerald and Kelvin discussing not only electrical problems, but other deep scientific subjects in after-breakfast conversations, and Lord Kelvin had stated to him since then that he knew none superior to Fitzgerald as a scientific man. He had a melancholy pleasure on this occasion in testifying to the great personal worth as well as the scientific attainments of Prof. Fitzgerald, and there were few men whom he would miss more and whose loss he would more keenly feel.

The motion "That our sincerest sympathy be extended to Mrs. Fitzgerald" was then put, and carried in silence, the members standing.

PHONO-ELECTRIC WIRES.

We have just received from Messrs. Maguire and Baucus, of 5, Warwick-court, Holborn, some interesting particulars of a new type of overhead conductor which they are introducing with considerable success in this country. The material is manufactured in America by the Bridgport Brass Company, who did so much in the earlier days of telegraphy in perfecting the processes of the manufacture of hard-drawn copper wires. The material out of which what the firm call phono-electric wire is drawn is a new alloy of copper which they have succeeded in producing, and which possesses exceedingly valuable properties. The main object of the new material is that of strength. In the hard-drawn copper wire such as is used for overhead traction and for telephone purposes, the mechanical strength lies entirely in the surface layer of the material. If this is abraded or is corroded, due to atmospheric conditions, the wire loses its mechanical strength, as the inner layers consist practically of soft copper. In a trolley wire in particular this abrasion is sure to occur, and also the influence of arcing on the wire tends to soften the outer layer and to render the wire liable to fracture. The above firm have placed before us a number of experiments which have been made with the phono-electric wire to prove that it is reliable as a substitute for hard-drawn copper, and that it possesses, in consequence of its uniformity and great strength, numerous advantages which are not possessed by the material previously used. These tests show that the phono-electric wires are for the same size twice as strong as annealed copper wire and 50 per cent. stronger than hard-drawn copper. We gather that its specific resistance, however, is lower, as the makers state that it is as tough as milled steel and four times as good as a conductor. In order to show how uniform is the strength of the material of this new wire, experiments were made on the tensile strength per square inch of a conductor of 00 gauge, its diameter being greatly reduced by removing surface layers. The same experiments were also made with hard-drawn copper wire. Before any material was removed the breaking strain on the copper wire was 52,000lb. per square inch, and on the phono-electric wire 73,500lb. The original diameter of wire was 365 mils. After 17·5 mils had been removed from the outside of each conductor, the tensile strength of the phono-electric wire had not been reduced, while the hard-drawn copper had dropped down to 48,500lb. per square inch. The process was continued, repeated experiments being made, and it was found that when 32½ mills had been taken off the wires, the tensile strength of the hard-drawn copper had been reduced down to its lowest limits of 34,500lb. per square inch, whereas practically no difference had been made in the strength of the phono-electric wire. The conclusion of these experiments is that after 1-32in. of the surface material has been removed from hard-drawn copper there is nothing but soft copper left, whilst most of the extra strength due to the hard drawing is removed when only half this thickness has been taken off. A table of breaking weights for various gauges of wire given in the pamphlet before us shows that, as a rule, the phono-electric wire is from 41 to 47 per cent. stronger than the hard-drawn copper. The elastic limit is also higher, which is a considerable advantage in overhead work. The ordinary twist test which is made on wire to show its power to resist bending also is in favour of the new material. It is, however, with respect to arcing such as would occur on trolley wires that a great claim is made, and experiments in this direction show that while the arcing such as takes place when the trolley is not running evenly anneals the copper conductors very quickly, it has practically no effect on the tensile strength of this new alloy. Against these advantages, the only disadvantage is that of slightly higher resistance, but as a trolley wire is not now often used as a feeder, this is of not so great importance as the mechanical strength. The corrosive effects due to atmospheric conditions are considerably less than on copper. We understand from the above-mentioned firm that they have already supplied considerable lengths of this material for the trolley lines at Dublin, Sheffield, Hull, and Liverpool, where it is finding favour with the engineers after continued use.

CONCRETE CONDUITS.

A London syndicate, having its offices at 109, Victoria-street, is introducing into this country a type of concrete slab for electric cables and telephone wires, etc., which has been largely adopted on the Continent, notably by the German Post Office authorities. Each slab contains only one row of troughs, each trough to contain one cable. The separate slabs are built up, if necessary, in good bond, as is done in brickwork, until the required number of troughs is obtained. Each slab forms in itself an integral whole of great stability. Though the walls of the troughs are constructed with the strictest regard to economy, they are so strong that a slab covered only with 2ft. of earth can safely resist the weight of a steam-roller passing over the roadway above. Iron pins inserted in the slabs prevent vertical and horizontal deflections of the slab troughs. If laid down in side-walks, the ordinary slabs can be employed even with a minimum of earth covering. In building up the conduits, the bottom course of trough is supported at the joints by a concrete bed. The slabs are, we understand, pointed at both ends, adjoining ends thus forming a groove, around which is wrapped a bag of cement so as to form a close joint flush with the body of the conduit. The slabs are manufactured with two, three, or four troughs, whereby any desired combination may be effected. The troughs are impregnated with a patent insulating material to protect the lead covering of the cables against injurious influences, the process being carried out under a pressure of 140lb. per square inch, whereby all alkaline reactions are destroyed and absolute protection thus afforded from moisture and the potassium contained in cement. Economy in initial cost, ease of laying in small trench, and great durability are amongst the advantages claimed for this type of conduit. It may be mentioned, in conclusion, that concrete slab troughs with iron linings are also supplied by the syndicate.

FORTHCOMING EVENTS.

FRIDAY, MARCH 22.

Board of Trade.—Adjourned enquiry into the application of the Electric Lighting Companies to increase the standard pressure of supply.

SATURDAY, MARCH 23.

Glasgow and West of Scotland Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Glasgow's Water Supply," by Mr. James B. Wyllie.

MONDAY, MARCH 25.

Society of Arts.—At 8 p.m., "Electric Railways," by Major Philip Cardew (Lecture III.).

TUESDAY, MARCH 26.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., general meeting. Paper on "Direct-Current Generators," by Mr. S. H. Short.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "The Æsthetic Treatment of Bridge Structures," by Mr. Joseph Husband. Paper to be read, time permitting: "The Burrator Works for the Water Supply of Plymouth," by Mr. Edward Sandeman.

WEDNESDAY, MARCH 27.

Institution of Electrical Engineers (Birmingham Section).—At 7.30 p.m., general meeting in the Physical Theatre of the University. Paper on "Polyphase Equipment in Factories," by Mr. W. Wyld.

Institution of Civil Engineers.—At 2 p.m., students' visit: Inspection of the Ilford Sewerage Works, and Sewage Disposal by Bacteriological Methods.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "Clocks, Carillons, and Bells," by Mr. A. A. Johnston.

THURSDAY, MARCH 28.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Papers: "The Electrical Transmission of Power in Coal Mines," by Mr. H. W. Ravenshaw, and "Portable Electric Lamps," by Mr. S. F. Walker.

FRIDAY, MARCH 29.

Electro Harmonic Society.—Smoking concert at St. James's Restaurant, W.

Royal Institution.—At 9 p.m., Lord Rayleigh on "Polish."

SATURDAY, MARCH 30.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Sound and Vibrations."

SEPT. 3, 4, 5, AND 6.

International Engineering Congress (Glasgow).

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THE INSTITUTION OF JUNIOR ENGINEERS.

Anniversary Dinner.

The sixteenth anniversary dinner in connection with the above institution was held at the Westminster Palace Hotel on Saturday evening last, when Prof. John Perry officiated as chairman in the absence of Sir Edward J. Reed, who was prevented from attending through indisposition. There were about 130 guests present. After the Royal toasts had been duly honoured,

Sir JOHN JACKSON proposed "Our South African Field Forces," referring to the splendid courage displayed by the volunteers. Sir DAVID TENNANT, Agent General for Cape Colony, responded.

In proposing "British Engineering," Sir WALTER PEACE, Agent-General for Natal, said that, although not himself an engineer, he had had much to do with engineers, and knew of what importance the profession they represented was to the British Empire. He had considerable doubt sometimes as to whether British engineers were keeping abreast of the times. Hitherto they had held a monopoly in the Colonies for iron and steel manufactures, but that condition of things was passing away. With regard to steel rails, he did not believe those of American manufacture were equal in quality to the British article, they being deficient in durability owing to a superfluity of carbon in their composition. In this connection it was a serious matter that there was no central autho ity established to fix a proper standard of quality of materials they wanted to buy. There was, consequently, no firm making to such a standard. The existing mode of classification, whereby the different grades of iron were stamped "Best," "Best Best," or "Best Best Best" was quite inadequate for modern requirements. Articles of a given quality were wanted, classified under some intelligible system, such as that instituted by Lloyd's in reference to ships. This plan would assist buyers. He coupled with the toast the name of Prof. John Perry.

Prof. JOHN PERRY, who responded, insisted that B B B evidenced that England had created the iron trade. The multiplication of B's denoted successive improvements of the original standard. It was all very well for young colonies to criticise, who, when they got to B B, would, he presumed, mark it B^2, but we at home had already got to B^3. One of the principal characteristics of the British public was inventiveness. This trait was especially noticeable in the Press. It was just because we Anglo-Saxon people had been free for 700 years or more that we now refused to be led. While susceptible to new ideas, we were, on the other hand, never slaves of new notions. Our ideas were used cautiously and experimentally. It was, however, interesting to observe that when a notion was once digested it was done thoroughly. We created engineering, but that was no blame to Continental folk. We taught the world that mining, etc., imbued a country with strength. It was, however, just as well to remember that accidents would happen. He would ask were we going to wait? One of the most important functions of the institution was to visit works. His (Prof. Perry's) own impression was that relatively few works in this country were comparable to what might be found elsewhere. To remedy this state of things, it was in the first place essential to educate the capitalists to put their trust in young engineers with whose education and competency no fault could be found.

Mr. WALTER HUNTER also responded. He outlined the industrial and commercial progress made by the country during the past century, giving comparative figures, and remarked upon the marvellous developments of electrical engineering. He looked to the junior engineers to carry on the good work and maintain the country's supremacy among the scientific nations of the world.

The next toast was "The Commonwealth of Australia," proposed by Mr. ERNEST KING, who dwelt upon the immense importance of the compact to the future prosperity of our Colonial brothers. Having regard to the enormous resources of the country, there was, in his (Mr. King's) opinion, a vast amount of work awaiting the attention of the engineer.

Sir HORACE TOZER, Agent-General for Queensland, in replying, said he would like to express a few words of hope to the young engineers. Neither they nor their industry was deteriorating or likely to deteriorate. The young engineers who had gone out from the Mother Country to the colony which he represented, were a benefit and a credit to the colony which they had made their home. Not one farthing's worth of engineering work for Queensland had ever gone out of the United Kingdom. The manner in which British firms of contractors had executed very considerable contracts in the colony left nothing to be desired, and proved the superiority of British thoroughness. There need be no fear of the decadence of British trade; it would never be left behind. He rejoiced in the new Commonwealth, which marked the development of the brain power of a young and rising nation.

"The Institution of Junior Engineers" was proposed by the Hon. W. P. REEVES, Agent-General for New Zealand. He maintained there was a great deal to be said for the juniors. The nation was not a nation of amateurs, as had been somewhere suggested, but a nation of energetic young men somewhat dominated by old men. He had no complaint to make about British engineers. Everything was satisfactory when it could be obtained, but the colony which he represented had been compelled to patronise Transatlantic competitors owing to the difficulty of getting work executed promptly by British firms. As an instance of British method, he would mention that the colony some time since wanted some new locomotives, and ordered them from an English firm. In reply, the firm said they would be glad to supply locomotives of a certain pattern and a certain weight. The authorities, however, pointed out that the bridges over which the locomotives were required to run would not stand this weight, whereupon the firm suggested that the bridges should be altered. Needless to say the order was lost. In his (Mr. Reeves's) opinion the weak spot in our armour was that we were a nation of over-capitalised industries. The weak spot was to be found in our financiers, promoters, and jobbers—not in our engineers or workmen.

The toast was acknowledged by Mr. PERCIVAL MARSHALL, who referred to the very low margin of safety sometimes allowed by American engineers, giving as an example the reputed case of an American bridge which successfully bore the weight of train for which it had been designed, but collapsed through the extra weight caused by a shower of rain. The junior engineer might be defined as one who did his duty. The institution was in a more prosperous condition than ever before; its finances were better, its membership on the increase, and, moreover, the work which was its function to perform was done better. It also fell to Mr. Marshall's share to propose "The President," which toast was acknowledged by the Chairman.

An excellent programme of music was rendered during the evening, the violin solos contributed by Mr. T. E. Gatehouse being especially appreciated.

ELECTRIC LIGHTING ENQUIRY.

Question of Increased Pressure.

In our last week's issue we continued the report of this enquiry up to mid-day of Thursday, March 14. After the consultation between the counsel in opposition to the proposed change, they proceeded to call witnesses in support of their case.

Mr. T. P. GUNYON, examined by the Hon. A. Lyttleton, put in his evidence the results of some enquiries he had made for electric lamps for both 100 and 200 volts. These showed that in practically every case the higher-voltage lamps cost more than those of 100 volts, and that the makers would only guarantee a shorter life. He also put in the results of some tests which he carried out on four groups of 8-c.p. 200-volt lamps supplied by different makers. Six lamps of each kind were tested. In all but one case there were considerable variations in the watts consumed per candle, the variations running from 4·2 up to 9 watts per candle. In the best group of lamps, however, the watts per candle for the six lamps were respectively 3·9, 4·2, 4·7, 3·7, 4·5, and 3·9. The names of the lamp-makers was not disclosed. The guaranteed life of the different lamps varied from 600 up to 1,000 hours. He thought the

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security against fire was less with the 200-volt supply than with the 100-volt. He had, on behalf of the London County Council, had to investigate 13 cases of supposed fire from electric light; six of these were on premises with the 200-volt supply, and the rest with the 100-volt. He thought there were cases in which insulation might be safe with 100 volts and would not be safe with 200. He thought that there might be considerably more damage done to consumers in consequence of this change, and that consumers had to pay more for their lamps and got a worse article.

In reply to Sir Courtenay Boyle, Mr. Gunyon said the increased danger from fire was due to the higher-voltage current passing through badly insulated parts of fittings.

Cross-examined by Mr. R. W. Wallace, Mr. Gunyon said the increased risk was due to bad workmanship, as if the work was well done there was practically no danger. He thought that the electric lighting undertakers had quite sufficient powers under the Electric Lighting Act to inspect consumers' premises, and to insist on good fittings being used. He had not made a sufficient number of life tests on 200-volt lamps to be worth giving, but he thought that the maker's guarantee was a good means of ascertaining the life of such lamps. He did not know that certain of the lampmakers he had asked to quote did not make 200-volt lamps. His comparisons between the lamps he had obtained and 100-volt lamps were made on the assumption that 100-volt lamps would take from 3½ to 4 watts per candle. He admitted that the lamps marked as "B" in the table gave fairly good results. The larger number of lamps tested, the more accurate the results would be.

Mr. BERNARD DRAKE gave it as his experience that 200-volt lamps were more expensive than 100-volt lamps, and he had received a large number of complaints as to the results of the change over. There was, in his opinion, no benefit to the consumers to the change. He could only explain Prof. Kennedy's evidence on the supposition that consumers had been more careful in turning out their lamps since the change over. In cross-examination he suggested that Prof. Kennedy's conclusions on his own figures were probably wrong. He did not believe in testing small quantities of lamps, but preferred to take evidence from people who complained of the worse light they got in practice. From these complaints he gathered that the lamps supplied by the Westminster Company on Prof. Kennedy's tests were the worst of the lot. He found no difficulty in making a 200-volt supply safe against fire.

Mr. JUSTICE ECK said that as engineer to the late firm of Messrs. Laing, Wharton, and Down he had had charge of a large number of wiring installations. In his experience, it cost about 15 per cent. more to wire with the higher voltage, and the cost of energy should be reduced by 39 per cent. to give the same light with the 200-volt lamp as with the 100. In cross-examination, the witness admitted that he had changed over a number of installations for companies, and that he had left in circuit switches which were not suitable for the high voltage. In reply to Sir Courtenay Boyle, he said that he had not communicated with the insurance companies or informed the consumers of these fittings being left in circuit. The figures he had given regarding the increased consumption and decreased light were the result of recent experiments in his own home. He agreed that Mr. Gunyon's tables of tests did not bear out his evidence.

Prof. AYRTON was then examined as to the cost and efficiency of high-voltage lamps. He gave particulars of a series of tests on 8-c.p. lamps for 200 volts, which were most unsatisfactory. He explained the evidence given by Prof. Kennedy in the appendix as being correct, but held that the conclusions based on it were wrong; while the units used per lamp remained the same, the consumers probably got much less light. There was considerable danger from shock when the three-wire system was used on a consumer's premises. In cross-examination, Prof. Ayrton said that his evidence was to the effect that manufacturers were selling high-priced inefficient lamps for the higher voltage. The lamps marked "B" in Mr. Gunyon's tests were not tried after they had been burning some time. He agreed that these higher-voltage lamps might be improved, and that it would be unfair to estimate the compensation to consumers on the supposition that the present lamps were the best obtainable.

The last witness called was Mr. N. W. APPERLEY, who gave evidence as to the increased cost of current in Lord Londonderry's house in Park-lane since the change over. The increase was from £180 to £288 without any increase in the number of lamps. He did not agree that the house had been used more during the year in question than during the previous years.

MONDAY, MARCH 18.

On the opening of this, the fifth day of the enquiry, the Hon. A LYTTELTON summed up the case for the London County Council. He said that the proposed change was one which the Board of Trade proposed to authorise, and that the London County Council were chiefly concerned with the terms as they would be revised. He held that after elaborate enquiry they had shown that the change would not be so satisfactory to consumers as had been represented by the undertakers, and that hence it was a serious matter to dispense with the consent of the consumer which had been required under the 1896 regulations. Without this consent the undertakers would claim to have the right to enter a consumer's premises and to alter his fittings in such a way as they thought right. This was, he thought, an infringement of the ordinary law of the country. In view of the facts of the case, he thought that any dispute should be taken to arbitration at the expense of the suppliers of electric light.

The same counsel then opened the case for the Windsor Hotel and the Junior Constitutional Club, and called Major CARDEW as the first witness. Major Cardew's evidence in examination was to the effect that certain alterations were required in the fittings and wiring of premises in consequence of the change, and that in his opinion the whole cost of these changes and the incidental expenses should be borne by the company. Under cross-examination by Mr. Roskill, the witness admitted that it would not be advisable for the Board of Trade to veto the change. He was still advising the use of 115 volts in certain new schemes, but had not advised any undertaking using 220-volt lamps to revert to a lower voltage.

Mr. A. H. ROSE, examined by Mr. Craies, said that in his experience a 200-volt lamp consumed on the average three-quarters of a watt more per candle than a 100-volt lamp. He thought that in changing over the consumer lost about 25 per cent. in the light he got for a given consumption of energy. Any improvement in the 200-volt lamp would also affect the 100-volt, and so the proportion would remain about the same.

Mr. V. D. B. COOPER was the next witness, and he gave, in examination, the whole history of the disputes between the Windsor Hotel and the Junior Carlton Club and the Westminster Electric Supply Company. As adviser to these two installations, he recommended that good contractors should be employed to make the alterations necessitated by the change over. In the case of the Windsor Hotel, which was wired originally in 1883, a considerable amount of rewiring was required. It was brought out in evidence that the company had refused to pay the amount of the suggested contractor's estimate, and that with a view of bringing pressure to bear they had raised the price to 8d. per unit. The Hotel Windsor had been previously charged 4d. per unit under a special agreement. As well as the suggested charge for rewiring, the hotel company asked for a guarantee that the bills should not exceed the average for the last three years before the change was made, or that they should guarantee a supply at 3d. per unit.

After a brief cross-examination, Mr. BALFOUR BROWNE said that in view of the fact that there were no less than 86 electric light undertakers in favour of the change, he did not propose to waste time over a squabble between an hotel and an electrical engineer, which could be settled by an arbitrator in half an hour. He did not see what objection these people could have to arbitration, provided their cause were just. Coming now to the draft of the proposed new clause which Sir Courtenay Boyle had given them, he suggested that it should be amended as follows: "Provided that no change shall be made in the pressure of the supply to any premises which on ——— were supplied with energy by the undertakers, except with the consent of the consumer; but where the consumer withholds his consent after the undertakers have offered to pay what in their opinion is the whole reasonable cost of and incidental to the change, and where the undertakers and consumers have failed to come to an agreement within one month, the undertakers may appeal to the Board of Trade, and that Board may, if it thinks fit, dispense with the consent of the consumer on such conditions as the Board impose." He thought that the alteration would prevent any undue delay in bringing the matter before the Board of Trade; he thought that the arbitration clause suggested by Sir Courtenay Boyle was much more fair than the amendment proposed by the councils for the City and the London County Council. He saw no reason why the arbitration should come under the Lands Clauses Act, as there was no analogy between taking a man's property and remodelling a few electric lighting fittings.

The case was then adjourned until Friday at 11 a.m., when other counsel will be heard, but no more witnesses called.

COMPANIES' MEETINGS AND REPORTS.

BAKER-STREET AND WATERLOO RAILWAY.

The half yearly meeting of the proprietors was held at the Westminster Palace Hotel on Monday.

Mr J T Hare who presided referred to the agreement with the London and Globe Finance Corporation of Nov. 4, 1897, for the construction of the railway. Up to now, he said, the works had been carried on by Messrs. Perry and Co. under agreements in pursuance of which this Company had paid them the amount of the engineers' certificates, less retention direct. The position

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now was that the railway company was entitled to enter on the works and employ Messrs. Perry and Co. or other contractors direct, in which case the London and Globe Corporation would have a claim only for the difference, if any, between the contract price and the sums already paid, plus the future costs. If, on the other hand, the Company was able to show damage by reason of the default of the corporation, they were entitled to have such damage estimated, and to prove for the amount of the estimate in the winding-up. The position with regard to the contract entered into for the construction of the railway authorised by the Acts of 1899 and 1900 was that the contractors had so far not been called on to commence, but by going into liquidation they had rendered themselves unable to perform it, and the Company was at liberty to regard the contract as abandoned, and prove in the winding-up for any damages it could show it would suffer by that contract not being carried out. The Company had ample assets to provide for the completion of the line, and negotiations were in progress for the transfer of the contracts to a strong financial syndicate, and the directors had reason to hope that these negotiations would terminate satisfactorily. He afterwards referred to the progress that had been made in the construction of the railway, etc., and pointed out that a large amount of the work had already been done. The line would run through the very heart of central London, and forming a connection with about 12 other railways and numerous tramway lines, followed a route second to none in London, and when it was completed it should not only be of the greatest benefit to the public, but also prove remunerative to the shareholders. A committee was now enquiring into the cause of the vibration of which so much had been heard in the case of the Central London Railway; there was little doubt that the Company's engineers would be able to obviate this on their railway. He moved the adoption of the report and accounts.

Sir Algernon West seconded the motion

In answer to a question, the **Chairman** said that all the capital of the Company was unaffected by the collapse of the Globe except the shares issued to the latter.

The motion was then carried unanimously.

A special meeting was afterwards held, when resolutions were passed approving the Bills for conferring further powers on the Charing Cross, Euston, and Hampstead and the Brompton and Piccadilly circus Railway Companies.

NEWMARKET ELECTRIC LIGHT.

The annual meeting of the shareholders was held on Monday at the Company's offices at Newmarket, Mr. G. H. Verrall, J.P. (chairman), presiding.

The **Chairman**, in moving the adoption of the report and accounts, stated that at the present moment there were connected with the mains 7,431 8-c.p. lamps, for 101 consumers, and applications had been received for a further 1,415 lamps from eight consumers. The Company were putting down additional plant for the supply of 6,000 8 c.p. lamps. When the mains were extended to additional roads, he had every reason to believe that there would be many more applications. Electric lighting companies did not usually pay a dividend before the fourth or fifth year, but he expected that they would be able to declare a dividend in the third year.

Mr. F. E. Gripper seconded the motion, and it was unanimously adopted, and the retiring directors, Messrs. H. J. Garrod and F. E. Gripper, were re-elected.

POTTERIES ELECTRIC TRACTION.

At the ordinary general meeting of this Company on Tuesday at the Cannon-street Hotel, **Mr. E. Garcke**, who presided, said that the directors had to congratulate the shareholders on the satisfactory report that they could present that day. The growth of business in the Potteries district since the introduction of an extended system of electric traction had been very remarkable. They would have done better still had it not been for the unfortunate strike in the district of potters and bricklayers, which lasted for two months (April and May), and not only interfered with the traffic, but delayed the work on the new generating station and the opening of the Chesterton and Silverdale lines, which did not get to work till Jan. 1 last. At the present time the Company was operating 28½ miles of line, and when the terminal extension to Blythe Bridge, now in course of construction, was completed they would be running over 30 miles of line.

The report was adopted, and further resolutions carried for the increasing of the capital of the Company in accordance with notice circulated to the shareholders, and also making a variety of alterations in the articles of association of the Company consequent thereon.

DIRECT SPANISH TELEGRAPH.

The accounts for the year ended Dec. 31 show a balance to the credit of revenue of £10,817. After adding the usual sum of £5,000 to the reserve fund, the balance will amount to £5,817, and the directors recommend dividends of 10 per cent. on the preference shares and 4 per cent., free of income tax, on the ordinary shares, amounting to £5,448. Half of this amount has been distributed as an interim dividend for the half-year ended June 30, 1900 There will then remain a balance of £369, which it is proposed to transfer to the contingencies account, and this account will then amount to £566. The traffic receipts show an increase of £1,029 as compared with the year 1899. The ordinary working expenses show a decrease of £210.

CHARING CROSS AND HAMPSTEAD RAILWAY.

The half-yearly meeting of the proprietors of this Company was held on Wednesday.

Mr. W. E. Jones, who presided, stated that 451 shares had been subscribed for, on which £2 had been paid; and the expenditure had been £151, leaving a balance at the bank of £780. He moved the adoption of the accounts.

Mr. Ernest Halsey seconded, and the motion was then carried.

An extraordinary meeting was afterwards held, when the **Chairman** proposed a resolution for raising the capital authorised by Section 37 of the Company's Act of 1899 by the creation and issue of new ordinary shares or stock at such time in such manner, and upon such terms and conditions as the Board should from time to time deem expedient, and for exercising the borrowing powers conferred upon the Company at such time as the Board should think fit.

Mr. W. T. Potts having seconded the motion, it was carried unanimously, and the proceedings terminated.

IMPERIAL TRAMWAYS.

The directors in their report for the year ended Dec. 31, 1900, state that the gross receipts of the Middlesbrough, Stockton, and Thornaby electric tramways amounted to £47 218. 17s. 9d., and the number of passengers carried to 8,782 970, compared with totals of £45 372. 13s. 8d. and 8,307,322 in the preceding year. These figures indicate a steady development and increasing popular favour, results which the directors are fostering in every possible way in their conduct of this important business. The net profit for the year amounts to £14,637. 10s. 9d., which is slightly in excess of that of the previous year and represents a return of about 6¾ per cent. upon the capital employed. The extension of the Middlesbrough line to Clarence Ferry is in course of construction, and the additional rolling-stock under order so that this branch will be opened in good time for the summer traffic. The net revenue account for the year shows an available balance of £35,286. 3s 2d., and after payment of interest on the debenture stock for the whole year and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last, amounting together to £23,386. 9s. 2d. it is proposed to appropriate the balance as follows: In payment of dividend at 6 per cent. per annum on the preference capital, £3,000; final dividend at 8½ per cent. per annum on the ordinary capital, £8,500; and to carry forward to the next account the remaining sum, £399. 14s. In addition the reserve funds have been increased during the year from £69,203 to £72,789.

HOVE ELECTRIC LIGHTING.

Directors: Colonel A. J. Filgate, R.E. (chairman); Colonel H. Wood, C.B (vice chairman); Harold A. Hoare, Esq.; Carleton F. Tufnell, Esq. Engineers: Messrs. Crompton and Co., Limited, London and Chelmsford. Secretary: Francis R. Reeves, Esq., M.I.E.E.

Report of the directors (with abstract of accounts) for the year ended Dec 31, 1900:

In common with all other industrial undertakings requiring steam power, the Company's revenue has suffered by reason of the increased cost of coal during the year, but, on the other hand, the increase in the consumption of electricity has more than compensated for the extra cost of coal. The progress of the Company is best shown by the following statistics:

Year.	Houses.	8-c.p. lamps.	Units sold.	Gross revenue.	Net revenue.
1897	397 ..	27,777 ...	268,243 ...	£7.269 ...	£3 602
1898	513 ...	36 967 ...	350.254 ...	9 480 ...	5 089
1899	671 ...	44,824 ...	444,499 ...	12,070 ...	7.097
1900	802 ...	52,919 ...	539,208 ...	13,828 ...	7,715

The result of the year's working is a net profit of £7,715. 14s. 5s., to which there has to be added the sum of £345. 17s. 9d. balance from the previous year, making a total of £8 061. 12s. 2d. After deducting debenture interest paid and accrued, the interim dividend at the rate of 7 per cent. per annum paid in October last, and providing for income tax, there remains a net balance of £5,161. 19s. 1d. to the credit of net revenue account. In addition to the £262. 5s. written off the preliminary expenses and installation account, as mentioned in last year's report, the directors have now written off £126. 12s. 1d., the balance of the preliminary expenses. The expenditure on general administration and management expenses during construction and fees on capital and registration, originally taken to account with the outlay on preliminary expenses, will stand as a final charge against capital. The directors propose to place £2,250 to the credit of the reserve fund, to declare a dividend (payable on April 15 next) at the rate of 9 per cent. per annum for the half-year on the share capital, making, with the interim dividend, 8 per cent. for the year, and to carry the balance of £545 15s. 1d. forward. During the past year the directors have issued 1,000 additional shares at the price of £7. 10s. per share, the premium on the issue being added to the reserve fund. With the addition now proposed to be made, the sum at credit of reserve fund will amount to £17 037. 17s. The amount (£600) annually set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, has proved insufficient to meet the outlays on this account during the past year, in consequence chiefly of the renewal of the Company's battery of accumulators. As a result, the balance of £315. 12s. 5d. has been taken from this reserve account, which now amounts to £945. 14s. 11d. The

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expenditure on capital account during the year has amounted to £6 862. 9s. the total expenditure up to Dec. 31 being £100,523. 3s. 9d. The site for a second generating station, referred to in last year's report, has been acquired by the Company, and the conveyance is expected to be completed during next month. The plans for this station are nearly ready, and is is intended to commence erection at an early date. In accordance with the articles of association, Colonel A J. Filgate retires from the Board by rotation, but offers himself for re-election. Messrs. J. H. Duncan and Co., the auditors, also offer themselves for re-election.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel	£2,479	2	4
Oil, waste, water, and stores	69	6	0
Proportion of salaries	379	12	0
Wages and gratuities	656	7	3
	3 584	7	7
Repairs and maintenance	600	0	0
Rents, Rates, and Taxes.			
Rents payable	248	19	2
Rates and taxes	64	11	5
	313	10	7
Management Expenses.			
Directors' remuneration	450	0	0
Salaries	652	0	0
Stationery and printing	75	4	9
General establishment charges	284	13	9
Auditor of Company	15	15	0
	1,477	13	6
Special charges—Insurances	149	16	3
Total expenditure	6 125	7	11
Balance carried to net revenue	7 715	14	5
	£13,841	2	4

Cr.	£	s.	d.
Sale of current (539 208 units)	13 069	9	1
Rental of meters and other apparatus	753	7	0
Transfer fees	2	7	6
Miscellaneous receipts	15	18	9
	£13,841	2	4

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	56,538	0	0
4½ per cent. debentures	7 300	0	0
4 per cent. debenture stock	17,700	0	0
Sundry creditors	3,759	14	4
Consumers' deposits	54	0	0
Creditors for interest	166	0	1
Unclaimed dividends	22	10	2
Reserve fund	14.787	17	0
Maintenance and repairs account reserve fund	945	14	11
Net revenue account—balance at credit	5 161	19	1
	£106,435	15	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	100,523	3	9
Stores on hand Dec. 31, 1899	103	8	7
Sundry debtors	4 990	19	6
Cash at bankers and in hand	818	3	9
	£106,435	15	7

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

Directors: Aymor H. Sanderson (chairman); J. Atkinson Hoaker; F. W Reynolds; F. E. Savory; R Percy Sellon M.I E.E. Consulting engineer: C. P. Sparks M.I C.E. Engineer: E. L. Ingram, A M I E E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1900:

The capital expenditure incurred during the year in respect of the Bournemouth Provisional Order, 1890, amounted to £26 342. 2s. The issue in March, 1900 of £70,000 4½ per cent. debenture stock was over-subscribed, and the premium received therefrom, after deducting the expenses of issue, has been carried to reserve. The balance from revenue account, together with the balance brought forward from last year, amounted to £12,579. 13s. 2d., from which must be deducted interest charges, depreciation, etc., leaving the sum of £8,052 10s. 5d. to the credit of net revenue account, as against £6 799. 13s. 5d. for 1899. Out of this sum the full year's dividend on the preference shares has been paid, and the directors now recommend the payment of a dividend on the ordinary shares of the Company at the rate of 6 per cent., less income tax, for the year ended Dec. 31, 1900. These payments absorb £7 391. 5s. 9d., leaving a balance of £661. 4s. 8d. to be carried forward. The equivalent of 53 379 8 c.p. lamps were connected to the Company's mains in Bournemouth at Dec. 31 last, showing an increase of 9 283 8 c.p. lamps for the year, and applications representing a further 1 896 8-c.p. lamps were then awaiting connection. The application of the Bournemouth Corporation in the last session of Parliament for a provisional order in competition with the Company was refused by the Board of Trade in respect of private lighting. The construction of the tramways between Bournemouth and Poole is practically completed, and the Company will shortly be supplying the necessary power for the working of the line. The Richmond (Surrey) Electric Light and Power Company, Limited, continues to make satisfactory progress. The directors have declared a dividend upon the ordinary shares of that company at the rate of 5 per cent. per annum in respect of the year ended Dec. 31 last, as against 4 per cent. for 1899. The retiring directors are Mr. Aymor H Sanderson and Mr. J. A. Hosker, both of whom, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, also retires, and offers himself for re-election.

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital authorised	150 000	0	0
Capital issued—			
7 500 preference shares of £10 each	75 000	0	0
7,500 ordinary shares of £10 each	75.000	0	0
	150,000	0	0
4½ per cent. debenture stock, redeemable at 107 per cent.	70,000	0	0
Sundry creditors on open account	12 111	17	4
Bills payable	8 050	7	9
Loans against security	16,950	0	0
Reserve from premiums received, £4 325. 14s. 3d.; less expenses of issue, £2 343. 18s 4d.	1,981	15	11
Leasehold and special redemption accounts	840	10	1
Reserve for bad and doubtful debts	55	17	4
Depreciation fund account	3,704	15	1
Balance at credit of net revenue account, £8,052. 10s. 5d.; less interim dividend, £1,565. 19s. 6d..	6,486	10	11
	£270,181	14	5

Cr. Assets.	£	s.	d.
Capital appropriated to the Bournemouth Provisional Order, 1890, including goodwill, £169 973. 9s. 10d.; less amount written off interest received, £401. 7s. 3d.	169,572	2	7
Investments in the Richmond (Surrey) Electric Light and Power Company, Limited	84 636	0	2
Provisional orders secured at cost: Poole and Branksome Order, 1897, £484 0s 6d.; Christchurch and District Order, 1899, £565. 7s. 5d.	1,049	7	11
Stores on hand	836	17	6
Sundry debtors	11,793	6	7
Office furniture, etc., less amount written off	26	19	0
Cash at bankers and in hand	2,267	0	8
	£270,181	14	5

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal and other fuel	3,196	10	0
Oil, waste, water, etc.	470	17	9
Engineers' salaries	385	6	10
Wages	951	5	6
Stores and works expenses	124	2	7
Repairs to buildings, engines boilers, etc.	226	18	1
Distribution of Electricity.			
Engineers' salaries	143	1	0
Wages	191	17	9
Repairs to mains, transformer stations, etc.	306	19	3
Rents payable and rates and taxes	822	3	6
Salaries, local office	358	13	9
Stationery and printing	85	12	0
Postage, travelling, advertising, and general charges	214	16	8
Auditor of Company	26	5	0
Auditor of County Council	10	10	0
Insurance	7	6	7
Leaseholds redemption fund	10	8	5
Reserve for bad debts	15	0	0
Balance	9,957	9	0
	£17,504	13	8

Cr.	£	s.
Sale of current	16 438	12 11
Rental of meters and indicators	722	9 7
Interest and discounts	63	11 6
Trading account	199	1 7
Rents receivable	74	7 1
Testing fees	6	11 0
	£17,504	13 8

NOTTING HILL ELECTRIC LIGHTING.

The fourteenth ordinary general meeting of this Company was held at the offices, High street, Notting Hill-gate, on Tuesday.

Sir William Crookes presided, and, in moving the adoption of the report and accounts said they had had a serious difficulty to contend with—the overloading of the present mains and the inability of the plant and machinery adequately to meet the demand for current during the winter months. As far as the customers were concerned, all that they had suffered had been an occasional dimness of light. Sufficient power had, however, already been obtained to cope with the Company's present requirements, and the directors trusted that such annoyances would not recur. With reference to their Bill, the powers they were taking in it were to acquire compulsorily a site in the Addison-road district in order to erect thereon a distributing station. Petitions had been lodged against the Bill by the owners of the freehold and by some residents adjoining the two sites, but they hoped to satisfy the objectors. A considerable quantity of current could now be sent out from Wood-lane, but it

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would not be available in the Addison-road district until the Company could erect machinery to distribute it in the area. To supply the northern part of the district in Notting Hill a distributing station had been erected, and would soon be in operation in Lancaster-road. The other distributing station in the rear of the offices had been working satisfactorily for some time The engineer advised that these arrangements as soon they were complete would enable the Company to resume connecting new customers in all parts of their area of supply, and very largely to increase the business.

Mr. J. W. Swan seconded the motion, which was unanimously adopted, and a resolution was afterwards passed approving the Bill referred to.

CITY OF LONDON ELECTRIC LIGHTING

Directors: Sir David L. Salomons, Bart. (chairman); Joseph Bevan Braithwaite, jun.; George Herring; Herbert Samuel Leon; Edward Lucas; Colonel B. H. Martindale, C.B.; Frederick W. Reynolds; Philip D. Tuckett. Frank Bailey, engineer. J. Cecil Bull, manager and secretary.

Abstract of report of the directors and accounts for the year ended Dec. 31, 1900:

The expenditure on capital account during the year ended Dec. 31, 1900, amounted to £242.974. 11s. 3d. The total revenue for the year was £223,776. 10s. 3d., from which must be deducted the following items: expenses of generation and distribution, £106,750. 16s. 4d.; rent, rates, taxes, general and special charges, £33 009. 18s. 4d.; transfer to repairs and maintenance fund, £25,000; expenses of issues of ordinary shares and second debenture stock, £2,285. 7s. 9d.; interest on loans, etc., £4 422. 9s. 5d.; leaving £52,307. 18s. 5d., to which must be added the balance brought forward from 1899, £1,622. 14s. 5d., making a total available revenue of £53.930. 12s. 10d. Of this sum the following amounts have been distributed or provided for: interest on first and second debenture stock for year ended Dec. 31, 1900, £19,687. 13s. 8d.; interim dividend on £400,000 6 per cent. preference shares paid in July last on account of the distribution for the year, £11.500, leaving a balance of £22.742 19s. 2d. Your directors recommend that a final dividend of 6s. per share for the six months ended Dec. 31, 1900, be declared, subject to the deduction of income tax, on the Company's preference shares, Nos. 1 to 40,000, making with the dividend of 6s. per share paid on account in July last a distribution at the full rate of 6 per cent. per annum on such shares. This will absorb £11,400 and leave a balance of £11,342 19s. 2d., which your directors propose to carry forward. The generation and distribution expenses for the year, including repairs and renewals were 61·13 per cent. of the gross earnings as compared with 49·31 per cent. for 1899, 36·1 per cent. for 1898. 31 3 per cent. for 1897, 34 per cent. for 1896 36 87 for 1895, 46 for 1894, and 54 2 for 1893. This unsatisfactory result is due to the high price of coal which obtained in 1900, and to the low average price per unit received from consumers. The average price per unit obtained in 1900 was 4·09d. Your directors, in view of these circumstances, have made a modification in the tariff, which it is believed will result in a substantial increase in the revenue. As a result of the recent capital expenditure it is anticipated that very considerable economies in the works costs will be possible during the current year. The number of customers and 8-c.p. (equivalent) lamps connected at Dec. 31, 1900 was 9 855 and 511 113 respectively. On March 6, 1901, there 540 389 8-c.p lamps (equivalent) applied for out of which 521,651 were connected, and the customers numbered 10 074. The Board of Trade units sold during the year 1900, excluding public lighting, were 11,272 968, as compared with 7 446,703 for 1899. The City of London Electric Lighting Act, 1900, has relieved the Company of the statutory obligation of setting aside a fixed percentage for depreciation every year, and the matter is now left to the discretion of your directors. In view of the fact that the sum of £16,349. 6s. 6d., which had been accumulated mainly out of revenue in former years, and which, until the passing of the Company's 1900 Act, could be used for any purposes of the undertaking other than for equalising dividends, has now been added to the depreciation fund, which stands at £96 045 15s. 7d., and that the large sum of £23,486. 4s. 11d., out of £25 000 set aside from revenue for the purpose, has been expended during the past year in maintaining the Company's plant, buildings, etc., in an efficient state of repair, your directors have not thought it necessary to provide any further amount for depreciation out of the revenue for the past year. This Act also authorised the Company to acquire compulsorily certain properties which are essential to the development of the Bankside works. Some of the properties have been purchased since Dec. 31, 1900, and negotiations are proceeding as regards the others, and there is a further capital liability in respect of the cost of the same, which will have to be provided for. As only 10,595 ordinary shares out of the 20,000 offered to the shareholders were subscribed for, your Board, to meet the commitments for capital expenditure, were compelled to obtain the sanction of the shareholders to further borrowing powers to the extent of £400 000, and these powers have been exercised by the creation of second debenture stock for this amount, of which £200 000 has been issued and subscribed. The declaration of Mr. Justice Farwell in favour of the Company that the three contracts with the late Commissioners of Sewers were valid has been varied by the Court of Appeal to the extent that two are invalid and that one is valid. This decision does not affect the Company's statutory right to supply electricity for private purposes throughout the City, but concerns principally the arrangements made with the Corporation, by the Company's predecessors, for the public lighting of the streets in the central and western districts of the City. Your Board are giving their careful consideration to the matter In accordance with the articles of association, three of their number (Mr Joseph Bevan Braithwaite, jun., Mr. Herbert Samuel Leon, and Mr. Edward Lucas) now retire, and, being eligible, offer themselves for re-election. Messrs. W H. Pannell and Co. retire, and, being eligible, offer themselves for re-election.

Revenue Account.

Dr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Generation of electricity—		
Coal and other fuel	4 936 2 11	73 191 14 10
Oil, waste, and stores	476 6 4	2 815 19 1
Water	175 16 6	2 052 3 2
Proportion of salaries	605 0 0	2 812 5 0
Wages and gratuities	1,754 19 2	10 672 0 4
Sundry expenditure	114 10 5	806 17 7
Total generation expenses	£8 062 15 4	£92,351 0 0
Distribution of electricity—		
Proportion of salaries	489 15 0	943 17 9
Attending mains and street boxes	112 2 7	776 1 5
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1,276 17 10	291 4 4
Wages and gratuities to transformer men and sundry stores	—	1,417 1 10
Carbons and other materials	890 18 6	139 1 9
Total generation and distribution expenses	£10,832 9 3	£95 918 7 1
Rents, rates, and taxes—		
Rents payable	675 3 10	5 401 10 6
Rates, taxes, and lighting	1,191 16 10	9,534 15 1
Management expenses—		
Directors' remuneration and salaries	922 17 9	7 383 2 4
Printing and stationery	132 16 4	1 062 10 9
General establishment charges	145 13 5	1,165 7 11
Meter reading	—	250 15 1
Auditors' fees	15 9 5	123 15 7
Trustees' fees	11 18 4	98 6 8
Legal charges	61 11 9	492 14 0
Special charges—		
Rebates and various fines	158 3 0	532 16 8
Bad debts	—	467 1 7
Official testing of meters	—	5 10 0
Insurances	129 19 1	1,929 10 9
Claims and allowances to reservists	—	224 19 3
Professional charges	—	277 9 2
Repairs to properties sublet	—	556 8 3
Total expenditure	£14 340 14 0	£125 420 0 8
Total of both public and private lighting		£139,760 14 8
Balance, being revenue for period carried to net revenue account		80,812 17 2
		£220,573 11 10

Cr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Sale of current	—	192 444 6 3
Revenue under contracts	13,192 14 4	—
Meter rentals	—	7,394 5 3
Rents receivable	443 4 9	6,648 11 2
Transfer fees	4 8 2	66 2 10
Rental of fittings, testing fees, etc.	—	379 19 1
	£13,640 7 3	£206,933 4 7
Total income		£220,573 11 10

General Balance Sheet.

Dr. Liabilities, etc.	£ s. d.
Capital account—amount received	1,666 453 0 0
Due from sundry tradesmen and others	58 653 1 10
Sundry creditors on open accounts	7 447 11 6
Loans from bankers	36 000 0 0
Sundry deposits from consumers	585 7 4
Depreciation and repairs and maintenance fund	97,559 10 8
Balance of premiums on issues as per last balance-sheet, £61,870. 18s., less written off expenditure on Wool Quay before abandonment as a generating station, £14,510. 1s.	47,360 17 0
Balance at credit of net revenue account, £34 242. 19s. 2d., less dividend paid on account, £11,500	22,742 19 2
	£1,936,802 7 6

Cr. Capital Expenditure and Assets.	£ s. d.
Capital expenditure	1,728 974 3 2
Stores at stations and elsewhere	42 861 16 4
Payments on account of contracts not completed	2 321 0 0
Sundry debtors for current supplied	81 537 15 5
Other debtors and payments in advance	2,853 7 7
Cash at bankers and in hand	2 832 9 5
Sundry deposits	2 001 0 8
Investments at costs and dividends thereon	73,420 14 11
	£1,936,802 7 6

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

361. What percentage losses are in modern machines usually allowed (*a*) in the armature, (*b*) in the field windings; and to what extent are these allowances dependent upon the purpose of the generator?—Z.

362. What is the practical method of calculating the air-gap reluctance of dynamos having slotted armatures? This little calculation is avoided in most text-books, and even in the one or two in which it does occur the results are widely different.—P. W. F.

ANSWERS.

Question No. 355.—In the event of a short-circuit occurring at night on a low-tension distributing network, what is the best course to pursue?

Best Answer to No. 355 *(awarded* 10*s.).*—The question is a general one, covering a multitude of particular cases, each of which may require different treatment. To indicate two main divisions, it is not clear whether the low-tension distributing network of a high-tension alternating-current system is meant, or the distributing network of a low-tension two or three or five wire system. As the first effect of the short-circuit will be felt at the station, the difference in systems involves a large variation in the means at the disposal of the engineer in charge to put things right again. The solution in each particular case is more usually found by the use of "gumption" on the part of the engineer than by his knowledge of theory. It is doubtful whether anyone can think out a set of cut-and-dried rules of procedure for every accident that can occur on his shift, or can remember his rule at the critical moment if he happens to have thought it out.

Treating the matter generally, however, it must be remembered that in every well-regulated station the minimum working plant and the minimum staff consistent with safety is employed on the night shift. (The question presumably deals with the time after the heavy load has gone off, as that is usually fairly early in the evening.) There is in every probability no mains engineer on the works, as even if repairs or extensions are being carried on, the mains engineer is nearly always in some inaccessible part of the area of supply. There should, however, be a telephone connection between the station and the mains superintendent's house, or at least it should be possible to ring up the chief engineer in desperate cases. If a short-circuit occurs, it is usually possible to (*a*) cut it out or (*b*) burn it out. In some low-tension stations, however, the chief engineers have discarded fuses throughout, and the only thing to do is to bring to bear all the power available from spare plant, battery, etc., until something goes. Occasionally, in the case of a heavy short, the plant gives way before the fault. In any case severe strains are produced both in the electrical and mechanical parts of the plant, which it seems a mistake to incur without some precaution. In alternating-current work it must be remembered that it is almost useless trying to parallel a machine with another working on a short—in fact, a heavy short will often pull the machines out of step. Even in direct-current work one cannot run up spare engines *ad lib.* to burn out a short, as the boiler power on night shift is (or ought to be) very limited, and a spare boiler cannot usually be got up in under half an hour even if it be a water-tube boiler under favourable conditions. In some cases it is found that where a short cannot be burnt out supply can be resumed by simply shutting down and starting up again—the explanation probably being that an arc has been set up bridging some insulation, which arc, of course, dies down on stopping the current, and is not renewed.

If a short occurs on a distributing network fed by transformers from high-tension feeders, one of three things will happen. The short, if small, may blow a fuse somewhere on the network, or may burn itself out; or if it is large, it will blow the primary fuses of the transformer or transformers feeding it. The engineer in charge must exercise his discretion as to whether any further attention (beyond logging the incident) need be paid to it. A complaint next day will probably indicate where the fault is if it is small. If a primary short occurs, it will blow the feeder fuse on the switchboard. The feeder should be tried once more with a light fuse, and if this goes the feeder should be locked off with the switch open, and the mains superintendent communicated with.

In low-tension work, a short on the network will probably be seen on several feeders. An attempt must be made to burn it out. If any protecting device, such as a circuit breaker or fuse, is in circuit, this will act if the machines will take the load. It is not always a safe thing to attempt to switch out a circuit on which there is a heavy short, as even with some so-called quick-break switches the heavy current may produce an arc which may get over on to other metal, wrecking the board. If the short is persistent, it is worth while shutting down for a moment and running up again. If this is no good, switch out the feeders showing the fault (if they are not all affected) and run up on the circuits which remain good. Communicate at once with the mains department, or failing this, the chief engineer.

The duty of the mains engineer varies with the magnitude of the area affected by the short. If the short is only slight, it may be difficult to locate, and may, therefore, be left until a complaint is received. If it is a serious affair, it must be located as soon as ever possible—the indications available being the feeders affected and the condition of fuses at junction boxes, etc. Possibly a complaint may arrive to assist matters, though this is not likely on night shift. It is not much use attempting to test a network for position of a fault, except in specially simple cases. A common method in serious cases is to cut the cable at a likely place and test the two sections for insulation. The fault will be found in one section only, which must be judiciously sub-divided until the fault is located. Another method where alternating currents are used is to keep supply on the cable and follow its course with a telephone and coil of wire. The induced currents in the coil make a hum in the telephone, which ceases at the point where the current goes to earth. Particular precautions must, however, be taken to avoid following an iron drain-pipe instead of the cable.

When the fault is found it must be cut out (if this is not already done) as close to the fault as possible, and notice given to the station engineer to resume supply to the surrounding consumers whose connections are intact. The question is now one of expediency and cost. It may be worth while to put a jointer on repairs at once, but he will want overtime money for nightwork, and possibly, if the job is a big one, personal supervision of the engineer himself will be necessary. The counter-balancing considerations are the time it will take to get the repair finished, the number of consumers cut off until the job is complete, and any special facility which any one of these consumers has for "making it hot" for the engineer if he finds his supply cut off. In the event of a short on a feeder, it is, of course, a matter of getting the work done in the shortest time possible to secure good work, and the mains engineer should grudge neither time spent in personal supervision nor expense in extra labour until the work is complete.—J. A. S.

Answer to No. 355 *(awarded* 5*s.).*—In the event of a short-circuit occurring at night on a low-tension distributing network, the best course to persue would be to burn out the fault. In most networks the sections are so arranged

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that each section can be isolated by taking out fuses, and consequently when a short develops in one of these sections the fuse is blown and the section isolated, and would soon be discovered. In a central station supplying current on the three-wire direct system, a short in the network would probably be between the neutral, or earth wire, and one of the outers. Now, if the resistance of the fault is very low, a large current will flow between the inner and the outer main, and if the section is properly fused, this would soon burn out the fuses, leaving the faulty section isolated. When the section had been discovered, the choice of leaving the repairing until next day or calling up the mains engineer, depends upon the nature of the load on the section. If a fault develops with sufficient resistance to prevent the rush of current, and thus blowing of the fuses, the best way is to disconnect the feeder nearest to the faulty section, which feeder is easily discovered by the state of the ammeters. The disconnection of the nearest feeder causes a rush of current through the faulty district, which, added to the current flowing through the fault, blows the fuses of the faulty section.

The result of a serious short would mean the fuses of the battery and balancer blowing, or failing this the armature of balancer would burn out, or one side of the battery would have to supply so large a current that it would probably ruin the battery. For this reason, upon a fault developing it is advisable never to use the battery to supply the current necessary. If the sections are not properly fused, the best way is to shut down and discover the fault as quickly as possible. This does not mean that the station is to be shut down, but only those feeders supplying the district in which the fault is discovered.—F. M. M.

Answer to No. 355 (*awarded* 5*s.*).—A very successful way of dealing with a short-circuit on a low-tension network at night is as follows: The system of wiring is not stated, so I take the triple-concentric with three feeders. Immediately the fault is observed by the switchboard attendant, either by the fuse blowing—in cases where you have a battery for nightwork—or where you have a generator feeding the mains and the fuse be too strong by the ammeter pointer falling off its pivot—such is the case

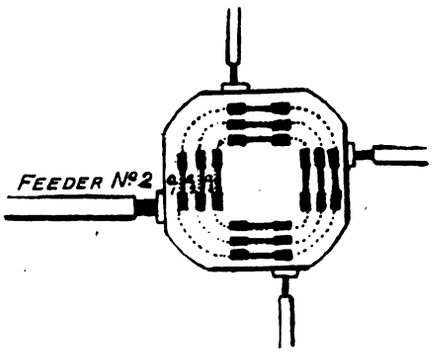

Fig. 1.

with Lord Kelvin's ampere-gauge—all switches should be taken out, including feeder switches. Instructions are then given, either to the mains foreman or jointer, whichever is the nearest to call, as to what part of the system the fault is on. This is known by looking at the feeder ammeters, and the one which has its pointer off the pivot is the feeder on which the fault is or nearest to. Suppose it to be No. 2 feeder, the man at once proceeds to the feeding point, where he disconnects the links at a_1, a_2, and a_3 (Fig. 1). A light fuse is then put in circuit with feeder at station, switch closed, and either battery or generator coupled to feeder. If the fuse stands, feeder is clear. Links are put back and still on No 2 feeder part of network is disconnected as at x (Fig 2). All switches are closed at station, and you again try battery on system with light fuse. If fuse blows, more network should be cut out, but if it stands you are sure that the short-circuit is cut out, and you again have supply on greater part of system. The man then takes out all connections in boxes on dead network, and commences from feeder box or other box with one line circuit in, with two short lengths of wire, with a light fuse connected across the two ends to test each circuit from line terminals to corresponding terminals of different circuits. If none of these blow the fuse they are connected to line circuit, and the man proceeds to another box on dead network, where he still uses the wires and fuse until he comes to the circuit which

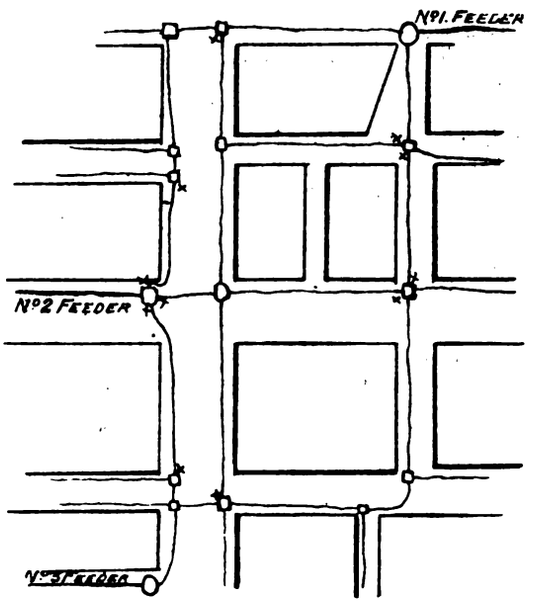

Fig. 2

blows the fuse. He then makes good all connections except faulty one, which is left cut out until examined and repaired in daytime.—A. R. W. A.

Answer to No. 355 (*awarded* 5*s.*).—A properly laid out network contains disconnecting boxes at every place where two or more streets containing mains join. These boxes should contain fuses properly proportioned to the size of the mains they connect. It is not necessary that every box should be fitted with fuses, but each box must have suitable means for disconnecting all the street mains which enter same. The fuses should then be distributed as nearly as may be on the circumferences of circles, of which the various feeding points are the centres. Each feeder box should be fitted with suitable means for easily disconnecting each pole separately, but should not contain any fuses on the feeder poles, but only on the distributors it feeds. At the station end each feeder may or may not be fitted with a fuse or an automatic cut-out; in the absence of the latter a switch should be provided on each pole. The sizes of the fuses in the disconnecting boxes should be governed by the section of the mains which are fused. If each main is fused to a current density of 1,500 amperes per square inch, they will be fully protected against damage from heating through excess current, while allowing sufficient margin for small faults and leaks to exist without interrupting the supply. With a network equipped as described, a short-circuit occurring even at top load need cause no great anxiety, though it may cause a local interruption of supply.

For the purpose of considering the best course to pursue, we may suppose a short-circuit of low resistance suddenly occurs on a distributor not very far from a feeding point. Then obviously most of the current through the short will be taken from the feeder nearest same, and the ammeter at the station will show at once the feeding point which is nearest the fault. If the current exceeds 150 amperes per square inch in the distributor on which the short occurs, the fuses on outers will blow; if, as will probably be the case, the distributor is alive from the other end as well, then, as all the current will now be fed from this end, the fuses here will give way, and the short will be completely isolated. If the faulty section was not detected by the ammeters, it would now be disclosed by the telephone. The only thing to do then would be to proceed at once to the section in question, disconnect at every box within the dead section, and connect up one at a time to the live network, flashing into each before joining up. The faulty piece is easily detected by the large flash due to the

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short as compared with the smaller flashes due to lamps switched on and bridging the outers. If the short occurs between neutral and one of the outers in a three-wire system the same reasoning holds, but the question is a little more complicated on account of the effect on the station balance. On thinking it over, however, it comes to this: that the balancer must be capable of supplying the maximum out-of-balance current which occurs in ordinary working, plus sufficient current to blow the largest fuse on any neutral distributor. This is at once obvious, when we consider that the balancer may be supplying, say, 100 amperes on positive side in district A at the moment a positive short of 200 amperes occurs in district B.

There is one species of short-circuit not covered by the above remarks—viz, a short on a feeder itself. In this case, if the current as shown by the feeder ammeter rises to an amount dangerously in excess of that for which the feeder is designed, the latter should be switched off at the works. This will cause the distributor fuses in the feeder box to blow, and the fault will thus be isolated.—E. M.

Question No. 356.—Describe a tramway scheme with distribution carried out on the three-wire system at 1,000 volts. Consider insulation and balancing difficulties; also saving in copper as compared with two-wire system at 500 volts.

Best Answer to No. 356 (*awarded* 10*s.*).—We will assume that the scheme comprises, say, five miles of main line, double track with four lines branching out of this, two on either side, each from one to two miles in length and single track with turn-outs. Such a route might, I think, be supplied with success on the three-wire system, with 1,000 volts across the outers. Some 40 cars would probably be required, and allowing an average of 30 amperes per car we should have to supply 1,200 amperes at 500 volts or 600 amperes at 1,000 volts. Three 400-kw. generators, allowing one as spare, giving 400 amperes each at 1,000 to 1,200 volts could be arranged to feed the network from a three-wire board similar to a lighting board, and fitted with the necessary traction instruments. There would be no difficulty with the insulation of such machines, nor any special novelty.

We will assume the generating station to be near the double line, and about in the middle of same. Two trolley wires will be necessary for the double line, and these should be fed, one from positive 'bus bar and the other from the negative, so that all cars going in one direction would be taking current from positive side and cars in the other direction from the negative side of system. With regard to insulation of car motors and wiring, since the rails would always be neutral, there would be no increased difficulty to be met provided the system is kept well balanced. The single lines on either side of the double track would be provided with a single trolley wire and worked in the ordinary way, being balanced one against the other alternately positive and negative.

The success of the scheme would mainly depend on the efficient balancing of the system, and for this purpose it would be necessary to have several balancer sets, consisting of ordinary shunt motors and dynamos working at 500 to 600 volts with fields crossed. These sets should be placed at different points of the line in sub-stations or suitable buildings. With the route above described probably three sets would be found sufficient, one at the central station and one about a mile to a mile and a half from each end of the double track. The station set should be of somewhat greater capacity than the others. To ascertain the necessary size of the balancers, we must consider the maximum out of balance likely to arise. The most unfavourable case would be a steep grade on the double line near the point where one of the single lines is taken off. In this case we might have two cars coming up the grade, taking, say, 100 amperes each, and the cars on the branch line another 100 amperes, or total of 300 amperes out of balance. This would require each balancing machine to be capable of dealing with something more than 150 amperes, and machines of 200 amperes capacity would be large enough. It must be remembered, however, that this want of balance may be partly neutralised by an opposite out of balance in some other part of the system. In any case the drop in the rails may easily be calculated. If we use 100lb. rails the resistance of a double track per mile, well bonded, will be about ·075 ohm; 300 amperes would give a drop of 22·5 volts per mile, and would produce a difference of pressure across the two sides of the system of over 45 volts. This shows at once the necessity of *distributing* the balancing machines so as to avoid contravening the Board of Trade regulation allowing seven volts drop between station and furthest point in rails. The balancers would have to be protected by automatic cut-outs, and would require restarting after a serious short on one side, unless the sections of track were nicely protected by cut-outs which would open before the sub-station cut-outs, but even if it were necessary to keep a man in each sub-station to attend to balancers it would certainly pay to use them. The outlay in copper for feeders would be exactly half, to which must be added cost of balancers and sub-stations, etc.; the net result would probably be a saving.

No doubt *the* one great difficulty in the working of such a system is the providing for the large out-of-balance currents which are likely to occur in ordinary working, and this fact, coupled with the Board of Trade regulations *re* maximum pressure, has operated to prevent any tramways being run on this system. The City and South London Railway, however, have adopted it for their extensions, and as the Board of Trade have sanctioned three-wire supply for lighting at 500 volts across outers, the pressure to earth being less than 300 volts, it seems not impossible that in course of time they may be induced to sanction supply of power for tramways at 1,000 volts across outers, more especially as, in the case of traction, the neutral is *permanently* earthed, and it should be quite impossible for the pressure to rise dangerously above 500 volts on either side.—E. M.

Answer to No. 356 (*awarded* 5*s.*).—The three-wire system for tramway work is the outcome of the various

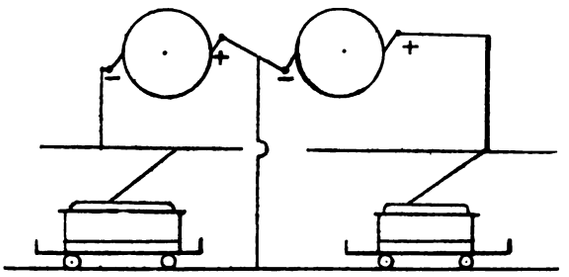
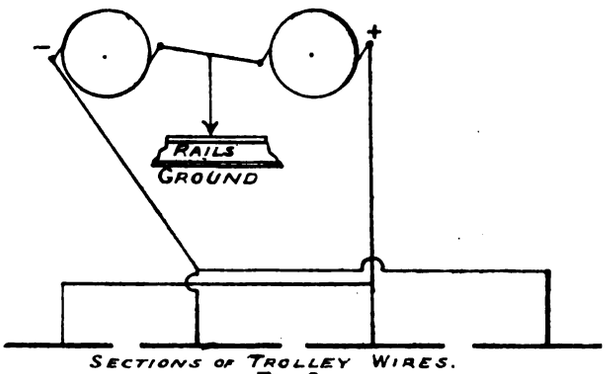


Fig. 1.

proposals made to avoid the troubles due to electrolytic action in connection with an earth return, and its general connections are shown in Fig. 1. The rails forming the centre or neutral wire or conductor, the earth, therefore, is mainly confined to the distance between the cars, instead of between the cars and the power-house, as shown. In Fig. 2 is shown the feeder and sections of the trolley wires. If the cars were



Sections of Trolley Wires.
Fig. 2.

bunched on one section of the trolley wire, this would, of course, disturb the balance, and a large flow through the earth to the power-house would result. This is a condition not at all likely to happen in practice.

The three-wire system is in use at Portland, Oregon, and the results are very satisfactory, the current being

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received from the Union Power Company, the distance from the power-house to the centre of the system being about 3½ miles, the load being about 2,000 h.p., and the three-wire plan was adopted to reduce the cost of feeders. A point showing the advantages was shown during construction. As the work was proceeding, it was found necessary to run part of the cars on the ordinary plan of two-wire tramway operation, and to change over when completed. As the feeders were calculated for the three-wire basis some difficulty was found in maintaining the pressure, the machines being speeded up to 600 volts, the loss on the lines being about 350 volts. When the work was completed and the full number of cars added the voltage of generators was lowered to 550 volts, and in spite of this lowering the pressure on the cars did not fall below 450 volts. The high pressure between the sections does not give trouble, except, I believe, that the section insulators have had to be lengthened, and care exercised in making all points and frogs of the same polarity. The wiring of the cars is the same as for the ordinary or two-wire system, and the saving of copper in feeders is about 50 per cent. over a complete metallic circuit. At the same time, the success of the system depends very much upon the judgment of the engineer in the laying-out of the overhead sections and their respective polarities with relation to the tracks lying in parallel streets, and if sufficient care is exercised the earth circuits can be made as short as possible, and thus maintain a fairly even balance of the load.—A. W.

APPOINTMENTS VACANT.

Electrical Engineer, Nelson Corporation, £200 per annum, March 25. Details in our advertisement columns.

Switchboard Attendants, Carlisle Corporation, March 25; Southend-on-Sea Corporation, 35s. per week, April 1. Details in our advertisement columns.

Meter Inspector, Brighton Corporation, in meter department, 25s. per week of 50 hours. Details in our advertisement columns.

Electrician, electrical works in the North-East of England. Details in our advertisement columns.

Inspector of Motormen, etc., Southend-on-Sea Corporation, 35s. per week. April 1. Details in our advertisement columns.

Canvasser, Aberystwyth and Chiswick Electricity Supply Corporation, Limited. Details in our advertisement columns.

Agents, by leading British manufacturing firm, making cables and wires, arc lamps, meters, instruments, etc. Details in our advertisement columns.

Assistant, Area Electricity Meter Company, Limited. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the electric lighting of the town for 30 years. Tenders by April 25.

Sunderland.—The Corporation invite tenders for indiarubber-covered cables, etc. Tenders by March 29. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of 104 arc lamp pillars, lamps, and accessories. Tenders by April 3. Details in our advertisement columns.

Ploesti (Roumania).—The Municipality invite tenders for the laying down and working of electric tramways for 30 years. The provisional deposit is £2,000. Tenders by April 3.

Kirkcaldy.—The Corporation invite tenders for engines and dynamos, storage battery, and overhead travelling crane. Tenders by April 15. Details in our advertisement columns.

Salford.—The Corporation invite tenders for wiring for motors, dynamo leads, engine room and switchboard connections, etc. Tenders by April 9. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for the supply and erection of various plant for electricity works. Full details in our advertisement columns. Tenders by April 11.

Leith.—The Town Council invite tenders for the supply, delivery, and erection of a 350-kw. steam dynamo, suitable for either private or traction supply. Details in our advertisement columns.

Grosswardein (Austria).—Tenders for electric lighting are required. The town has a population of 51,000, and 1,220 lamps, averaging 2,000 hours per year, will be guaranteed. Particulars may be obtained from the Municipal Authorities. Tenders by March 30.

Cheltenham.—Tenders are invited for the electric lighting of St. John's Church, Cheltenham. Specifications, etc., can be had from Mr. Weaver, Carlton-place, Hewlett-street, Cheltenham. Tenders by March 25.

Zagazig (Egypt).—The Local Commission invite tenders for the electric lighting of the town. Specifications, etc., may be obtained from the Public Works Department, Cairo, where tenders may be addressed until April 15.

Darwen.—The Corporation invite tenders for the supply and delivery of feeder cables, pillars, and overhead electrical equipment in connection with the electric tramways. Tenders by March 25. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane, and workshop equipment. Tenders by April 22. Details in our advertisement columns.

Farnworth (Lancs.).—The Urban District Council invite tenders for the wiring of the electricity works in Albert-road. Specifications, etc., may be obtained from Mr. J. D. Pember, electrical engineer, Council Offices, Farnworth. Tenders by 25th inst.

Bradford.—The Corporation invite tenders for the supply, delivery, and erection of a combined motor balancer and boosters, with switch gear for same, at their electricity works, Bolton-road, Bradford. Tenders by April 3. Details in our advertisement columns.

London, W.—The Directors of the Metropolitan Electric Supply Company, Limited, are considering the expediency of adopting larger units, and are prepared to receive designs for complete two-phase steam units. Full particulars appear in our advertisement columns.

Wallasey.—The Urban District Council invite tenders for the supply of tramway points and crossings. Further particulars may be obtained on application to the district engineer and surveyor, Mr. W. H. Travers, Public Offices, Egremont, Cheshire. Tenders by 26th inst.

Dundee.—The Town Council invite tenders for the supply and delivery of about 1,540 tons of steel girder rails and 60 tons of fishplates. Specification, etc., on application to Mr. Wm. Mackison, C.E., Municipal Offices, 91, Commercial-street, Dundee. Tenders by March 28.

Burnley.—The Corporation invite tenders for the supply and delivery of steel rails fishplates, soleplates, tiebars, and bolts and nuts required in the construction of about seven miles of double tramway track. Specification, etc., may be obtained at the office of the Borough Surveyor. Tenders by 26th inst.

Burnley.—The Tramways Committee invite tenders for the supply of the necessary materials for the overhead equipment in connection with the trunk line. Specification, etc., may be obtained from Mr. R. Birkett, borough electrical engineer, Aqueduct-street, Burnley. Tenders by March 23.

Metropolitan Asylums Board.—The Board invite tenders for the supply and erection of a complete electrical generating plant and a complete boiler plant for heating at the asylum now in course of construction at Tooting Bec., S.W. Tenders by April 24. Details in our advertisement columns.

Christiania.—Tenders are invited by the Norwegian State Telegraph Department for supply of telegraph wire, bronze wire, and telephone cables. Specifications and conditions of tender may be inspected daily between 12 and 1 on application at the Technical Department of the Telegraph Office in Christiania. Tenders by April 6.

Wolverhampton.—The Tramways Committee invite tenders for (A) the complete overhead equipment of about five miles of tramway route; (B) the supply and laying of feeders, conduits, and switch pillars for the same. Specification, etc., may be obtained upon application to Mr. C. E. C. Shawfield, borough electrical engineer, Commercial-road, Wolverhampton. Tenders by 23rd inst.

Warrington.—The Corporation invite tenders for (Section 1) supply, delivery, and laying of steel rails, paving, etc., forming permanent way; (2) supply, delivery, and erection of steel poles, brackets, trolley wire, insulators, etc., forming a complete overhead equipment; (3) electric tramcars. Specifications, etc., can be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's gate, Westminster, S.W. Tenders by March 27.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Bloom-street generating station of (a) switchboard for connecting four 1,800-kw. generators to the lighting and traction systems; (b) four continuous current motors for driving mechanical stokers and economisers. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall. Tenders by March 25.

Palencia (Spain).—Tenders are invited for the installation and working of a telephone system for not more than 20 years; 10 per cent. of the annual receipts will have to be paid to the Government. Tenders may be addressed to the General Post and Telegraph Department by April 21. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Newport (Mon.)—The Corporation invite tenders for the supply and erection of: (Section 4) constructional steelwork, bunkers,

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etc.; (5) steel flue; (6) coal and ash conveyor; (8) overhead travelling crane; (9) steam-boilers; (10) mechanical stokers; (11) fuel economiser; (12) water-storage tanks; (13) compound condensing vertical engines; (14) electric generators; (15) condensing plant with cooling towers; (16) feed pumps. Specifications, etc., may be obtained from Mr. H. F. Parshall, 8, Princes-street, Bank, London, E.C. Tenders by March 25.

London, W.C.—The British Electric Traction Company, Limited, on behalf of the Gravesend and Northfleet Electric Tramways Company, invite tenders for the construction of new tramways in Gravesend and Northfleet, and the reconstruction of the existing tramways in Gravesend; for the supply and construction of the necessary electrical equipment for working the overhead system. Copies of the specifications and schedules can be obtained on payment of £10, returnable upon receipt of a bona fide tender, from the secretary, Mr. Charles Dade, Donington House, Norfolk-street, Strand, London, W.C. Tenders by 25th inst.

RESULTS OF TENDERS.

Walsall.—The Corporation have accepted the tender of T. Tildesley, Willenhall, near Wolverhampton, at £2,020, for enlarging the electricity generating station in Wolverhampton-street, Walsall.

Batley.—The tender of Messrs. John Fowler and Co., Limited, of Leeds, for the supply and fixing of steam dynamos and balance motor-generator, etc., at the new electric generating station, has been accepted by the Council.

Dagenham (Essex).—The West Ham Town Council have accepted the tender of Foster Bros., Suffolk-road, Norwood Junction, at £595 10s., for erection of a dynamo-house at their small-pox hospital, Dagenham, Essex.

Bristol.—The Electrical Committee have accepted the tenders of Messrs. W. Bennis and Co., Bolton, for coal-discharging plant; Messrs. Babcock and Wilcox, London, for coal conveying plant; and Messrs. W. H. Allen, Sons, and Co. for condensing plant.

Great Yarmouth.—The following tenders have been accepted: W. H. Allen, Son, and Co., Limited, Bedford, two 300-h.p. engines with dynamos by the British Schuckert Electric Company, Limited, £3 693; Babcock Boiler Company, two boilers, £1 810.

Whitehaven.—The Electricity Committee have accepted the tender of R. G. W. Bradley, Millom, for the construction and completion of a chimney shaft, 120ft. high, and flues, in connection with the extensions at their electricity station, West Strand, Whitehaven, at £800. 19s.

Wolverhampton.—The Corporation have accepted the following tenders for extensions at the generating station in Commercial-road: Electric Construction Company, generator and Davey-Paxman engine, £3 240; Willcock and Co., further buildings, £1,332; T. Parker, Limited, electric fittings, etc., £374.

Middleton (Lancs.).—The Corporation have received the following tenders for a traction switchboard (Contract No. 8): Brush Electrical Engineering Company, London (accepted); Cowans, Limited, Salford; Crompton and Co., Limited, London; General Electric Company, Limited, London; Mechan and Sons, Glasgow; B. Thomas, Manchester; J. Fowler and Co. (Leeds), Limited, Leeds; W. J. Fryer and Co., London; Walsall Electrical Company, Limited, Walsall; R. W. Blackwell and Co., Limited, London; Dorman and Smith, Manchester.

BUSINESS NOTES.

TRACTION.

Dufftus (Scotland).—The Parish Council have withdrawn their opposition to the proposed Hopeman tramway.

Glamorganshire.—The County Council have decided not to oppose the granting of the Pontypridd tramways order.

Glastherpes.—Provided the weather permit, the erection of the poles for the overhead system of traction will be commenced at once.

Gravesend.—The National Electric Traction Company have deposited plans with the Town Council for the proposed electric tramways.

Kinver.—We understand that Colonel Yorke, R.E., will inspect the new electric tramway to Stourbridge on behalf of the Board of Trade to-day.

Brierfield.—The District Council have decided to apply for sanction to a loan of £4,000 in connection with the purchase of the Burnley tramways.

Manchester.—The Tramways Committee are considering a proposal in favour of forming a sick and benefit society for the tramway employés.

Cardiff.—The Mayor has received a letter from an occupier in Cathedral-road urging the extension of the electric tramways to the top of the road.

Southport.—The Corporation have received a memorial from occupiers in Lord-street objecting to the proposed electric tramway in that thoroughfare.

Portmadoc.—The Urban District Council at a special meeting passed a resolution to oppose the scheme of the proposed electric railway from Beddgelert.

Merthyr Tydvil.—Major Trotter has carried out the official inspection of the electrical equipment of the tramways.

Glasgow.—The Town Council have agreed to the magistrates making the regulations for the Corporation tramways, subject to the approval of the Council.

Wallsend.—The Town Council have agreed that they could not approve the Tyneside Electric Tramways Bill if goodwill were included in the purchase clause.

Plymouth.—The result of the poll which has been taken on the question whether there should be a Sunday service on the Corporation tramways is as follows: for, 7,633; against, 4,817.

Whitehaven.—At the last Town Council's meeting another spirited discussion took place with regard to the West Cumberland Electric Tramways Bill, which the Council recently decided to oppose in Parliament.

Berlin.—It is reckoned that 458,445 648 passengers travelled last year on the elevated railway, the trams, omnibuses, and electric cars of the city, being a total increase of 43,763,227 persons on the preceding year.

Aston.—The District Council have passed resolutions in favour of giving notice to the Birmingham and Aston Tramways Company of their intention to purchase the undertaking and making application to the Board of Trade to hold the usual enquiry.

Heston.—The School Board have decided to grant the use of a portion of the site for the Spring-grove Schools to the London United Tramways Company for the purpose of erecting sheds, etc., in connection with the transforming station in course of construction.

Continental Tramways.—While the Parisian local railway authorities are considering the adoption of electric traction for steam, it is interesting to note that several of the tramways are now run by electricity—for example, the lines to Auteuil, Sceaux, and Vincennes.

Folkestone.—The Board of Trade enquiry in regard to the Corporation's application for a provisional order for a scheme of tramways came to a conclusion on Saturday. We understand that the original scheme, involving an outlay of over £90,000, is very much pared down.

Fulham.—The Law and Parliamentary Committee have recommended that the promoters of the King's-road and Victoria Station Railway Bill be requested to insert a clause in the Bill making themselves liable for the general rate during the pulling down and rebuilding of properties.

Tynemouth.—The electric tram service was inaugurated on Monday. The new line, which is worked on the overhead system, reaches from North Shields to Whitley, a fashionable watering resort three miles away, and it is intended to still further extend it. The cost up to the present is about £60,000.

Ashton-under-Lyne.—The Board of Trade have sanctioned the borrowing by the Corporation of £26,570 for the construction of the tramways authorised under the Ashton-under-Lyne Tramways Order, 1900. Of this £17.110 is for permanent way and £9,400 the estimated expenditure on electrical equipment.

County of London and Brush Provincial Electric Lighting Co.—The directors recommend a final dividend upon the ordinary shares of 4 per cent. per annum for the half-year ended Dec. 31 last, making 4 per cent. for the year, and on the preference shares of 6 per cent. per annum for the half-year to Dec. 31, 1900.

Birmingham Tramways Co.—The directors recommend a dividend of 5 per cent. per annum for the six months ended Dec. 31 last, together with a bonus of 5 per cent. for the year, making a total dividend of 10 per cent. per annum on the ordinary shares. This will leave £38,559 to be carried to reserve fund.

West Riding.—The County Council have adopted the recommendation that the County Council are of opinion that all motor-cars should, for purposes of identification while travelling, be numbered or otherwise marked and registered, and that the drivers should be under obligation to stop when signalled to do so.

Local Authorities' Veto.—The West-end Tramways Opposition Association have circulated a letter among local authorities calling attention to the alteration proposed to be made in the Standing Orders of the two Houses of Parliament with reference to Tramway Bills, which will abolish the veto hitherto vested in local and road authorities.

Pembroke (Ireland).—On Monday the Urban District Council again received a deputation from the Wexford Railway Company in reference to the proposed Dublin Scalp and Enniskerry electric tramway. It is contended that the advertisements published did not correctly state the object sought to be obtained under the provisional order.

Sheffield.—At a meeting of the Tramways Committee on Tuesday the Chairman reported that at a recent meeting of chairmen of all the standing committees of the Corporation he offered, on behalf of the Tramways Committee, to pay a further sum of £5,000 out of the tramway receipts in relief of the rates. The chairman's action was approved.

Warrington.—The question of the overhead system of traction, which it is proposed to adopt in the town, was raised at the monthly meeting of the Council, when it was stated that the Telephone Company had agreed to place their wires underground, and that probably the Government would do the same in the case of the telegraph wires.

London County Council.—The newly-constituted Highways Committee consists of the following gentlemen: Sir J. Dickson-Poynder, Messrs. J. A. Baker, R. M. Beachcroft, J. W. Benn,

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E. Browne, N. W. Hubbard, W. C. Johnson, S Low, M. Maybew, R. Parker, W. R. W. Peel. R. C. Phillimore D S. Waterlow, T. Wiles, and T. McKinnon Wood.

Southampton.—At the City Council meeting last week, the report of the Tramways Committee was presented, including the estimate for the year ending March 31. 1902 The estimated income was £41,500, and the estimated expenditure £33 260, leaving a net estimated profit of £8 240 of which they proposed to allocate £5,000 to the reduction of the borough rate.

West Cumberland Electric Tramways.—The following have petitioned the House of Commons for leave to oppose by counsel the Bill at the committee stage: Workington Corporation, Lord Leconfield, London and North-Western Railway and Furness Railway Companies, Whitehaven Corporation, Cleator Moor Urban District Council, North British Railway Company, and others.

Bury, Rochdale, and Oldham Tramway Co.—At the half-yearly meeting of this Company last week, the Chairman referred to the approaching purchase of the tramways by the local authorities, and said fair progress was being made, but they did not yet know what the purchase price would be fixed at, nor when it would be fixed. He was hopeful of a price being mutually agreed upon.

Wolverhampton.—At a meeting of the Town Council last week the Chairman of the Tramways Committee stated that the present position was this—the Corporation had had to agree to the insertion of a clause in their Bill that the powers to purchase the tramway lines in certain outlying districts should not be exercised without the consent of the owners of the undertaking, now the British Electric Traction Company.

Leeds.—The question of a reduction of the fares on the Roundhay Park route will be discussed at the next meeting of the Tramways Committee. The Corporation have now received the Board of Trade certificate as to the efficiency of the permanent way of the Beeston and Elland-road tramway. With regard to the electrical equipment of the lines, it is expected that the Government inspection will take place shortly.

Hampstead.—On the motion of Sir Richard Temple, the Hampstead Heath Protection Society resolved on Tuesday night to offer vigorous opposition to the proposed tube railway under Hampstead Heath. The Earl of Mansfield presided at the meeting, and it was stated that a petition against the proposal would be sent to the House of Lords. The Borough Council have withdrawn their opposition to the Charing Cross and Hampstead Railway Bill on certain terms.

Bath.—At a meeting of the Corporation on Tuesday a report was presented from the Electric Traction Committee which showed that the Light Railway Commissioners, in the draft of an order for the establishment of electric trams in the city, had made considerable alterations in the agreement entered into between the private promoters and the authority when they consented to jointly apply for the order. After some discussion, the further consideration of the report was deferred.

Bury.—The clerk has been instructed to communicate with the Rochdale Corporation with a view to inducing the latter to run the trams to Bamford. The Norden District Council are also being communicated with. The Town Council have resolved that the estimates for the permanent way, overhead equipment, cars, and car sheds be approved, and that application should be made to the Board of Trade for borrowing powers for the sum of £60,000 for carrying out the work.

Chester.—The City Council and the Rural District Council have intimated that no objection will be offered to Messrs. Watson's intention to try a service of motorcars between Chester and Farndon. At a recent meeting of the Lighting Committee, Mr. Thursfield reported he had occasionally to charge small accumulators on electric vehicles, and the following charges were fixed: 6d. per unit, with a minimum charge of 2s., to cover cost of supervision; exceeding 20 units, 3d. per unit.

British Columbia Electric Railway Co.—This Company have convened an extraordinary general meeting, to be held in London on the 25th inst., for the purpose of obtaining the sanction of the proprietors to a further issue of capital. In their covering circular the directors state that, in anticipation of a further increase both in the railway and lighting business, they have decided to purchase additional rolling-stock, and to considerably increase the electric lighting plant and make other extensions rendered necessary.

Tunbridge Wells.—In a letter to the editor of the *Kent and Sussex Courier*, Mr. R. N. Goldie says: "I feel confident that Tunbridge Wells would reap large benefits by introducing electric tramways but unless the scheme is thorough and complete from its inception and in all its details, with a view also not so much to present profits but rather future benefits, it will be far wiser to leave the matter in the hands of the next generation, for a compromise between those for and those against electric tramways can only mean disaster as far as the success of the enterprise itself is concerned."

Tube Vibration.—The Special Committee appointed to enquire into the question of the alleged damage to frontages and others caused by vibration in the working of the traffic of the Central London Railway resumed its sittings this week. Lord Rayleigh presiding. Further evidence was given as to the vibration in premises in Holborn, New Oxford-street, and other places. The City Corporation have instructed the remembrancer to get leave of the property owners on the line of route of the Central London Railway to appear on their behalf before the Board of Trade Committee.

Newport (Mon.).—In July next the Corporation will take over the whole of the tram services from the present lessees, and the system will be worked by the Municipality. The initial work in connection with the proposed central power station, which is to be erected upon a site purchased from Lord Tredegar at cost of over £8,000 off the Corporation-road, is nearly complete. The cost of the buildings, machinery, etc., is estimated at £200,000. For this outlay the Corporation will be able to supply power for various industrial operations.

Newcastle.—At a meeting of the Tramways Committee last week the deputation appointed to visit Glasgow reported in favour of the adoption of the Chisholm iron blocks in all parts of the system where heavy traffic existed, as they were an excellent contrivance for strengthening the rails. The electrical engineer, Mr. Hopkinson, reported that the first orders for cars were now in a fairly well advanced state of completion, and that the firm were prepared to deliver five cars every week after the lapse of a certain time. It was further reported that 11 miles of track were now completed.

Scarborough.—When the Scarborough Electric Tramways Bill came before the Standing Orders Committee of the House of Commons, the Examiner of Private Bills reported non-compliance with the Standing Orders the company not having obtained the sanction of the Scarborough Town Council. The Chairman decided that the Standing Orders could not be dispensed with, and the Bill is therefore rejected for the present session. The Corporation intend to retain in their own hands the powers to construct tramways, and will this year apply for a provisional order to construct tramways in various parts of the town.

Liverpool.—Owing to a telephone pole weighing about two tons falling on to the electric tramway trolley wire, traffic on the Wavertree route was delayed for more than two hours on Sunday morning. The wire did not break, but was forced almost to the ground by the weight of the pole. The Bootle magistrates were recently engaged in hearing a number of summonses taken out by the Liverpool Corporation against persons for travelling on the electric tramcars beyond the penny stages without paying the additional fare. The defendants stated that the stages were most confusing, and caused people to get muddled. In each case a fine of 2s. 6d. and 2s. 6d. costs was imposed.

Richmond.—With regard to the opposition of the Town Council to the tramways scheme, the London United Tramways Company, it is reported, offer not to insist on the overhead electric system, but to let the Council choose any system it likes if it will only assent to the company's Bill. The company also offer to carry out street widenings at a cost of £30 000 pay an annual subsidy of £500 carry ordinary passengers from Richmond to Hammersmith for 2d. and workmen for 1d., and to bind themselves to carry out no extensions in the borough without the consent of the Corporation. The Council have not yet assented. A meeting of tradesmen has passed a resolution strongly in favour of the scheme.

Dundee.—From a statement showing the rates of wages on the electric cars it appears that the motormen are paid 24s. per week for the first six months, and 25s. per week during the second half-year. In the second year the pay is raised to 26s., in the third year to 27s., and thereafter it remains at 28s. Motormen, however can have an addition to their pay by means of merit badges awarded at the pleasure of the committee, each carrying an additional 1s. per week, and the maximum number being five. The conductors to begin with receive 22s. per week, rising after three years' service to 26s. Ten hours constitute one day, including 15 minutes in the depôt either before or after the time employed on the road.

Bradford.—The City Council have approved the action of the Tramways Committee in rescinding a previous resolution that 5 per cent. of the gross receipts from the tramways, together with the revenue from advertising on the cars, be set aside annually as an insurance fund commencing from Jan. 1, 1900, and deciding, in lieu thereof, that 5 per cent. of the net profits, or such other proportion as may be from time to time determined, be set aside annually as an insurance fund against accidents. During a three minutes' sitting of the City Council on Tuesday, £30,000 were voted on account of electrical and tramway works. Intimation was also given that sanction had been obtained for the borrowing of £140,000 for the same purposes.

County Councils and Tramway Schemes.—In the House of Commons last Friday Mr. J. W. Lowther moved amendments to Standing Orders 134 (c) and 170 (a) with the object of giving the county councils a *locus standi* to appear against tramway schemes when the tramways proposed were to run along roads for which the county councils were responsible, and of extending from 21 years to a maximum of 42 years the period at the end of which the local authority might purchase a tramway undertaking, as it was found, especially in the case of electric trams, the life of which was put by engineers at 42 years, that the shorter period was not sufficient. These alterations would apply to the whole of the United Kingdom. The amendments were agreed to.

London County Council Tramways Bill.—This Bill came before the Standing Orders Committee of the House of Commons on Tuesday, Mr. Halsey presiding. The report of Mr. Campion, one of the examiners of private Bills, with reference to non-compliance with Standing Orders, was submitted. In this it was pointed out that the promoters had failed to obtain the necessary consent of certain of the borough councils, the road authorities of districts through which it was proposed to construct lines. The opposing authorities included the Councils of Hackney, Stoke Newington, St. Pancras, Holborn, Marylebone, Westminster, and the city of London

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among others. Ultimately the committee decided to allow the Bill to proceed, on the condition to which the County Council had assented—namely, to strike out of the Bill the powers to make the tramways objected to by the local authorities.

LIGHTING AND GENERAL.

National Electric Wiring Co.—The directors recommend a dividend of 4 per cent. for 1900.

Camberwell.—The Borough Council object to the erection of overhead wires by the Postmaster-General.

Watford (Herts).—A report has just been submitted by Messrs. Cardew and Preece on the electric light scheme.

Sunderland.—The Town Council have decided upon an extensive scheme of street-lighting by electricity, involving the erection of nearly 100 lamps.

W. T. Glover and Co., Limited.—The preference and ordinary share transfer books will be closed until the 31st inst., inclusive, for the preparation of dividend warrants.

Cleethorpes.—Mr. C. S. Vesey Brown, Lincoln, is to visit Cleethorpes next week to confer with the Electrical Committee regarding incandescent lamps for street-lighting.

Wednesbrough.—The District Council have appointed delegates to attend a proposed conference to be held at Wakefield in connection with the South Yorkshire Electric Power Bill.

Gourock.—A deputation from the Town Council visited London last week in connection with their application for a provisional order for the supply of electricity for lighting purposes.

Stamford.—The Urban Electric Supply Company will shortly commence operations in Stamford in order to fulfil their obligations under the Stamford Electric Lighting Order, 1900.

Bournemouth and Poole Electricity Supply Co.—The directors recommend a dividend on the ordinary shares at the rate of 6 per cent. per annum, less income tax, for the year ended Dec. 31.

Share Market.—During the past week electric shares have been steady, with some demand for lighting shares. A fair number of traction shares changed hands. B.E.T. continued to rise.

London Gazette.—A receiving order has been made out *re* A. I. Greenberg, carrying on business as the Midland Electrical Company, 20, Caroline-street, St. Paul's, Birmingham, on debtor's petition.

Rothesay.—The engineer has been instructed to obtain from an independent expert a report upon the whole electric lighting system of the burgh on account of the complaints which are being made.

Maybank Power Station.—The British Electric Traction Company have placed an order with Messrs. Frank Suter and Co., 66, Berners-street, W., for two "Helios" tramway generators of 440 kw. each.

Burton.—The charge for electrical energy for heating and power has been fixed at 2d. per unit for 117 hours or less per quarter, and at 1d. per unit for any additional number of hours during daylight.

Pudsey.—A public meeting of owners and ratepayers on Tuesday sanctioned the opposition by the Corporation of the Bills of the South Yorkshire Electric Power Company and the Electric Power (Yorkshire) Company, now before Parliament.

Farnham.—The Urban District Council in committee last week heard Mr. Gripper (from Edmundsons' Electricity Supply Corporation) and afterwards decided to recommend the Council to take the necessary steps to light the town with electricity.

Weston-super-Mare.—The Urban District Council are making enquiries of the Weston-super-Mare and District Electric Supply Company, as to whether they would be prepared to light any portion of the Marine-parade with electric light by July 1 next.

Luton.—The Borough Engineer states that the electric light and power buildings are nearly completed, and the works are being carried out to his satisfaction. A correspondence is taking place with the National Electric Wiring Company *re* free wiring.

Arc Lamp Pillars.—Messrs. J. W. Brook and Co. inform us that the lamp standards supplied at Lowestoft were also designed by them. This design has been registered under No. 350 728. An illustration of these handsome columns appeared in our issue of March 1.

Edinburgh.—During the fortnight ended the 14th inst. the amount of fresh electrical energy applied for was equal to 4,481 8 c.p. lamps. Of this total, the equivalent of 300 was asked in respect of motor power, and the remaining 4,181 for lighting purposes.

Leeds.—The Highways Committee of the Corporation have just granted an application by the Lighting Committee to lay cables for electric lighting in a number of streets in the east end of the city, including South Accommodation-road, Cross Green-lane, and Easy-road.

Cable Communications Committee.—At a meeting of this committee on Tuesday evidence was given by Mr. B. T. Ffinch, Director-in-Chief of the Indo-European Telegraph Public Works Department, and Mr. C. H. Reynolds, late Director-General of Telegraphs in India.

Hebburn.—The Electricity Company have received deputations relating to the supply of electricity in the district from the Northern Counties Electrical Power Company, the County of Durham Electrical Power Distribution Company, and from Messrs. Hancock and Balfour.

Arbroath.—The resolution of the Corporation to undertake the electric lighting of the burgh in place of allowing a company to carry out the scheme is being criticised by a considerable section of the ratepayers.

Sale of Plant.—An important sale of electric light fittings of all kinds will be held, on account of dissolution of partnership, at 22 and 23 Victoria-parade, Torquay, on March 27 and 28. Particulars of this and other sales will be found in our advertisement columns.

Brighton.—The Town Council's scheme for the improvement of the Aquarium contains a complete electric installation, which is to take the place of the existing gas lighting, and a special form of lighting at night will be applied to the fish tanks, and help to illuminate the corridors.

Merthyr Tydvil.—The Board of Trade have transmitted for the observation of the Council the system proposed to be adopted for the supply of energy under the Merthyr Electric Lighting Order of 1899, and the matter has been referred for report to Messrs. Hancock and Dyke, of London.

Whitehaven.—The blower for forced-boiler draught has been tried, and Mr. Stiven has reported on it as very satisfactory, stating that it would effect a saving in coal, as it would enable an inferior coal to be used. Mr. Bradley's tender for the erection of the new chimney has been accepted.

Alleged Non-Compliance.—Mr. Elijah Hawkes, of Cathall-road, Harrow Green, has applied for a writ of sequestration against the Leyton Urban District Council for alleged non-compliance with the order of the Court in working the gas-engines at the electric light works in Cathall-road so as to cause a nuisance. The case is to be heard during the latter part of this week.

Greenock.—The accounts of the electricity department for the period from Aug. 14 1897, to Dec 31, 1900, show that the amount authorised to be borrowed was £100,000, and that £50 000 had been borrowed. The total expenditure was £40 769. 4s. 10d., of which £2 700 went in lands, £6 341. 16s. 3d. in buildings, £12 151. 3s. 7d. in machinery, and £13 288. 13s. in mains and services. The revenue account shows a balance of £764. 3s. 3½d., which has been carried to net revenue account.

New Firm.—Mr. A. H. Hunt has opened an office and warehouse at 59 Gresham street, E.C., for the supply, to the trade only, of electrical plant, fittings, switchboards, and accessories. Mr. Hunt, who has been connected with the electrical industry for over 16 years, was on the staff of the Edison and Swan Company for the last 12 years, during the greater part of which he had complete charge (under the general manager) of the estimating, buying, pricing, catalogue, and advertising departments, as well as other technical administrative work at the company's head office, Queen street. We wish Mr. Hunt every success in his new venture.

Farnworth.—The electric lighting and traction schemes of the District Council are rapidly approaching completion. Hitherto the lighting in the district has been solely by gas supplied by a private company. The new project for electric lighting and the tramway will, it is expected, involve a cost of about £22 000. At present the tramway system is being operated by the Bolton Corporation. When their undertaking is complete, however, the Farnworth Council will supply the current and run their own cars, which are now building; and by an agreement with the Kearsley District Council, Farnworth will also supply the current for lighting and traction in the Kearsley area, but the Council of the latter district will lay their own lines and erect their own poles. Operations for laying the cables in Farnworth have commenced this week, the work being in the hands of the British Insulated Wire Company, Limited. The Council's generating station in Albert-road is advancing towards completion, both as regards structure and equipment, and it is expected that on an early date the current for lighting purposes will be available. The plant includes three Lancashire boilers, driving three vertical compound engines of 200 h.p., coupled to three dynamos of 120 kw. output. There is also being provided a set of accumulators consisting of 250 cells. The engineers are Messrs. Lacey, Clirehugh, and Sillar, of Westminster and Manchester.

Stock Exchange.—The Stock Exchange Committee have appointed April 3 a special settling day for Edmundson's Electricity Corporation's 13 363 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 6,638 to 20.000; and Johnson-Lundell Electric Traction Company Limited, 37 398 shares of £5 each, £3 paid, Nos 20,008 to 52,581; 52.654 to 53.119; 53 353 to 53,766; 53,814 to 53.850; 55,715 to 58,923, and 59,110 to 59,807. The committee have also ordered the undermentioned securities to be quoted in the official list: British Insulated Wire Company, Limited further issue of 30,000 ordinary shares of £5 each, fully paid, Nos. 40 001 to 70.000 and 30 000 6 per cent cumulative preference shares of £5 each, fully paid Nos. 40,001 to 70 000; and Edmundson's Electricity Corporation, Limited, 13,363 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 6.638 to 20.000, and a further issue of £45,000 4 per cent. first mortgage debenture stock. Application has been made to the committee to appoint a special settling day in, and to grant to, Cape Electric Tramways, Limited, further issue of 40 000 shares of £1 each. Application has also been made to allow the following securities to be quoted in the official list: Buenos Ayres and Belgrano Electric Tramways Company, Limited, £120,000 5 per cent. second debenture stock, in lieu of provisional certificates now quoted, and 100,000 ordinary shares of £5 each (special application); Kensington and Knightsbridge Electric Lighting Company, Limited, and the Notting Hill Electric Lighting Company, Limited, further issue of £26,991 4 per cent. debenture stock.

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Fulham.—The resident engineer's last report states that since the last meeting applications equivalent to 133 8-c.p. lamps had been received, making the total applications 162 in number, equivalent to 12,132 8-c.p. lamps.

Ludlow.—The electric lighting scheme prepared by Mr. Packer has been deposited at the town clerk's office for the inspection of members of the Council. The Electric Lighting Committee are prepared to move its adoption at a special meeting. The question has been adjourned until the 28th inst.

Nantwich.—Mr. G. R. Peers, electrical engineer to the Nantwich Urban District Council, having asked on behalf of that Council whether the Guardians would use the electric light in the workhouse in case the Council took the main cables up the Barony-road, the Guardians have decided not to accept the offer at present.

Macclesfield.—We learn that the Town Council have received an intimation from the Board of Trade that the application of the Electrical Power Distribution Company for an order enabling them to supply Macclesfield with electricity has been disallowed, and that the application of the Corporation is now being considered.

Bradford.—At Tuesday's meeting of the City Council the Electricity Committee notified the receipt of sanction from the Local Government Board to the borrowing of £140,000 for lighting and traction extensions. They recommended the letting of contracts for works extensions amounting to £21,937, which was approved.

South Yorkshire Electric Power Bill.—When this Bill came before the Standing Orders Committee of the House of Lords on Monday, it was decided that compliance with the Standing Orders should be dispensed with, on condition that the proposed exemption of the company from the provisions of Section 81 of the Electric Lighting (Clauses) Act, 1899, should be struck out.

Cardiff.—At a meeting of the Electric Lighting Committee on Tuesday the Electrical Engineer stated that he thought the time had now come for the committee to reduce the charges for electrical lighting, and intimated that it was his intention by the next meeting to draw up a new scale of charges for electric lighting and for the supply of electricity for motive purposes.

Driffield.—We have already referred to the negotiations between Dr. Brand and the National Telephone Company and the Postmaster-General with a view to the establishment of a telephone exchange in Driffield and the connection of that town with the trunk system at Hull. We learn that half the amount of the seven years' guarantee of £100 demanded by the latter has been raised.

Teddington.—The District Council have given general consent to the laying of the Post Office telephone distributing pipes under the footways and streets in the district on condition that the Postmaster-General makes good the footways and streets disturbed to the satisfaction of the Council's surveyor, and that the option of restoring the paths and roads at the cost of the Post Office Department be first given to the Council.

Personal.—We are informed that Mr. Wm. Boyd, A.M.I.M.E., A.M.I.E.E., has severed his connection with the Central London Railway Company. Mr. Boyd was on the engineering staff of the Electric Traction Company during the construction of the Central London Railway, and joined the railway company's staff when the line was opened to organise their electric lighting department, of which department since he had entire control.

Bristol.—The Town Council are about to appoint a committee to enquire as to the extent to which telephonic communication is used by the inhabitants of the city and the payments made therefor, and to consider and report to the Council upon the expediency of applying to the Postmaster-General, under the powers of the Telegraph Act, 1899, for a license to enable the Council to provide a system of telephonic communication.

Colwyn Bay.—We understand that Mr. A. R. Tudman has been appointed manager of the electric lighting undertaking of the Urban District Council. Draft specifications for the extension of the electric plant submitted by the engineer have been approved, and tenders will now be issued. The engineer has been requested to report on the cost of supplying an arrangement to stop the noise and vibration caused by the exhaust steam.

Abersychan.—At the last monthly meeting of the Urban District Council the Clerk intimated that the Council could not take any steps in the matter of the proposed provisional order for the lighting of the district with electricity until October next, and when the provisional order was obtained the Council would have the prior right of supplying the district over others, and to purchase the electricity from the South Wales Electric Power and Light Company, and to retail it to the inhabitants.

Bury (Lancs).—The estimates for the generation of electricity for purposes of lighting and traction have been approved, and application is to be made for borrowing powers for the sum of £21 500 for the purpose, repayable within a period of 30 years. The whole of this sum is not in addition to the £60,000, borrowing powers for which are already obtained, but simply an addition of £4,000 or £5,000 for extra plant required in connection with the traction scheme. Reference to a loan of £50,000 for the latter will be found in another column.

St Marylebone.—At last night's meeting the Legal and Parliamentary Committee recommended the Borough Council to communicate with the other metropolitan borough councils in favour of immediate action being taken for the promotion of legislation for the removal of the restrictions imposed upon metropolitan borough councils in relation to the promoting and opposing of Bills in Parliament, consequent upon the application of the Borough Funds Act, 1872, by Section 6 of the London Government Act, 1899, and that such legislation be retrospective.

Matlock.—It is reported that the Smedleys Hydro. Company have bought the old disused mills near the railway station, Matlock Bridge, for an electric power station. The mills have been empty for years, and have a right to water power from the River Derwent, which will be invaluable. The Urban District Council are petitioning in the House of Commons against the Notts and Derbyshire Electric Power Bill, to prevent the local authority losing control over electric lighting in this district.

Grimsby.—At Tuesday's meeting of the Public Lighting Committee a sub committee recommended that a number of incandescent lamps be kept in stock and sold to consumers at a small profit. Objection was taken to that course on the ground that they would be entering into competition with tradespeople who were ratepayers. The Chairman explained that the profit was not the idea of the committee. What they desired was to offer the people a good article, and thus in the end make a saving at the works. The recommendation was adopted.

Bingley.—At the last meeting of the District Council it was reported that the electrical engineer consulted by the Council—Mr. Quin, of Blackpool—had recommended that the Council should oppose the Yorkshire Electric Power Bill, and should make terms with the promoters of the South Yorkshire Bill. The latter had agreed to every requirement that the Council had made. The Clerk added that the opposition to the Yorkshire Electric Power Bill was intended to be carried forward if terms could not be arranged with the company. He believed there would be a combination formed of local authorities to oppose that Bill. The recommendation was adopted.

Beckenham.—In reply to a letter from a consumer offering to guarantee 20 per cent. on the outlay if the Council would lay a cable to his house in 14 days, the Council have decided to accept the offer provided the time condition was withdrawn. They have decided not to lay a cable in Mackenzie-road at present, unless requisitioned by the necessary number of inhabitants. The South Hill Park district is now receiving electric light from Beckenham. It is proposed that all the parishes within the Bromley union situated in the metropolitan district be asked to unite with the Council in approaching the General Post Office with a view of a telephone installation being commenced by them in the district at the earliest possible moment.

Dublin.—A long discussion took place at the special meeting of the Council last week in regard to the electric lighting loan. The following resolution was proposed: "That Standing Order No. 12 be suspended to enable the Council to forthwith take into consideration and to confirm the report of the Lighting Committee (No. 36), recommending the acceptance by the Municipal Council of the tender of Messrs. J. and W. Stewart of Belfast, for building a chimney shaft at the Pigeon House Ford, also giving particulars of the contracts already arranged and of the works in connection with the electric lighting scheme for which tenders have not yet been invited." The necessary three-quarter majority not being forthcoming, the meeting was adjourned.

Incandescent Electric Lamp Co.—The new extensions to the "Robertson" lamp factory at Brook Green were opened on the 16th inst., when the Company gave a tea to 300 of their employés. The tea was followed by a concert, to which the employés had invited their friends, and a company of nearly 700 enjoyed an excellent concert, which, judging from its length and its last number, called "Awake, and Hail the Morn," appears to have been rather a protracted one, see that the sun did not rise on that day before a quarter past six. The concert was held in the large hall 130ft. long by 40ft. wide, which has been set apart by the directors of the Company for the purpose of a dining hall for the employés. In addition, this room is intended to be used for concerts, dances, etc., which are held periodically by the employés.

King's Lynn.—The Town Council have resolved that, on completion of the electric lighting extensions a bonus of 100 guineas be given to the electrical engineer in consideration of his services in the designing and construction of the extensions; also that his salary be increased by £50 per annum, as from March 31 next, with house, garden, rates and taxes free, and coal, light, and water found as heretofore. The Mayor has been asked to turn on the current when the extensions (which are nearly finished) are ready. The electrical engineer's last report showed that applications had been received for 68 additional lamps of 8 c.p. or equivalent, making a total of 7,945 lamps for private consumers. An additional recording ammeter is to be fixed at a cost of £18. The small gas-engine which drives the pump will be offered for sale, and the pump driven by an electric motor.

London County Council.—At Tuesday's meeting of the Council the following report of the Fire Brigade Committee was agreed to: "We have it in contemplation to recommend the Council to extend the electric light installation at the chief station, and in that connection it will be necessary to obtain additional plant. As some time will doubtless be occupied in the manufacture of the plant, we desire to obtain tenders for it from selected firms at once, so that everything may be in working order by next autumn. The cost of the plant will probably somewhat exceed £500 and we accordingly ask authority to open the tenders at our meeting on the 28th inst., with a view to our submitting a recommendation to the Council at its last meeting before the Easter recess. We recommend (*a*) that standing order No. 210 be suspended in order to admit of the following resolution being passed; (*b*) that the Fire Brigade Committee be authorised to open tenders for electric lighting plant for the chief station of the brigade."

Ashton.—According to the minutes of the Lighting Committee passed at the last Council meeting the engineer was instructed to draw up particulars and obtain quotations for the following

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matters and things recommended by Mr. Hammond, and arising out of his inspection and report on the existing plant—viz.: (1) one weir-type feed pump; (2) alteration of steam-pipes; (3) duplicate feed to boilers; (4) scheme to deal with the coaling of the works; (5) alterations to the switch gear. The chairman and engineer were empowered to engage a draughtsman to prepare drawings of the proposed alterations and extensions. The town clerk was instructed to apply to the Board of Trade for permission to raise the declared voltage from 200 to 240. Mr. Appelbee was instructed to obtain a quotation from Messrs. Browett and Lindley for the work necessary to be done in order to deal with the water in the low-pressure cylinder of the engines. A quotation for the supply of an artificial load was accepted. An additional oil filter is to be purchased. The application of the Guardians for the supply of current to their offices was granted.

Hornsey.—At the last meeting of the Urban District Council the Electric Lighting Committee submitted the following report, which was agreed to: "The committee had before them a letter received from the Local Government Board enclosing their sanction to the borrowing by the Council of £73,500 for purposes of electric lighting and their formal approval of the use of the proposed site in Tottenham-lane, Hornsey, for a generating station. The committee also had before them and carefully considered and approved forms of tender and contract, with general conditions and specification, for the machinery and other works, prepared by Mr. R. Hammond, the engineer, and recommend that advertisements for tenders be issued in the *Electrical Engineer* and other journals. The tenders when received will be referred to Mr. Hammond for him to schedule and report thereon to the committee. The committee also had before them plans and an estimate prepared by the Council's engineer, in consultation with Mr. Hammond, for the erection of a chimney shaft and engine and boiler houses, which the committee approved. They recommend that advertisements be at once issued for tenders for erection of the chimney shaft, and also for the erection of the other buildings as soon as the specification is ready."

Private Bills.—In the House of Lords the following Bills have been read a second time: Barrow-in-Furness Corporation, Belfast Harbour, Bolton Corporation, Bournemouth Corporation, Bristol Corporation (Docks and Railways, etc.), Dover Corporation, Folkestone Corporation, Handsworth Urban District Council, Islington and Euston Railway, King's Norton and Northfield Urban District Tramways, Leeds Corporation (General Powers), Llanelly Harbour, Manchester and Liverpool Electric Express Railway, Manchester Corporation, Mersey Docks and Harbour Board, Piccadilly and City Railway, Ripon Corporation, Salford Corporation, Sheffield Corporation, Smethwick Corporation, Harrogate Corporation, Mersey Docks and Harbour Board (Canada Dock Works, etc.), Tyneside Tramways and Tramroads, Chester Corporation Tramways, Charing Cross, Euston, and Hampstead Railway (No. 1), Charing Cross, Euston, and Hampstead Railway (No. 2), Brompton and Piccadilly-circus Railway, South-Western and Isle of Wight Junction Railway, Birmingham (City) Tramways, Wigan Corporation Tramways, etc., Charing Cross, Hammersmith and District Electric Railway, King's-road Railway, and the South Lancashire Tramways Bills. In the House of Commons the following private Bills have been read a second time: Bingley Urban District Council, Blackburn Corporation, Bradford Corporation, Brighton Corporation, Bury Corporation, Bury Corporation Tramways Burton-upon-Trent Corporation, Caledonian Electric Power, Cardiff Corporation, Cleveland and Durham County Electric Power, Clyde Valley Electrical Power, Derby Corporation, Derbyshire and Nottinghamshire Electric Power, Devonport Corporation (Gas), Eccles Corporation, Humber Commercial Railway and Dock, Kingston-upon-Hull Corporation, London County Council (General Powers), Mansfield Corporation, Newry Port and Harbour Trust, Pembroke Urban District Council (County of Dublin), Rhyl Improvement, Shannon Water and Electric Power, Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, Thames Piers and River Service, Wallasey Improvement, Wells Corporation Water, Yorkshire Electric Power, Dublin St James's Gate Brewery Tramways, Gateshead and District Tramways, Bexley Tramways, South Yorkshire Electric Power, Swansea Harbour, and Metropolitan Electric Supply Bills. Notice of opposition to private Bills deposited for consideration this session has been given in the House of Commons against the Metropolitan District Railway and the Caledonian and the Clyde Valley Electrical Power Bills. A number of other Power, Gas, and Water Bills already mentioned are being opposed. Notices of a similar kind have been given in the House of Lords against the Piccadilly and City Railway, Manchester and Liverpool Express, Central London Railway, Charing Cross, Hammersmith, and District Electric Railway, City and Brixton Railway, City and North-East Suburban Electric Railway, Islington and Euston Railway, King's-road Railway, and the North-East London Railway Bills.

LEGAL INTELLIGENCE.

GUTTA PERCHA CORPORATION, LIMITED.

The public enquiry into the promotion and failure of this corporation was resumed this week at Bankruptcy Buildings, Carey-street, before Mr. Registrar Hood.

Mr. George Shenton, one of the promoters of the Gutta Percha Corporation, said the patents which were taken over by the corporation were the Serullus and Honrant patents, the owners of them at that time being the Isonandra Syndicate of Paris. He went to Paris with Prof. Ramsay in order to enquire into the value of the patents. The syndicate had already manufactured samples, and possessed the necessary plant and machinery for carrying out the Serullas process. They also had a large stock of leaves. The plant and machinery were eventually sent to Borneo, by instructions of the Isonandra Syndicate. The first contract which he entered into with regard to the promotion was with Omnium, Limited. A number of other persons were interested in the promotion. The Globe Venture Syndicate afterwards took up the promotion, and agreed to "issue the company," to provide directors, and to find money for promotion expenses. The syndicate carried the matter through. By an agreement of Aug. 14, 1897, Mr. Joseph Bruer, as agent of the Isonandra Syndicate, sold the patents to Mr. Ernest Stanier, and by agreement of the following day Stanier sold them to Mr. Harry Parson Smith, as trustee for the proposed corporation. Under the agreement of Aug. 14, 1897, the purchase price was £63,500. The witness thought he had something to do with the fixing of that price. The price payable by the corporation to Stanier was £150,000. Stanier was the nominee of the witness and of others—for instance, the Globe Venture Syndicate, who were his co-promoters. The witness was to receive through Stanier a portion of the difference between these prices. Stanier was under an obligation to divide the profit between a number of interested parties, including Omnium, Limited, and Mr. Hubert Waldron, the solicitor in the matter. The witness could not render an account showing the manner in which the profit was distributed. He thought that the accounts of the Globe Venture would show the figures. He could not say the amount of cash which he received, but it exceeded £1,000. He received shares for between £10,000 and £15,000. No cash was, he thought, received by him in respect of the shares. He passed on the shares to other persons. Baron Olliveira, who had introduced witness, was interested in the promotion, and received a commission from the witness. By the agreement of Aug. 15, 1897, the vendor was to provide underwriting by responsible persons for £30,000. The witness considered that he was under an obligation in respect of this underwriting. He obtained some of the underwriting letters, but not all. The Globe Venture Syndicate obtained some of them One Crick, a junior clerk, underwrote the balance of the £30 000 which was not underwritten by others. The public subscriptions had been small, and the underwriters were called upon to the extent of 68 per cent. According to the prospectus the working capital was to be provided by £50,000 of preference shares, reserved for that purpose. He thought this provision for working capital to be sufficient. Prof. Ramsay said he had made improvements on the patents, and the witness suggested that they should be sold to the corporation. The price was fixed at £1,000 in cash and £10,000 in shares. The improved process was taken over by the company, and the witness received half the cash and shares.

Mr. Brougham said that Prof. Ramsay had stated that he was willing to give the patents to the company, and witness suggested that he should sell them, but the witness did not agree to this statement.

Mr. James Aratoon Malcolm, upon examination, stated that he was manager of the Globe Venture Syndicate, Limited, and of the Corporation. He and Mr. Waldron were appointed by the first directors of the Corporation to report on the underwriting letters. He reported that the underwriting for £30,000 was good. He had no reason to doubt the accuracy of the Official Receiver's statement that only £4,133 was received in respect of the underwriting.

The examination of several other witnesses closed the enquiry.

UNAUTHORISED CONNECTIONS.

At the Stratford Police Court on Saturday last, Kenneth Ling, a hosier, of 326, High-road, Leyton, was summoned by the Leyton District Council for laying or causing to be laid an electric line connecting with the electric light of the Council without having the consent of the Council; and he was further summoned for using the current generated by the Council by means of the line.

Mr. Ralph Vincent, who prosecuted for the Council, said that the proceedings were taken under the Electric Lighting Act of 1882, whereby the provisions of the Gasworks Clauses Act of 1847 were incorporated. Section 180 provided for a penalty of £5. The defendant had apologised to the Council, who had not, under the circumstances, charged him with the theft of the electric current.

Defendant pleaded guilty, and said he had explained the matter to the Council. His light broke down some time previous to the dates on the summons, and when he made a connection with the Council's line "he found he got a light, but he did not see how he obtained it." The result was that he got the current without it going through the meter.

Mr. Barnett Tabrum: In other words, you were helping yourself to the Council's electricity without paying for it?

Defendant: I did not mean to do that.

Mr. Tabrum said it was a curious defence, and imposed a fine of £5 and 7s. costs.

The money was paid.—*Daily News.*

DUNDEE ELECTRICAL ENGINEER'S FAILURE.

Sheriff Campbell Smith in Dundee Sheriff Court last week examined in bankruptcy James Matthew Hiley, who was a partner of the firm of Hiley and Orchar, electrical engineers, Dundee, against whom a petition for sequestration was submitted. On

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examination Hiley stated that Orchar and he began business two years ago, the former supplying the machinery. In February of this year Orchar left for Hong Kong. The machinery had been sold at £76. 10s., but he did not know who got the money. The state of affairs of Hiley and Orchar, which was submitted, showed assets to be £174. 16s. 5d.; liabilities £378. 3s. 11d. Hiley's assets amounted to nil, while Orchar's were set down at £121. 5s. Their respective liabilities amounted to £5 each.

PROVISIONAL PATENTS, 1901.

MARCH 11.

5087. **Electric alarm attachment to nickel alarm clocks.** David Mundell, 490, Crown-street, Glasgow.

5088. **"Simplex" trolley head for electric tramcars.** James Delaney Russell, 64, Woodside street Edgehill, Liverpool.

5089. **Improvements in multiple-conductor cable terminal or analogous fittings.** George Hinde Nisbett 15, Water-street, Liverpool. (Complete specification.)

5121. **Improvements in insulating strips or cores for rheostats, electric heaters, and similar devices.** Philip Middleton Justice, 55, Chancery-lane, London. (The Erie Exploration Company, United States.) (Complete specification.)

5124. **Improvements in conduits for electric cables and the like.** Carl Axel Wilhelm Hultman, 6, Lord street, Liverpool. (Complete specification.)

5153. **Improved means for increasing the efficiency of electric incandescent lamps.** James William Thomas Cadett, 43, Southampton-buildings, Chancery lane, London.

5164. **An improvement in brakes for induction coils.** Jules Carpentier, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5165. **An improvement in switches for varying electrical resistance.** Siemens Bros. and Co., Limited, and Maurice Hird, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MARCH 12.

5171. **Improvements in non-inductive resistances.** William Du Bois Duddell and Thomas Mather, 47, Hans place, London.

5172. **Electric thermal device for working switches, registering apparatus, and the like.** George Charlton and Walter Edward Barton, 24, Cavendish-road, Leicester.

5175. **Self-lubricating pulley for electric car trolley head.** Richard Myers Tyrer, 150, Boundary-road, St. Helens.

5220. **Improvements in electric bipolar dilator.** Charles Leonard Mosher, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 25, 1900, being date of application in United States.) (Complete specification.)

5227. **Improvements in or relating to the arrangement of electrical cables or groups of conductors.** Carl Axel Wilhelm Hultman, 6, Lord-street, Liverpool. (Complete specification.)

5247. **Improved switch for controlling electric motors.** Arthur George Bloxham, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Helios Electricitäts Actien-Gesellschaft, Germany. (Complete specification.)

5260. **New or improved apparatus for automatically registering the time during which an individual telephone instrument has been in actual use.** August Carl Krause, 16, Oakden-street, London.

5262. **Improvements in receivers for electric demand indicators.** Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

5265. **Improvements in and relating to the recovery of precious metals by electrolysis.** John Frederick Webb, Joseph Edward Lilley, and John Chapman, 1, Queen Victoria-street, London.

MARCH 13.

5292. **Improved system of guard wire protection for electric trolley or other high-pressure uninsulated wires.** Edward Woodrowe Cowan, Alfred Still, and Thomas Lodwick Miller, Springfield-lane, Salford, Manchester.

5305. **Improvements in micro-telephones.** Emil Volkers, Görlitz, Germany. (Complete specification.)

5306. **An improved means of picking up positive electric pressure from a closed tubular rail or subway without a longitudinal slot or a surface contact by a wheel suspended over it, and returning the negative current to the tube.** Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

5343. **A method of and apparatus for actuating devices on public electric supply or distribution systems.** Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

MARCH 14.

5391. **An improved switch for electrical lampholders and the like.** Joseph Herbert Bosworth and George Major, 181, Osler-street, Birmingham.

5402. **Improvements relating to electric pendant lamps.** Robert Hall Best, 18, Southampton-buildings, Chancery-lane, London.

5411. **Improvements in electric measuring apparatus.** Rudolf Ziegenberg, 78, Fleet-street, London. (Complete specification.)

5413. **Generator for the intensification of gravitational or electric stress.** Gordan Earl-Adams, 10, Canterbury-road, Brixton, London.

5421. **Improvements relating to electrical "reformers."** Albert Nodon, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 17, 1900, being date of application in France.) (Complete specification.)

5427. **Improvements in the manufacture of electric cables and apparatus therefor.** Horace Walter Dover, 53, Chancery-lane, London.

5449. **Improvement in underground conduits and accessories therefor for use with electrically-propelled tramcars and like vehicles.** George Wilkinson, 165, Queen Victoria-street, London.

MARCH 15.

5452. **Electrically-heated radiators.** William Herbert Milnes, 333, Oxford-street, London.

5460. **Improvements in and relating to prepayment meters for the supply of electricity.** James Finlayson and William Scott, 96, Buchanan-street, Glasgow.

5464. **Improvements in or connected with overhead conductors for electrical tramways and the like.** Herbert Hampton Hall and George Smith, 57, Barton-arcade, Manchester.

5477. **New or improved means for diverting or cutting off electric currents in overhead electric trolley or like wires or cables and guard wires, and disconnecting broken cables or line wires.** John Edwards Hill, Commercial-street, Halifax.

5487. **Improvements in electric heating and cooking apparatus.** Friedrich Wilhelm Schindler, 15, Took's-court, Cursitor-street, Chancery-lane, London.

5488. **Improvements in electric bell pushes.** John S. Ross, 95, Bath-street, Glasgow.

5489. **Improvements in or relating to electric tramways.** Frank George Sealy, 111, Hatton-garden, London.

5496. **Improvements in electric meters.** Emile Batault, 21, Ely-place, Holborn-circus, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 17, 1900, being date of application in France.)

5510. **Improvements in commutator brushes and brush-holders for electric meters or dynamo-electric machines.** Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5523. **Improvements in wireless telegraphy.** John Robert Milnes, 22, Southampton-buildings, Chancery-lane, London.

MARCH 16.

5542. **Improvements in and relating to trolley-wire guards or "protectors" of overhead-driven electric tramways.** James Townsley Pearson, St. James's Hall, Burnley.

5547. **Improvements in electric railways and tramways on the sectional conductor system.** John Milnes, 15, Water street, Liverpool.

5560. **Improvements in electrical switches.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Manchester. (Complete specification.)

5562. **Improvements in and relating to devices for cutting out broken or short-circuited sections of trolley wires used in connection with electric traction systems.** John Wylie Donaldson, 70, Market-street, Manchester.

5576. **Improvements in electric arc lamps and electrodes therefor.** Charles Andrew Lee, 56, Paulton's-square, Chelsea, London.

5589. **Improvements in electric telegraphy.** Alexander Muirhead, 323 High Holborn, London.

5592. **An improved method of manufacturing filaments for incandescing electric lamps.** William Lawrence Voelker, Clun House, Surrey-street, London.

5596. **Improvements in the electrolysis of chlorides of metals of the alkalies and alkaline earths for the purpose of obtaining chlorine, and apparatus therefor.** George Jones Atkins, 115, Cannon-street, London. (Complete specification.)

5598. **Improvements relating to portable electric lamps.** Moritz Kaeser, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on April 6.

1900.

4576. **Overhead travelling electric cranes.** Vaughan and Foster.

4685. **Electricity meters.** Wright and Reason Manufacturing Company, Limited.

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4796. Electric switches, principally for high-voltage circuits, and also applicable to switch lampholders. Lightfoot.

4842. Electric firedamp detector or indicator. Wood.

5430. Cable suspenders for multiple switchboards or similar apparatus. Oppenheimer. (Actiengesellschaft Mix und Genest.)

5561. Transformer of alternating currents into continuous currents of equal or different tension. Rougé and Faget. (Date applied for under International Convention, Sept. 27, 1899.)

5562. Apparatus for transforming single and multiphase alternating currents into continuous currents and inversely. Rougé and Faget. (Date applied for under International Convention, Nov. 14, 1899.)

6209 Joints and electric bonds for street mains or pipes. Brewer. (Knudson.)

6568. Heating of conductors of the second class in electric incandescent lamps. Raab.

6569. Heating of conductors of the second class in electric incandescent lamps. Raab.

6731. Combined telephone exchange and alarm systems. Wise. (Goldstein and Latimer.)

6931. Transmission and distribution of electricity. Lorrain. (Bedell.)

7662. Variable speed gear for mechanically or electrically propelled vehicles. Ricci.

7372. Manufacture of electrodes for secondary batteries. Tribelhorn.

7678. Automatic letter-writing telegraph. Pollák, Virág, Egger, and Silberstein.

8610 Chains for electric light fittings. Cheshire.

8827. Electrical batteries. Butler.

10326 Electrical stop gear for steam and other engines or machinery. Shaw.

14924. Electric accumulators. Rose, Halifax, and Antrobus.

19416. Telephone call recorders. Stroud.

20544. Method of and apparatus for the separation of paramagnetic and dia-magnetic materials. Gates.

23322. Speed regulators for electric lifts. Wetter. (Elektrizitäts Aktiengesellschaft, vorm. Schuckert und Co.)

23963. Electrical glass furnace. Voelker.

1901.

471. Electric motors. British Thomson-Houston Company, Limited. (Priest.)

1394. Acceleration limiting and recording devices. British Thomson Houston Company, Limited. (Davis.)

2335. Manufacture of thermo-electric couples. Hermite and Cooper. (Date applied for under International Convention, Aug. 1, 1900.)

2900. Fusible cut-outs for electric circuits. H. M. Salmony and Co., Limited. (Elektrizitäts-Actiengesellschaft, vorm. W. Lahmeyer und Co.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Mar. 16	576	516	+ 60	—	—
Birmingham Trams.	,, 16	4,168	4 074	+ 94	43,498	—
Blackburn Corp'rat'n	,, 15	446	421	+ 25	4.255	3.850*b*
Blackpool Corporatn.	,, 14	242	169	+ 73	30 162	22,215
Blackpool-Fleetwood	,, 16	180	212	- 32	1 574	1 684
Bolton Corporation..	,, 17	1,271	863	+ 408	15 299	8,361
Bradford City Trams	,, 17	826	359	+ 467	8,367	3,838
Bristol Tramways Co.	,, 15	3,841	2,718	+1,123	—	—
Carlisle Tr'mw'ys Co	,, 15	123	—	—	1,219	—
Central London Ry.	,, 16	6,157	—	—	66 819	—
City & South London	,, 10	2,060	1,303	+ 757	20,133	11,775
Cork E. T. and L. Co.	,, 14	366	325	+ 41	3,557	3 180
Dover Tramways ...	,, 16	156	135	+ 21	1,689	1,586
Dublin & Lucan E.R	,, 16	72	89	- 17	774	630
Dublin U.T., elec. cars	,, 15	3,168	2,944	+ 224	—	—
Dublin S.D. Electric	,, 15	711	669	+ 42	—	—
Dundee Tram Co. ...	,, 13	569	350	+ 219	—	—
Glasgow Corporation	,, 16	8,500	8,356	+ 144	—	—
Halifax Corporation	,, 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	,, 16	714	581	+ 133	34,648*b*	31,776
Hull Corporat'n E.S.	,, 16	1,540	741	+ 799	68,783*b*	—
Liverpool Corporat'n	,, 2	7,789	7,063	+ 726	69 889	59 651
Liverpool Overhead	,, 17	1,574	1,340	+ 234	16,269	15,641
Portsmouth Corpn...	,, 16	544	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 17	2,974	—	—	—	—
Southampton Trams	,, 14	626	336	+ 290	—	—
Southport Corporat'n	,, 16	*a*443	—	—	7.011*d*	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. *b* Since April 1, 1900. *d* From July 18, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	10 11
——— 40,001-70,000	5	—	10½-10½
——— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
——— 5 per cent. Mortgage Debentures	100	—	100-105
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
——— 6 per cent. Cum. Pref., 1-50,000	1	—	3/.6-5/16
——— 4½ per cent. First Mortgage Debentures	108	—	86-90
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1⅝-1⅞
——— Non. Cum., 6 per cent. Pref.	2	—	2½-2⅝
——— 4½ per cent. Debenture Stock	100	..	103-108
——— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	109-113
——— Ordinary	5	—	15-16
——— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	2	—	2½ 2¾
——— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	2	—	1½-2
——— 5 per cent. Debentures	5	—	3-4
——— 4 per cent. Deb. Stock, Red	100	—	88-90
——— 5 per cent. Second Deb. Stk., Prov. Crts.	—	—	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1½-2
——— 7 per cent. Cumulative Pref.	2	—	2½-3
——— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
W. T. Henley's Telegraph Works, Ordinary	5	—	15-16 xd
——— 4½ per cent. Preference	5	—	5½-6 xd
——— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
——— 4 per cent. Debentures	100	—	102-105
Telegraph Construction and Maintenance	12	—	38 42
——— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	11-12
——— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	—	11½-12½
——— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7½
——— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅜-½
——— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	..	70-75
Bournemouth and Poole, Ordinary	10	—	12½-13½
——— 4½ per cent. Cum. Pref.	10	—	10-11
——— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7-8 xd
——— 7 per cent. Preference	5	—	8-9 xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¾-7¼
Charing Cross and Strand	5	..	9-10 xd
——— 4½ per cent. Cum. Pref.	5	—	5⅜-5⅝
Chelsea Electricity Supply	5	—	5¾ 6¼ xd
——— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	7½-8¼
——— 6 per cent. Cumulative Pref.	10	—	13-14
——— 5 per cent. Debenture Stock	100	—	122-127
——— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	..	101-103
County of London and Brush Provincial, Ordinary	10	—	8 9
——— 6 per cent. Cum. Pref.	10	—	11½-12½
——— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	106 109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5½
——— 4½ per cent. First Mort. Deb.	100	—	103-106
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7⅝-8⅛
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	—	1½ 1⅝
——— 6 per cent. Pref.	5	—	3-4
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	12½-13½ xd
——— ,, 35,001-98,769	5	—	9½-10½ xd
——— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
——— 3½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1½-1⅝
——— £5 Shares	5	—	7-7½
——— £4½ Shares, New	4½	—	5⅞-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5½-6¼ xd
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	200 220
——— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
——— 4 per cent. Debenture Stock	100	..	90-90
South London, Ordinary	5	—	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	13½-14½
——— 7 per cent. Pref.	5	—	8½-9½
——— 3½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	—	12-13
——— 80,001-109,487	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	8⅞-9½
——— Pref. Half-Shares	5	..	4⅞-5⅛
——— ,, ,, deferred	5	..	4-4½
City and South London, Consolidated Ordinary	100	—	46-50
——— Ordinary	10	—	4-5
——— 4 per cent. Debenture Stock	100	—	112-117
——— 5 per cent. Pref. Stock '91	100	—	132-137
——— ,, ,, ,, '96	100	—	122-127
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway	100	—	99-101
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	10-10½
British Electric Traction, Ordinary	10	—	15-16
——— 6 per cent. Cm. Pf. 30,001-60,000	10	—	11½-12½
——— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4½-5
——— 5 per cent. Deb. Stock, Red.	100	—	104-107
——— Prov. Cert., all paid	100	—	96-99
Kidderminster and District Lighting and Traction, Pref.	5	—	3½-4
New General Traction, Ordinary	5	—	3½-3⅝
——— 6 per cent. Cum. Pref.	10	—	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10⅝
——— 5 per cent. Cum. Pref.	10	—	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
——— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
——— 4½ per cent. Debenture Stock	100	..	107-109
Telephones.—			
National Telephone, Ordinary	5	—	3½-3⅝
——— 6 per cent. Cum. First Pref.	10	..	11-13
——— 6 per cent. Cum. Second Pref	10	—	11-13
——— 5 per cent. Non. Cum. Third Pref.	5	..	4½-4⅝
——— 4 per cent. Deb. Stock, Red.	100	—	97-100
——— 3½ per cent. Deb. Stock, Red.	100	—	92-95
Oriental Telephone and Electric Company	1	—	⅞-1⅛

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NOTES.

Manchester Telegraphs.—We are pleased to note that the Postmaster-General has appointed Mr. W. E. Halton to be chief superintendent of telegraphs at Manchester.

A New Electrical Paper.—To those more interested in the electrical profession from a financial point of view, *Electrical Investments* will be found of considerable value. The first issue of this new publication has just made its bow to the public under a title which leaves no doubt as to its object. In short, *Electrical Investments* is practically devoted to the financial side of electrical undertakings, and to the investor the large share list of companies which is included cannot but be a very desirable feature. The new journal is brought out under the auspices of the "Manual of Electrical Undertakings," and will be published twice a month.

Rockhampton Gas Company.—We have received a copy of the report and accounts for the half-year ended Dec. 31, 1900, of the Rockhampton Gas and Coke Company, Limited, of Queensland, who also supply electricity for lighting purposes. The operations of the company in this direction show a slight improvement upon the corresponding period of last year. The balance carried to net revenue account stands at £217. 2s. 11d., while the profit and loss account shows a net profit for the period under review of £1,587. 13s. 7d. This enabled the directors to recommend a dividend at the rate of 7 per cent. per annum upon the ordinary shares and 9 per cent. per annum upon the preference shares.

Theatre Dimmers.—At the end of last month Mr. C. Wirt read a paper on theatre dimmers before the Chicago Electrical Association. We are surprised to find that he advocated as the best form of fireproof rheostat one using galvanised steel wire coils supported on porcelain insulators. The wire coils in this rheostat were brazed to the copper connectors. We also gather that the galvanised steel wire coils were surrounded by ground glass sand. In connection with this dimmer a large number of contacts are required in the regulator in order to get a gradual effect, as the author states that even with 100 contacts it is possible to see slight fluctuations in the grading of the light. It is for this reason that in England the highest authorities on theatre lighting advocate the use of liquid resistance for regulating the lighting effects. With this type of resistance an absolute gradual alteration in the intensity of the light is obtained, which is utterly impossible with the wire resistance such as is referred to above.

Standardising Switchboard Instruments.—A suggestion is thrown out in a short article by Mr. T. W. Freet, jun., in the *Electrical World*, on the provision of switchboard connections by which any of the ammeters or wattmeters on the switchboard can be easily calibrated. With the introduction of the moving-coil type of instrument now so largely used, it is becoming almost the universal practice to measure the current in any circuit by the fall in voltage across a low-resistance strip inserted in that circuit. The author suggests that provision should be made for the insertion of the low-resistance shunt for a standard instrument in the various circuits and the switchboard. It is possible to do this by arranging the shunt to come in the switch contacts, but a more easy way of obtaining uniformity would be to have an additional pair of contacts which could be bridged by the shunt. If this were done, there would no longer be any need to remove the instruments on the switchboard for calibration, as they could actually be tested from time to time against a standard instrument. It seems to us that the correct place for the connections to be made would be near the connections of the shunt for the ordinary instrument, so that the temperature conditions would be the same.

American Electrolysis Law.—Having regard to the decision of the House of Lords Committee on the question of electrolysis in the case of the Sheffield Corporation Bill, it is interesting to note the state of the law relating to this subject in America. In the State of Indiana, for instance, a short time ago a Bill was introduced in the Legislature which aimed at the prevention of electrolysis. Some of the more important terms of this Bill are given in the *Electrical Review* of New York. In the first place, every street railway company which uses the overhead trolley system or any other system employing an uninsulated or earthed return for the current must instal the double trolley system or its equivalent according to the approval of the Board of Public Works or on approval of the councils in cities where they do not have such boards. If within two months of the date upon which the Bill goes into effect any company has failed to submit plans, or fails to carry out the plans six months after their approval, it shall be liable to a fine of £5 per day. Upon failing to pay this penalty, the company shall forfeit its charter. The earthing of any wires conveying an electrical current for electrical lighting, power, and heat are also proposed in this Bill.

Aberdeen Electrical Subway.—The members of the Aberdeen Association of Civil Engineers recently paid a visit of inspection to the electrical subway, Crown-street, in that city. This subway is constructed to carry all feeder cables with their pilot leads for supplying energy to the tramways and for the distribution mains in the west, north, and central districts of the city. We understand that arrangements are being made for carrying along the side of the subway 56 feeder cables, capable of supplying upwards of 10,000 h.p. These cables will be of the low insulation class, and are to be supported on porcelain insulators resting on iron pins screwed into cast-iron wall plates built into the brick lining of the subway every 6ft. At present two rows of cables on each side of the subway are being allowed for, but provision is made for four additional rows when found necessary. The subway is to be electrically lighted by lamps placed in the roof every 20ft., and midway between these lamps a socket will be placed for connecting a portable hand lamp. Efficient ventilation will be provided by means of an electrically-driven fan at the Union-street termination of the subway. The total length of the present section of subway is about 700 lineal yards, and the cost £8,500.

Electric Tramways in Siam.—The Belgian Minister at Siam has communicated to the *Bulletin Commercial* an article in which he states that the Bangkok Tramways Company and the Siam Electricity Company, Limited, intend to amalgamate. It is interesting to note that such amalgamation cannot take place unless the companies place themselves under the jurisdiction of the Siamese Government, as no territorial concessions are made in Siam to any companies unless they have expressly agreed to place themselves under the jurisdiction of the country. Moreover, the Government are now preparing a law, which will shortly come into force, relating to limited liability companies proposed to be formed by strangers in that country. The article states that if this amalgamation take place, a new tramway line will have to be built which will cross the new quarter of the town and the streets near the Royal city, and will run into the suburb of Sam-Sen, where the King is just now building a summer residence. It appears that the old line will have to be completely

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remodelled, as the existing rails have been down since 1897, when animal traction was introduced. It is estimated that the new rails alone will cost about £9,000 to £10,000. This is another instance showing the useful work which is being done by the Belgium consular and ambassadorial officials abroad.

Employment in Spain.—The latest report issued by the Foreign Office states that the increase in the use of electric lighting and tramways has created many openings in the electrical businesses in Spain for young English engineers. They should not, however, think of settling in Madrid, which offers few openings for foreigners. It would be preferable to search for employment in the electrical undertakings in the country towns, where they could learn the language quickly, and at the same time study the customs and requirements of the country.

Glasgow Exhibition.—An interesting feature of the Glasgow Exhibition, to be opened in May by the Duke of Fife, as representing King Edward, will be a complete reproduction of a telephone exchange in full working order. The National Telephone Company have the matter in hand, and they intend to introduce to the public notice on this occasion many novelties, which in due course are to be adopted in the company's exchanges throughout the United Kingdom. One of the improvements in use which will be shown is the call lamp, which dispenses with what is now looked upon as the old-fashioned drop indicator.

Progress in Canada.—Some recent statistics of the Dominion Government show the marked development that has taken place in electrical matters in Canada during the past decade, especially for lighting purposes. There were 80 establishments selling electric light in the Dominion in 1891, whereas in 1897 there were 187, which increased in 1900 to 297. Again, the electric lamps supplied by the establishments selling electricity for light numbered 443,897 in 1897, and 807,772 in 1900. Ontario, perhaps, has made the most rapid strides in the employment of electricity for lighting purposes, having more than doubled the number of lamps used in three years, the figures being 201,955 in 1897, against 418,573 in 1900. Almost as good progress has been made in Quebec province, where in the same time the number of electric lamps was increased from 185,892 to 235,322. In 1900 British Columbia had 13 electric companies, with an equipment of 52,653 lamps. There were but two establishments supplying electric light in 1897.

Electric Light and Tramways in Trinidad.—We understand that the Legislative Council of Trinidad have just granted a concession to a Canadian syndicate to light the city of Port-of-Spain by electricity, and to run electric cars on a more extended scale than the present mule lines. Negotiations between the representative of the syndicate and the Government of the colony had been proceeding for some time previous to the concession being granted, one condition of which is that one-fifth of the shares in the new enterprise will be placed at the disposal of local investors. The estimated cost of the scheme is put at about £200,000, and the syndicate has arranged to take over the existing electric works and tramcar system. Last year the syndicate also proposed to take over the Belmont Tramway Company's system, but the offer was not agreed to. The company, however, has just lately again been approached by the syndicate, and we understand that negotiations are proceeding which, it is anticipated, will probably end in the syndicate's offer being accepted.

Standardisation Bureau.—A Bill approving of the establishment of a national standardisation bureau has been passed by the United States Government. The functions of the bureau will consist, among other duties, in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions, with the standards adopted or recognised by the Government; the construction, when necessary, of standards, their multiples and sub-divisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials when such data are of great importance to scientific or manufacturing interests, and are not to be obtained of sufficient accuracy elsewhere. Our contemporary, the *Electrical World* of New York, expresses a hope that one of the first objects to be provided for will be the testing and supply of secondary incandescent lamp standards upon application of lamp manufacturers and central stations.

A New Insulation.—According to an American contemporary, a patent was recently granted on a method of insulating fine wire of the kind used in electrical measuring instruments and the like with a structureless coating of cellulose. The wire is first passed through a solution of cellulose, made by dissolving cotton-wool in an ammoniacal solution of cupric oxide; the latter reagent is prepared by first precipitating with caustic soda a solution of sulphate of copper to which salammoniac has been added, preserving the precipitate under water, and when the reagent is new, adding the hydrated cupric oxide to ammonia so long as it dissolves. The solution produces a deep-blue mucilaginous liquid. After the wire has been passed through the solution it is allowed to dry, and is then passed through diluted hydrochloric acid in the proportion of one part of acid by weight to five parts of water, and is afterwards freely washed in pure water and dried. The dilute acid dissolves out the cupric ammonia, and leaves the cellulose upon the wire in the form of a horny, brownish grey, structureless coating. For larger wires, or thicker films of cellulose, the coating may be impregnated with linseed oil, or some other similar substance, to increase its toughness and flexibility.

Central London Railway Management.—In a letter to the *Financial Times* Mr. George Goring complains of the present management of this company's business, and states his intention of calling a private meeting "for the purpose of discussing the unsatisfactory position of the company in relation to the shareholders, with the object of proposing some alteration in the organisation and management." It has been suggested that a first-class carriage should be placed at each end of the trains with a slot turnstile, charging an extra penny for admission. It is also proposed that at the two extreme stations threepence should be charged. These slight variations, Mr. Goring points out, would not cause an alteration in the general administration, but would raise the revenue to a sum adequate to pay a fair remuneration to the shareholders. "The present system," he continues, "is discouraging to the progress of similar ventures, as the public see no advantage in investing where they receive such small interest for their money, while industrials, under the management of practical and sound men of business, pay a liberal interest. There is a proposal to raise a large loan for the purpose of improvements, and it will take about £18,000 to pay the yearly interest on this further issue of shares, thereby depleting the already miserable pittance of interest by one-half, and many shareholders are of opinion that some decided steps should be taken to increase the revenue before this great expenditure is carried out."

The Osmium Lamp.—A paper was read at the annual meeting of the Deutsche Gasglühlicht Gesellschaft on the

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new osmium lamp invented by Dr. Auer von Welsbach. The author (Mr. Schols) emphasised the fact that the efficiency of an artificial source of light is greater the higher the temperature of the light-emitting surfaces. This has led to the substitution of the platinum filament in an electric incandescent lamp by one of carbon, but the high temperature to which it is subjected causes this material to disintegrate, whereas osmium, in virtue of its very high melting point—the highest of all known metals—resists such action for a very long time. However, the employment of osmium in the form of a filament is of recent origin, which may be attributed to the difficulty hitherto experienced in working the metal mechanically. The principal advantage claimed for it as a lamp filament consists in that it enables a high candle-power to be obtained with a small consumption of current. Lamps requiring 1·5 watts per candle-power possess a life of from 700 to 1,200 hours and upwards. A lamp which had been burning 1,500 hours was found to be in splendid condition, and had lost only 12 per cent. of its original candle-power. The consumption of the lamp at the beginning was 1·45 watts per candle, and after burning 1,500 hours 1·7 watts. On account of its greater conductivity the osmium filament requires less voltage than the carbon filament, and lamps have been constructed requiring only from 20 to 50 volts. On most existing systems it would, therefore, be necessary to burn a number of the lamps in series, or to transform the voltage, which would, of course, tend to counterbalance any saving effected in the lamp itself. Hence, even apart from the rarity of the metal, its commercial application to any considerable extent in the form of a lamp filament is a question of considerable doubt.

Electrical Machinery on Gold Mines.—We have already referred in these columns to the proposal of the Mysore Gold Mining Company to drive the machinery on their mines by means of electricity. We are pleased to see that the scheme is progressing favourably, and within the next 18 months we may expect to hear that a considerable portion of the mine machinery at least is being propelled by electrical power. For effecting this object it is intended to obtain the necessary power from the Cauvery Falls, some 90 miles from the Colar goldfield, where there is available an immense resource of hitherto unapplied energy. As stated by the chairman at a recent meeting of the company, an agreement has been entered into with the Mysore Government by which the Mysore State undertakes to provide and instal, in addition to the plant necessary for generating, transmitting, and transforming the electrical power, all conductors, motors, electrically-driven air-compressors, and other apparatus and buildings necessary for distributing and utilising such power. The agreement is for 10 years from the date on which the power is first used on the field, and it is anticipated that satisfactory and economical results will ensue from the establishment of this method of operating machinery on the property. At the ordinary meeting of the Nundydroog Company the chairman also referred to the scheme of the Mysore Government for the supply of electrical power from the Cauvery Falls. He announced the decision of his Board to be that in the first instance this electrical power shall only be applied to what he called non-vital portions of the company's machinery. It was not their intention to discard steam power, which, although expensive, could always be relied upon. From the *résumé* given by the chairman of the agreement regarding the supply of power between the company and the Mysore Government, it appears that for the first year the Government will charge £29 per horse-power per annum; for the second, third, and fourth years it will be reduced to £18 per horse-power per annum; and for the fifth year such sum not exceeding £24 per horse-power per annum as the Government may determine. During the remainder of the 10 years only £10 per horse-power per annum will be charged.

High-Speed Electrical Monorail.—Sir Frederick Bramwell communicates some noteworthy remarks to the *Journal* of the Society of Arts on the subject of the proposed "monorail" between Liverpool and Manchester. Regretting that he was unable to take part in the discussion of Mr. F. B. Behr's paper before the society on the 13th inst., he refers more particularly to the question of brake power. Together with the late Mr. Cowper he was called upon by the Midland Railway Company to examine into two systems of vacuum brakes exactly 20 years ago. He devised a simple apparatus which enabled the speed of the train at any moment to be accurately known, and also after the brakes were applied showed the rate at which that speed diminished, and the time occupied in the stoppage. His recollection quite confirmed the statement that with an ordinary portion of the whole weight of the train being supplied with brake power, the speed of the train could be reduced at the rate of three miles per second—that is to say, a 30-mile-per-hour train could be brought to rest in 10 seconds, and without shock. But with respect to the brakes needed for the higher rate of 100 or 120 miles proposed to be obtained on the "monorail" system—a system in which he entirely believed, and one which he hoped a more intelligent committee than the one which dealt with the matter last year would pass into law in session 1901—it might be worth while to ask whether another system of braking, not dependent upon the insistent weight applied, might not well be considered. He referred to the "clip" brake used by the late Sir James Brunlees on the inclines of the São Paulo Railway. These brakes, as their name implied, gripped the sides of the rails after the manner of a pair of tongs. A single handle worked two such brakes, one on each rail. Sir Frederick Bramwell concludes by expressing the opinion that such brakes, when properly brought before the notice of a Parliamentary Committee, ought to dispel all fear as to the ability to stop high-speed trains.

Progress in Telephones.—While the local authority were debating the question of establishing a municipal telephone in Hull, the National Telephone Company had been building in Mytongate, in that city, an exchange which may justly be styled one of the most scientific and modern telephonic systems in Europe. The switchboard with which the branch has been equipped is said to have no equal, except its duplicate, recently installed at Bristol. At present the switchboard is equipped for 1,800 subscribers, but if necessary this number may be increased to 6,300. The board controls 2,434 separate instruments scattered about the district, and is linked with no fewer than 2,047 telephone lines. The main advantages which are secured by this up-to-date switchboard are automatic calling, automatic clearing, and common battery speaking. The last-mentioned improvement is an advantage of considerable value, for it renders unnecessary any battery on the subscriber's instrument. The automatic calling and clearing device, however, is that which most calls for special mention. By lifting the receiver from the book, the subscriber supplies the signal by causing a small electric lamp to glow opposite the operator in the switch-room, and it is by the flashing of these lamps that the operator knows when the subscribers have commenced and ended their conversation. The replacing of the receiver on the hook lights the "clearing lamp," and not until both lamps are lit does the operator switch the subscribers off. At each operator's table there

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is an auxiliary lamp, so that if the calling lamp is faulty the auxiliary one can be lighted. Other departments of this new exchange are equally interesting, the test-room particularly, which contains the lightning arresters for protecting the delicate apparatus of the switchboard, and an ingenious arrangement for guarding the apparatus against the tramway trolley wires. Another interesting spot is the intermediate room, where upon a large iron frame the wires are arranged so that the work shall be fairly distributed among the operators at the switchboard. The power-room contains two dynamos, a combined gas-engine and dynamo, and a motor and dynamo. It is practically a double plant, the power from the dynamos being used by day and the power from the accumulators by night. At present the company have 6,009 miles of cables and 1,348 miles of overhead wires in Hull, and also seven branch exchanges working from Hull.

Arc Lighting.—The twenty-first article on elements of illumination by Dr. Louis Bell, in the *Electrical World*, gives an interesting *résumé* of a report on arc lamps by a committee of the National Electric Lighting Association. The investigations of the committee of this association we have referred to before, but Dr. Bell incorporates in his *résumé* some information of his own, which makes it more interesting. Dealing with the question of alternating arcs, he advises that a frequency of from 50 to 60 cycles per second gives the best result. At higher frequencies than 60 the arc is apt to become noisy, and at frequencies below 40 the light is unsteady. Dr. Bell adds that the light of the alternating arc is really of a pulsatory character, and that if a pencil is moved rapidly to and fro in the light of such an arc a number of images is shown—one for each pulsation, and this effect would be very distressing if one had to view moving objects like quick-running machinery by such light. A tale is told of a certain theatre in which alternating arcs were installed for some gorgeous spectacular effects, and of the extraordinary centipedal results when the ballet came on. On the question of the relative efficiency of the various kinds of arc lamps, the direct-current open arc stands first, requiring only about one watt per spherical candle-power. With a globe the watts per spherical candle rise to about 1·3. This figure for an alternating arc without a globe becomes 1·7. All the enclosed arc lamps give much poorer results than these. Commencing with the direct-current enclosed lamp without an outer globe, the figure becomes about 2·4 watts per candle, while as much as 3·3 watts per spherical candle-power are taken by a smaller lamp with an opal outer globe. The alternating-current enclosed lamps with a clear outer globe takes about three watts per spherical candle, and with an opal outer globe 3·6. Dr. Bell points out that when the horizontal candle-power is considered, all alternating-current enclosed arcs do better than is indicated by the above figures. He also adds that, when comparing arc lamps with incandescents, it must be remembered that when the incandescents are rated on the mean spherical candle-power, they will not do much better than from 4 to 4·5 watts per candle. Brief allusion is also made to experiments on the Continent with carbons impregnated with metallic salts. These have been got to give exceedingly good results as high as 0·5 watt per spherical candle-power. But the use of these impregnated carbons has not yet become commercial for some unexplained reason.

Cable-Laying.—The laying of underground cables is a subject of increasing importance, and Mr. Arthur Devey's paper, entitled "Notes on Some Systems of Laying Underground Cables," which was read before a meeting of the Glasgow Section of the Institution of Electrical Engineers recently, may be said to have come at a most opportune time. The author at the outset classed the usual systems of laying cables under three headings—first, laying cable direct in the ground, armoured or unarmoured; second, pipe or conduit systems; third, solid systems. Where the initial cost was a consideration, the first of these was much in favour. It was usual to cover the cables with timber to indicate their presence, and so prevent mischief from this cause. The best covering was probably an inverted three-sided wood trough. Laying direct in the ground had the advantage of being a very flexible system, and the work could be carried out whatever the weather might be. Its disadvantage, however, was that the outer layer of jute sooner or later rotted off, exposing the iron or steel armour, which in turn got eaten away; of course, the quickness or slowness of these actions depended on the nature of the soils in which the cable was laid. Turning to pipe or conduit systems, their advantages lay in the fact that cables could be drawn out in case of need and new ones drawn in without disturbing the surface of the streets; also, that spare ways could be laid for future extensions. Their disadvantages were, however, numerous. In the first place, they were not flexible, and unless the pipes or conduits were laid practically straight and level, it was exceedingly difficult to get the cables in, and still more difficult to get them out again when necessary. Another serious disadvantage lay in the fact that if a fault occurred on the cable, it was necessary to draw out the whole of the faulty length and to draw in a new length, which meant keeping a large stock of cable on hand to be able to meet any demand. Again, it was practically impossible to keep a pipe or conduit system dry, while a still greater one was the risk of explosions from gas leaking into the pipes or boxes. Whatever pipe or conduit system was adopted, it was absolutely essential that it must have a perfectly smooth interior, be free from all lumps or projections; the joints should be watertight, and so arranged that the jointing material could not get into the interior of the pipes or conduits. Its various units should be as long as possible, so as to minimise the number of joints, and these units should be capable of being easily cut into short lengths, so as to get round bends or obstacles. The system should always be laid with a fall from one manhole to the next, so that all water might drain away easily. With regard to the "solid" system, this seemed to be the chief favourite for the moment, although it was curious to note that the Americans considered it absolutely antiquated and out of date, they pinning their faith to the conduit systems. Its advantages were its flexibility, a great desideratum in large towns where pipes of all sorts were so numerous, combined with at least quite as good mechanical protection as iron pipes, whilst there was no danger to be feared from gas. The best system, in the author's opinion, would probably be armoured cable laid solid in wood troughs, with a minimum thickness of bitumen of 1in. all round, the troughs and covers to be of 1in. thickness also. Such a system would be expensive, but it should be a guarantee against damage of all kinds, whether mechanical or electrical, and therefore would prove cheapest in the long run.

Patent Law Reform.—After nearly 12 months' investigation and some 16 meetings, the committee appointed by the Board of Trade to enquire into the working of the Patent Acts in certain specified respects have issued their report, which contains some recommendations of considerable importance both to the general public and to inventors. The questions which were submitted to the committee, who had for their chairman Sir Edward Fry, and Lord Alverstone as one of their members,

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were: (1) Whether any, and if so what, additional power should be given to the Patent Office to control, impose conditions on, or otherwise limit the issue of letters patent in respect of inventions which are obviously old, or which the information recorded shows to have been previously protected. (2) Whether any, and if so what, amendments are necessary to Section 22, dealing with compulsory licenses, of the Patents, etc., Act, 1883. (3) Whether the period of seven months' priority allowed by the Act of 1883 to applicants for letters patent under the International Convention may properly be extended, and if so, on what conditions. On the first question, the report points out, upwards of 42 per cent. of the specifications accepted in the first week of June from 1877 to 1899 were anticipated, either in whole or in part. The committee are of opinion that the grant of invalid patents is a serious evil, and that, in addition to the existing enquiries, an examination ought to be made in the Patent Office into the question whether any invention claimed in a deposited specification has been claimed or described in any, and what, specifications of letters patent granted in the United Kingdom dated less than 50 years previous to the date of the application. This enquiry should not, however, be extended to provisional specifications which have been published but not followed by a complete specification, and the committee think that, consequent upon the limitations of this enquiry, an enactment should be passed to the effect that the publication of an invention in specifications of letters patent granted in the United Kingdom dated 50 years or more previous to the date of the application, or in a provisional specification of any date of the kind before mentioned, should not of itself be deemed an anticipation of the invention. As to the second question, in regard to Section 22 of the Act of 1883, the committee recommend its repeal and the substitution for it of an enactment embodying, amongst others, the following proposals: That the right of applying be confined, as at present, to a person interested; that the jurisdiction be transferred to the High Court; that the jurisdiction shall apply to all letters patent, whether granted before or after the passing of the proposed enactment; and that the Court have power to make an order conferring a license on the applicant upon such terms as to the duration of the license, the amount of royalties, security for payment and otherwise as the Court, having regard to the nature of the invention and the circumstances of the case, shall deem just. Replying to the third question, the committee think the seven months' priority allowed may reasonably be extended to a year, subject to the conditions that foreigners who apply shall file a complete specification, that upon acceptance, or at the end of the 12 months, the specification shall be published by the Patent Office, and that the extension of time be met by a corresponding concession in favour of British inventors abroad. In a note to the report, the chairman regrets the omission of the enquiry whether an invention claimed is obviously old. He thinks that the enquiry, if made in conjunction with that into anticipation by previous specifications, would add very little to the trouble of the examiner, and he fears that the omission of this enquiry may let through some of the patents which it is expedient to check.

The Electrolysis Question.—The only opposition to the Sheffield Corporation's Bill before the House of Lords Committee, presided over by Lord Newton, was offered by the Sheffield United Gas Company to the proposal for electric tramway extensions. The question raised was as to making provision in excess of the present protection given to gas companies against the possible effect of the electrolytic action of electricity escaping from tramway mains. This is the proviso which the gas company desired to have inserted in the Bill: "Provided that, notwithstanding anything contained in the said Acts or this Act, if it be proved that any injury, or damage to any mains, pipes, or apparatus of the Sheffield United Gaslight Company shall have resulted from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction or any of the tramways for the time being belonging to the Corporation, nothing in the said Acts or this Act shall relieve the Corporation from any liability to make compensation for such injury or damage which would have existed but for the passing of the said Acts and this Act." The promoters of the Bill objected to this special clause being inserted, contending that the general regulations of the Board of Trade were sufficient to protect the petitioners, and that so long as the Corporation carried out the Board's regulations, they were entitled to the same protection as other local authorities who worked tramways by electric power. If these regulations were not sufficient, it was for the Board of Trade to amend them. The electrical engineer of the Sheffield Corporation tramways, Mr. A. L. Fell, gave evidence on behalf of the promoters to the effect that every proper precaution against electrolytic action had been taken in the construction of the tramways. For instance, the rails were laid in a solid bed of concrete and were plastered up with Portland cement and sand on each side, so that they were practically insulated from the general body of the earth. Again, every joint was bonded, and the tracks themselves were cross-bonded. The records showed that the amount of current passing back to the power station otherwise than by the rails was very small. In Mr. Fell's opinion the insertion of such a proviso as was proposed by the gas company would cause endless litigation. Mr. Horace F. Parshall also gave evidence. He had had American experience, and in the United States there were no regulations like those of the Board of Trade in this country. A tramway company was allowed to adopt any system of traction they wished, and if the company did damage they had to fight it out in the law courts. He had examined the Dublin Tramway Company's system particularly, and he found no deterioration in the rails through electrolysis, and there was no talk of electrolysis in any of the numerous installations with which he was connected. In his opinion the Board of Trade regulations afforded all the protection that was necessary to the owners of gas and water pipes. Mr. Robert Hammond agreed that, particularly in Sheffield, even though the pipes were situate in ashy and damp ground, the Board of Trade regulations furnished sufficient protection. If electric tramways were properly constructed, there was no risk whatever of electrolytic action. Among the witnesses called on behalf of the petitioners were Prof. J. Perry and Prof. W. E. Ayrton, both of whom agreed that there was serious danger of electrolytic action to pipes laid near electric tramway lines. The former stated that under Board of Trade rules 5 per cent. of leakage might take place, but a single ampere of current continuing for one week, to leave metal and enter soil of a certain kind, would remove a cubic inch of iron or two cubic inches of lead. Prof. Ayrton referred to the London County Council plans of electric traction, stating that the return conductor has to be as wholly insulated as the going conductor, which would afford an absolute safeguard to the pipes in the roads through which the tramways would be laid. He was inclined to think that the Board of Trade rules were drawn up under a misconception, for whatever was the difference of potentials, electrolysis would take place. The Committee finally decided to allow the Bill to proceed, subject to the addition of the clause proposed by the gas company.

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THE DIESEL OIL-ENGINE.

On Monday last, we, in common with a large number of other engineers, had the privilege of inspecting at the works of Messrs. Scott and Hodgson the first Diesel engine which has been made in England. This firm, who have their works at Guide Bridge, near Manchester, have taken up the manufacture of the Diesel engine in this country, and their first production is remarkable for several improvements over types of the engine made under the inventors' direction abroad. As, however, this first engine had only been completed some 10 days when we saw it, there has been no time to conduct full tests of efficiency. The indicator cards, however, show that it is fulfilling in every way the conditions which should result in excellent economy.

Although the general principle of the oil-engine invented by Mr. Rudolph Diesel, of Munich, has been often published before, we propose to give a brief *résumé* of the same in describing the new engine which the owners of the English patents have constructed. From the first it has been recognised by all experts in engine design that the principles of the Diesel engine are sound, and the slow progress made by the engine commercially has been due to mechanical defects in the construction of the engine. Briefly, the cycle of events laid down by the inventor as requisite for a perfect heat-engine are as follows: The rapid compression of the working charge of air in the main cylinder to a point at which the temperature of the charge exceeds that at which the combustible used will be spontaneously ignited. This combustible, which in the present case is crude petroleum oil, is then injected in a fine spray into the heated compressed charge of air, and it burns without shock. In consequence of the above conditions, the combustion is absolutely complete. Another point is that the expansion takes place over a very large range, as the volume of the compressed charge of air is only some 5 per cent. of the total volume of the cylinder at the end of the working stroke. The temperature range of engine is much greater in consequence than that of any other known engine, and the Carnot efficiency of the Diesel engine thus is higher than that of any of its competitors. The exhaust temperature is extremely low for an oil-engine, as it is not too warm to hold one's hand on.

Coming, now, to the actual engines for realising the above conditions, the inventor has had his engines constructed on the Otto cycle, giving only one working stroke for every two revolutions. The engine we saw on Monday, and which we illustrate below, however, was so designed that a charge of oil is burned at every forward stroke of the piston. In this engine the working cylinder is 7⅞in. diameter, and the stroke is 10½in. Beyond the cylinder in which the work is done is a second cylinder, which acts as an air-pump to flush the burnt charge out into the exhaust. At the side will also be seen another small air-pump, which provides the supply of air at 600lb. pressure for injecting the air into the main cylinder. The cycle is then as follows: At the beginning of the backward stroke of the main piston the cylinder is full of air, which is compressed into the very small clearance at the back of the cylinder. The pressure rises to about 420lb., with a corresponding large rise of temperature, owing to the fact that the cylinder walls are unable to take up much heat in the short time during which the compression takes place. Air from a reservoir tube, at 600lb. pressure, is then used to inject a fine spray of oil into this heated charge of air. Complete combustion takes place, and the charge expands, as shown in the indicator diagram (Fig. 2). As the piston completes its forward stroke, the exhaust valve, which is situated at the back of the cylinder, opens, and from the diagram it is gathered that this takes place while there is still some 30lb. pressure in the cylinder. Fig. 3 is an enlarged diagram taken of the exhausting period. At the extreme end of the forward stroke the piston uncovers ports in connection with another air reservoir in the engine bed-plate, which contains air at about 4lb. above atmospheric pressure. This causes a flush of clean air to sweep out the cylinder into the exhaust before the exhaust port is closed and a second compression begins. The first duty of this pump is to keep the flushing air reservoir charged with air, but it also acts a pressure pump to supply air to the smaller air-pump. At the end of each forward stroke the pressure in the pump rises to about 40lb., and at this instant the small pump takes in a charge of this compressed air. The small pump has a diameter of only 3⅛in., and its diagram is shown in Fig. 4 The compressed air goes under ordinary conditions into one of the three vertical reservoir tubes seen in Fig. 1. The other two tubes are also charged by the same pump, and are kept charged ready for starting up

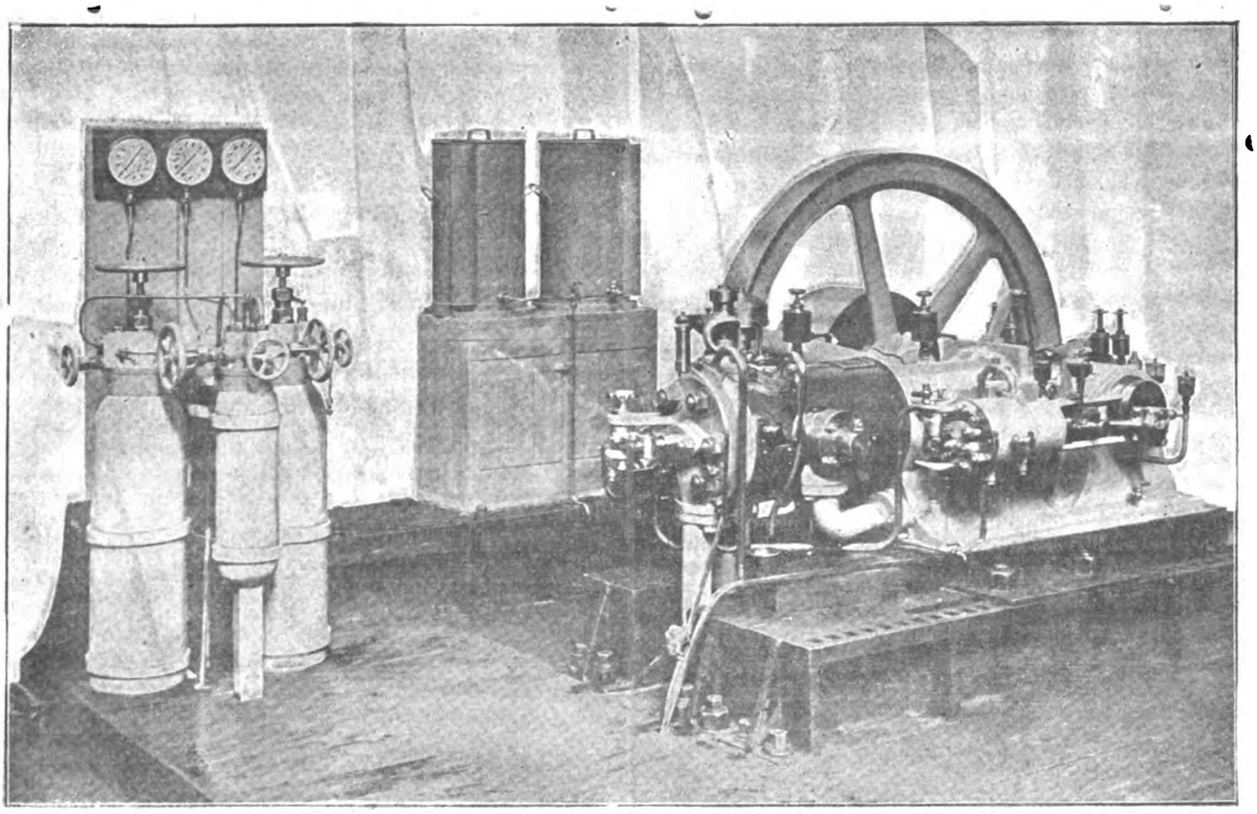

FIG. 1.—View of the Diesel Engine at the Works of Messrs. Scott and Hodgson.

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the engine from rest. The governing of the engine is effected by varying the quantity of oil admitted. This is done by varying the time during which the valve in the oil supply pipe is opened.

The general arrangement of the engine at Guide Bridge is shown in Fig. 1. The small tube in the front of the two larger tubes is alone connected to the air-pump under ordinary conditions. Before the engine is stopped, however, the valves are open to the larger cylinders, so that the

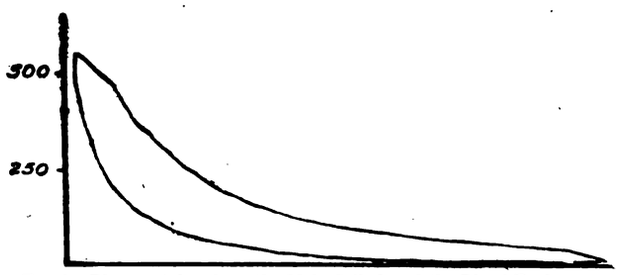

FIG. 2.—Diagram taken from the Main Cylinder of the Diesel Engine. The vertical scale shows the pressure in pounds.

pressure in them is raised rather more than 600lb. In starting the engine, it is moved round by hand until it is just past the dead centre, with the piston at the back end of the cylinder. A lever on the governor is then moved so that oil is admitted as required. Immediately the pressure is turned on from the air reservoirs the engine starts working like a compressed-air engine. For the first few strokes the compression on the back stroke is relieved. As the engine gets up considerable speed after

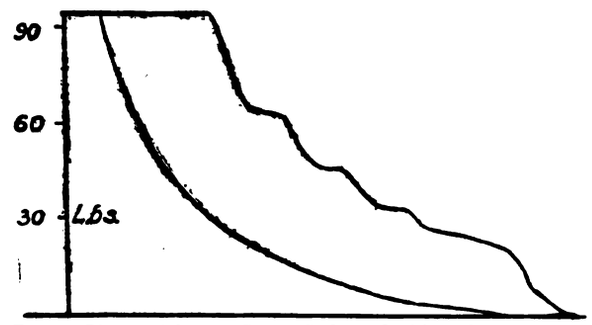

FIG. 3.—Diagram taken on Larger Scale, and with weaker spring of that period of the stroke at which the exhaust to atmosphere is taking place

a few revolutions, the compression of the air is allowed to take place on the back stroke, oil is then injected in the usual way, and the engine is ready to take up its load. The actual time taken in starting is only a fraction of that required to start an ordinary oil-engine, in which the heating up of the ignition tube and the vaporiser requires a considerable time. It will be seen, however, that the ease of starting entirely depends in the air pressure being maintained in the tubes which act as

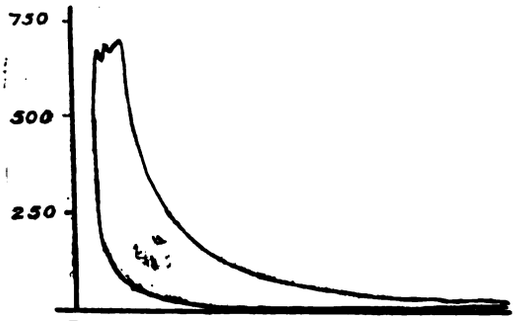

FIG. 4.—Diagram from the Air Pump Cylinder.

reservoirs. This is largely a question of the valves employed. The engineers at Guide Bridge informed us that they had surmounted the mechanical difficulties, and that the storage cylinders would hold up sufficient pressure to start the engine for six weeks.

Another point of interest in the engine is that it does not require a refined oil. The two tanks seen in Fig. 1 contain respectively a raw Tegernsee oil and a refined oil. While relative experiments as to the work obtained by these two oils had not been completed when we saw the engine, it had been proved that the low-grade oil gave no trouble whatever. The apparatus used for breaking up the oil into very small particles when introducing it into the heated charge of compressed air consists of holes in metal plates, through which the oil is forced by the compressed air from the reservoir. The holes in the one plate are not opposite those in the next, and the zigzag course results in a very fine pulverisation of the oil. These holes can be made as much as $\frac{1}{75}$in. in diameter, and, as might be expected from this, no clogging whatever takes place. Again, the facility for using a crude petroleum, is, from a monetary point of view, a greater advantage of the engine than even its increased efficiency, as compared with other types. It is also found that the quantity of the crude oil required is practically the same as that taken when the oil has been refined. As regards the combustion, we were able to tell from the exhaust that this was carried out completely, as there was no smell whatever of petroleum and no staining of a handkerchief held directly in the discharge—in fact, when this engine was first run the exhaust delivered directly into the workshop without causing any inconvenience whatever to the workmen. There was a slight white vapour in the exhaust, which was said to be due to the lubricating oil not being quite of the right composition. The engine ran wonderfully smoothly, and without that shock which is usually associated with gas and oil engines.

After the inspection of the engine the company were taken on to Manchester by the special train which had been used on the way from London, and in the course of the evening a dinner was given by the Diesel Engine Company, Limited, at the Albion Hotel. The menu of the dinner itself was a revelation of what Manchester caterers can do, and the arrangements of the speeches were a pleasing exception to usual rules. Mr. HENRY HODGSON, a partner of the firm of Messrs. Scott and Hodgson, was in the chair, and proposed the usual loyal toast, which was the only toast of the evening. After this had been honoured, Mr. Hodgson proceeded to give a brief *résumé* of the steps which the firm had taken in developing and improving the Diesel engine. The first engine working on the Diesel principle, and giving a working stroke for every revolution of the engine, had been made by them, and inspected by the company that day. It was also the first horizontal engine, but they were making the next ones of a vertical type for certain mechanical reasons. The heat efficiency obtained already exceeded 37 per cent., and it was quite possible that with an increase in dimensions they would reach as much as 40 per cent. It would be seen from the illustrated diagrams that oil was steadily burnt during the first 10 or 12 per cent. of the stroke, and that without explosion. In consequence of this the engine ran more like a steam-engine than a gas-engine. As commercial men, they were largely interested in the consideration of how far this oil-engine would be able to replace other prime movers. In consequence of its consuming only about half the oil required by the ordinary types of oil-engines, and also because it could work with a low-grade oil, it would easily replace its rivals in that direction. It had been estimated in Germany that with oil at 4½d. per gallon it was more economical than a steam-engine using coal at 16s. 6d. per ton. While coal was much cheaper in this country, the same applied to oil, and with crude petroleum at 1½d. per gallon the Diesel engine would be able to compete commercially with steam-engines for driving works. There were many other fields, such as marine work and automobiles, in which the engine should have a large field of service.

Prof. W. C. UNWIN, at the request of the chairman, then gave a brief *résumé* of the various opportunities he had had of inspecting engines of the Diesel type on the Continent. When the book written by Mr. Diesel was issued several years ago, he at once recognised that the author was working on the right lines, and he had been pleased to see at Augsburg from time to time the success which had been obtained. In the ordinary oil-engine they had to contend with what he might call the temper of the engine—for instance, the engine often refused to start. An overload would stop the engine exceedingly quickly, and often the

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engines refused to work without apparent cause. The clogging of the various parts was another point of difficulty. When making an inspection, at the request of Mr. Oppenheimer, at Ausburg he was struck with the ease with which the Diesel engine was started, and with its capabilities of dealing with overload. The most remarkable feature from an economical point of view was that the efficiency was so good at light load. The consumption of oil per indicated horse-power showed a most remarkable state of things. From some experiments carried out by Prof. Schröter it was seen that with the engine he experimented with the consumption of oil per indicated horse-power hour at normal full load was 0·352lb. At three-quarter load this figure was reduced to 0·348lb. and at half load to 0·33lb. It must be remembered that in the majority of cases engines were not worked at their full load, and hence the economy with light loads was a most important factor in estimating the performance of the engine. The Diesel engine was certainly the most efficient engine at the present day, and he saw no reason why it should not be manufactured for large outputs.

An informal discussion followed, in which the question of the complication of the engine was referred to. It certainly has more working parts than an ordinary oil-engine, but the construction may be simplified in the future. It was pointed out by Mr. Hodgson that the novelty of the engine was rather apt to give an idea of complication, but that the engine had been worked by unskilled labour for a considerable number of years on the Continent.

The proceedings terminated with a vote of thanks to the directors of the Diesel Engine Company for their hospitality. We understand that this first engine is to be exhibited at Glasgow, and that several more engines are now nearing completion in the shop. As regards the financial status of the company, we learn that its nominal capital is £500,000. Of this £40,000 has been issued in preference shares, of which £30,000 has been paid up. Of the remaining shares, £320,000 worth of ordinary stock has been issued, we presume, as purchase money, which seems to us to be a heavy amount in comparison with the £40,000 provided for working capital.

WESTINGHOUSE "O.D." TRANSFORMERS.

The illustrations accompanying this article show some of the peculiarities of construction of a new Westinghouse transformer recently placed on the market. It is classified among the other well known and widely-adopted types of the same make under the name "O.D. transformer." The design of the transformer is based upon the results of over 15 years' experience in the manufacture of transformers, and it is claimed that all other transformers are excelled by it as far as all-round electrical efficiency and general mechanical design are concerned. The general principles of construction of the well-proved Westinghouse transformer have been retained in the "O.D." type, so that the introduction of the new type cannot be said to be of the nature of the many strange types which have appeared from time to time during the past few years, and which have achieved no success in actual practice. The transformer under notice can, therefore, hardly be termed a novelty; it is really a perfected form of a type which has during many years held the best of records.

The new transformer has been designed to secure the best all-round results. No one characteristic has been over-developed at the expense of any other: at the same time the most important features of transformer performance were ever kept in mind, and the outcome has been a transformer which embodies such points as highest efficiency under both all-day and full loads; the best of regulation with either arc or incandescent lamps or motors or other inductive loads; highest insulation resistance both against normal pressures and disruptive discharges; simplicity of construction; and permanence and reliability of the materials used in construction. The "O.D." transformer is of the oil-immersed type. The oil is not used, strictly speaking, as an indispensable part of the insulation of the transformer. Experience has shown that oil is not only most valuable on account of its insulating properties, but that it is one of the best cooling mediums, that it preserves and increases the life of the coil insulating materials, and that it adds to the power of the transformer for resisting lightning discharges. As a matter of fact, many of these transformers are in use without oil, especially in the case of smaller sizes, and they are designed to be reliable whether used as oil or dry transformers. However, it may be said that the makers prefer the use of oil wherever possible. In view of the fact that these transformers are designed for dry work, it should be mentioned that every transformer before being sent from the works is tested in the dry state. All sizes of transformer are submitted to the following tests, in every case

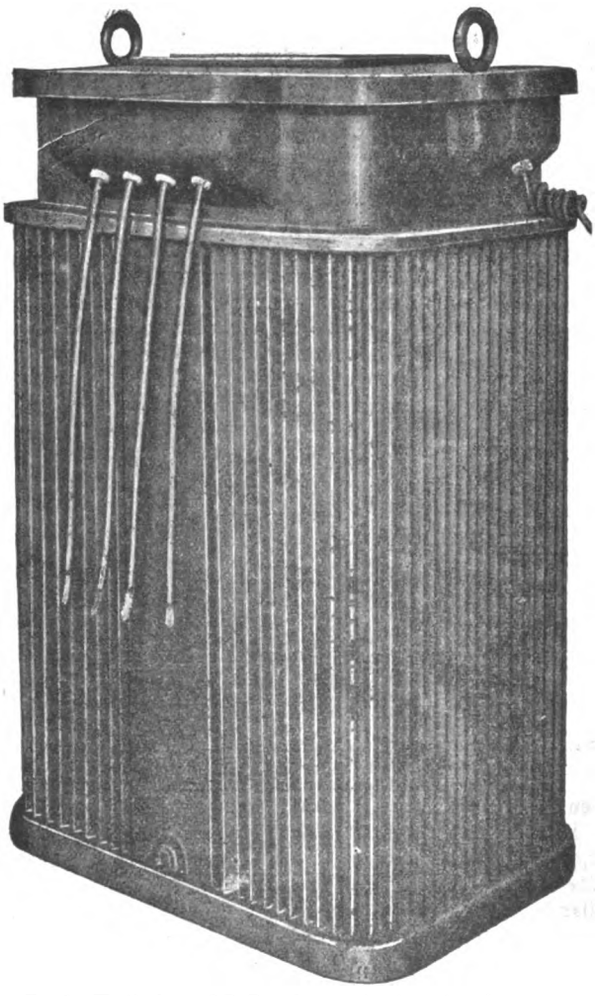

FIG. 1.—Westinghouse O.D. Transformer, showing external appearance of larger sizes.

the transformers being without oil: (*a*) a continuous run of several hours at overload under normal pressures; (*b*) a continuous run at three times the normal voltage at no load; (*c*) an insulation test of 8,000 volts between primary and secondary; (*d*) an insulation test of 6,000 volts between primary and iron core; (*e*) an insulation test of 4,000 volts between secondary and iron core. The iron losses and the transforming ratios of each transformer are also accurately measured.

The practice of winding each transformer for two primary and two secondary voltages was first introduced on the original Westinghouse transformers, and has proved to be so useful that other makers have very generally adopted it. The "O.D." transformer windings are arranged for two primary voltages and three secondary voltages. At the present time, when the voltages of lighting circuits are being raised and changed so frequently, and when alternate-current motors are coming to the fore, the advantages to be secured by this arrangement of several pressures will be at once perceived. The pressures adopted for the standard sizes are: In all sizes, primary pressures of 1,050 and 2,100 volts; in sizes up to 3 kw. capacity, secondary pressures of 52·5, 105, and 210 volts. Larger sized trans-

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formers may have these secondary pressures, or three pressures twice as much respectively. Sizes ranging from ½ kw. capacity up to 50 kw. capacity are stocked. The smallest size is about 7 5in. square by 13in. high (outside

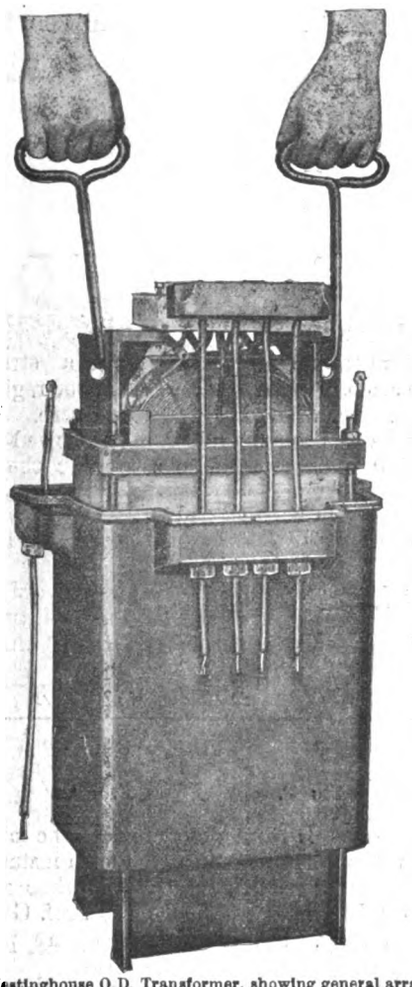

FIG. 2.—Westinghouse O.D. Transformer, showing general arrangement of parts (small sizes).

dimensions), and has a gross weight of 76lb. The 50-kw. size is about 22in. by 27in. by 44in. high, with a gross weight of 1,800lb.

The transformer coils are wound separately, are all similar in form, and are placed on the core side by side; there is thus no straining of the coils, and the insulation resistance between them is of the highest value. The primary coils are wound in many layers, with few turns per layer; the difference of potential between adjacent turns is thereby reduced to a small value. The secondary coils are wound, of a square section conductor, in a manner which avoids the usual crossing of the wires at the end of each layer. By using square wire the section of conductor available in a given sized coil is 30 per cent. greater than it would be were round wire used. The secondary resistance is correspondingly reduced and the transformer efficiency increased. By the arrangement of flat coils, parallel and spread apart with the ends exposed, as shown, the cooling surface is very great, and forms one of the distinguishing features of Westinghouse transformers.

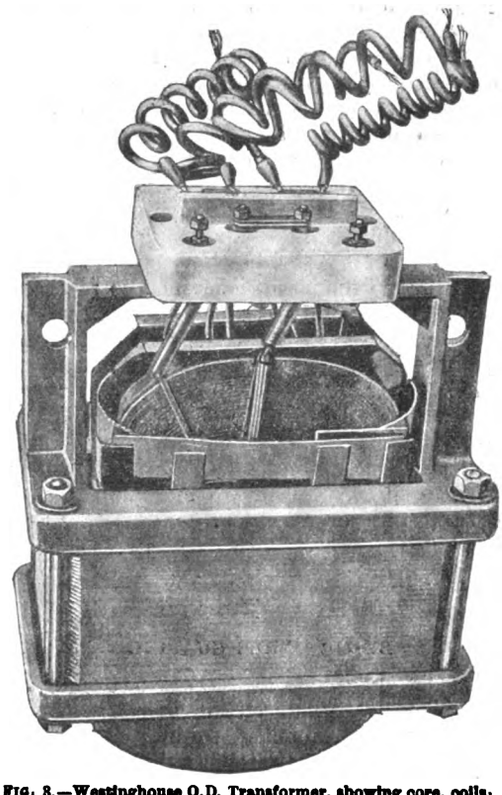

FIG. 3.—Westinghouse O.D. Transformer, showing core, coils, and terminal block.

With the large cooling surface thus obtained, it is not necessary to make any parts larger or to sacrifice efficient electrical design in any way for the sake of securing cool running, as has been done in many other types of transformers.

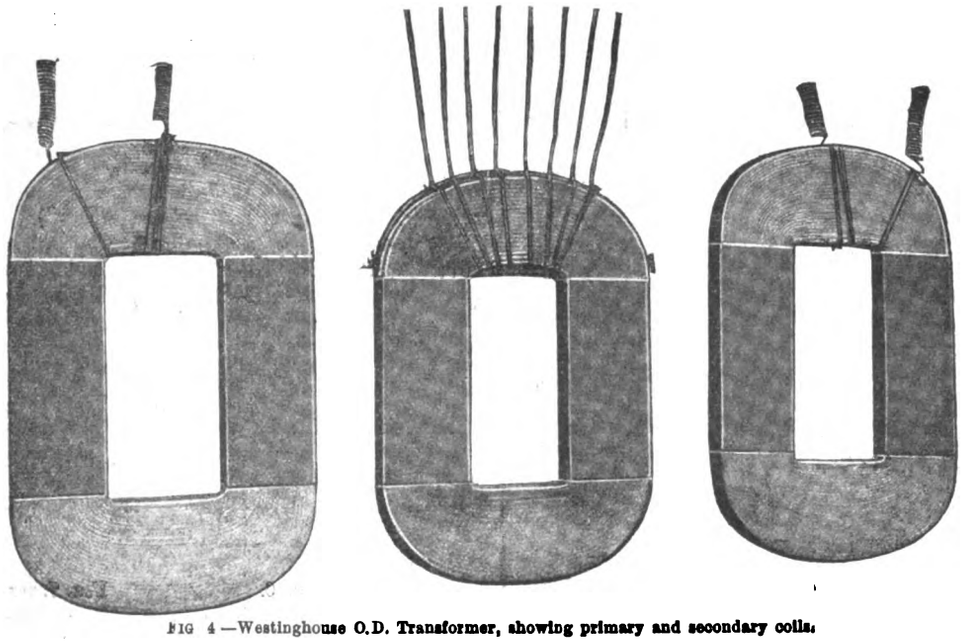

FIG 4.—Westinghouse O.D. Transformer, showing primary and secondary coils.

The porcelain block just under the cast-iron lid of the transformer carries terminals to the four primary-coil leads and for the eight secondary-coil leads. The changes in the primary windings from series to parallel,

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or *vice versâ*, are quickly made by screw and link connection; the secondary-coil combinations are, however, made by soldered connections, a soldered connection being most reliable for heavy current work. Just below the terminal block the leads from the coils are bared to prevent the capillarity of the insulation siphoning the oil from the case. The outer oil-containing cases of "O.D." transformers up to the 10 kw. size are of cast iron; larger-sized transformers are enclosed in a corrugated sheet-iron case fitted with a cast-iron top and bottom. The cooling surface of the corrugated iron is large, and conduces to further cool running of the transformer.

Although made in certain standard sizes and of certain standard ratios, as previously stated, the "O.D." transformers are made also in special forms for much higher pressure work and in very large capacity units. It is interesting to note that before placing these transformers on the market a most rigid series of tests were applied to them. A complete line of them was built, and each one carefully tested for iron and conductor losses and for insulation resistance. The transformers were then operated for a year at double the normal working pressure. At the end of this time a repetition of the previous tests on each transformer proved the permanency of the materials used in their construction. Practically no deterioration had taken place in the iron of the cores, and each transformer was subjected to six and eight times the normal working pressure for several short periods of time, the transformer coils withstanding pressures up to 20,000 volts. It will thus be seen that the result of the whole test was extremely gratifying, the factor of safety of these transformers being thus proved to be considerably in excess of that usually considered necessary or expected.

INDUCTION EXPERIMENTS.

BY MR. EMILE GUARINI.

The following experiments were made to show that it is possible to obtain in an induced circuit a current producing the same effect as a continuous current. The author made a series of experiments, using the connections which are illustrated in the various figures. In the first experiment he connected the external coatings of two condensers to a small Wimshurst machine, the diameter of the plates of which was 10in. The other coatings of the two condensers were connected to the terminals of the high-resistance winding of an induction coil, the resistance of which was 11,000 ohms. The primary circuit of the induction coil, which had a resistance of ½ ohm, was connected to a

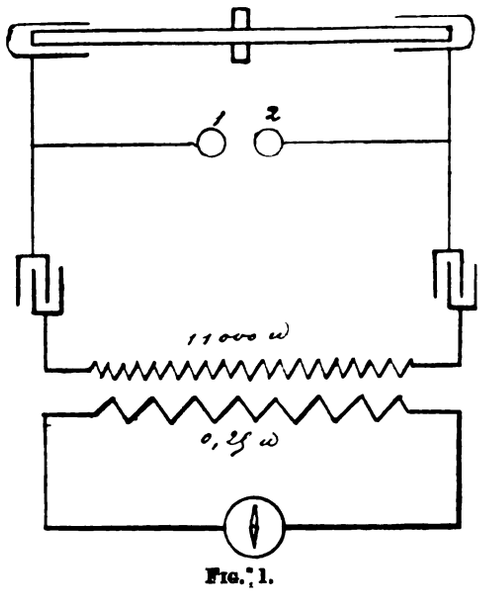

FIG. 1.

galvanometer, and the interrupter of the coil was disconnected. When a strong spark was made to pass between the balls (1 and 2), the needle of the galvanometer was deflected through a certain angle α. It then returned to rest. If the sparks passed in rapid succession, the galvanometer was reflected through a constant angle β, and did not return to zero except when the sparks ceased. He then changed over the poles, and the deflection of the needle was reversed. He replaced the galvanometer

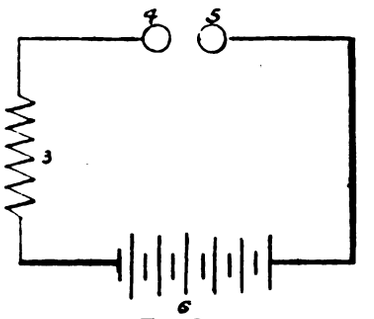

FIG. 2.

by a milliampere-meter. Then when a strong spark passed between the balls the ampere-meter registered two milliamperes, after which it returned to zero. With continuous sparks the ampere-meter only showed one milliampere, and it only returned to zero when the succession

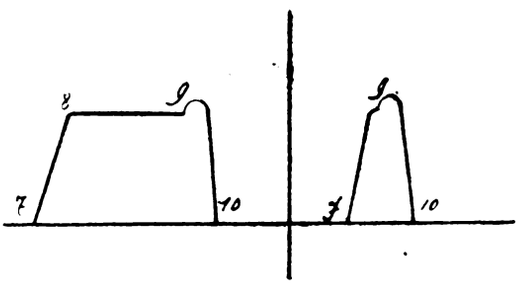

FIG. 3. FIG. 4.

of sparks ceased. Having then replaced the milliampere-meter by a voltmeter, this indicated for an instant 0·5 volt when a single spark passed, and 0·3 volt when a series of sparks was passing between the balls. Prof. Govi, of the Naples University, has remarked upon phenomena

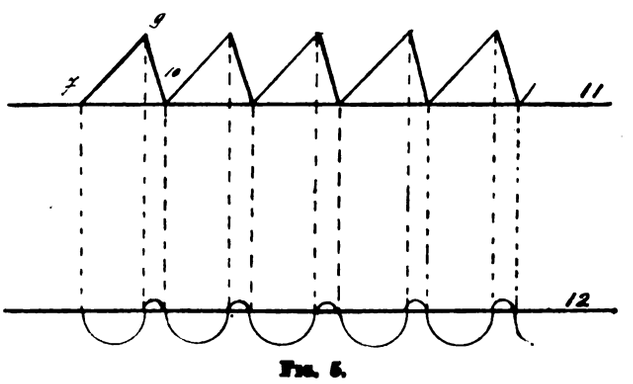

FIG. 5.

somewhat similar to this experiment in one of his publications ("Trattato Elmentare di Titica"). Between the extremities of the secondary wire of a Ruhmkorff coil the Italian professor has made sparks to pass by means of a Holtz machine, and has obtained elec-

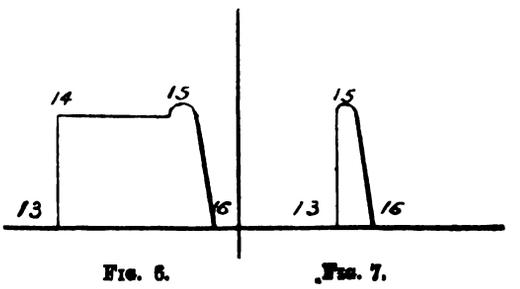

FIG. 6. FIG. 7.

trolysis in a voltameter. He also obtained a deflection of the needle of a galvanometer inserted in the primary circuit when the interrupter of the coil was disconnected—that is say, he obtained the effects of a continuous current. Mr. Vichet, professor at the Higher

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Normal School of Paris, also showed experimentally, in 1873, that the high-tension current produced by a Holtz or a Wimshurst machine was able to be transformed into a current producing analogous effects to those of a battery. The way in which his experiments were carried out is not known. As regards the theory of the subject, if we take coil 3 in Fig. 2, formed of several layers of insulated metal wire, and of which the extremities terminate in two small spheres (4 and 5) not far apart, and then in the air-space between 4 and 5 connect any source whatever of energy which would give a continuous current (this source of energy is indicated by Fig. 6 in the diagram), then at the instant when the generator

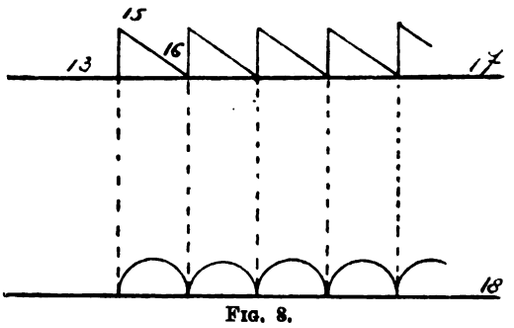

FIG. 8.

of electricity is connected to the circuit, and when it is disconnected, a small spark is produced between the terminals 4 and 5, in spite of the fact that the ordinary conditions of the circuit are such that there is no potential difference sufficient to cause a spark to cross the air-gap in question. This spark seems to be a single one in consequence of the rapidity of the phenomena, but in reality it is composed of an exceedingly rapid succession of small sparks. Each of these sparks closes the circuit, which remains open during the time between the passing of two

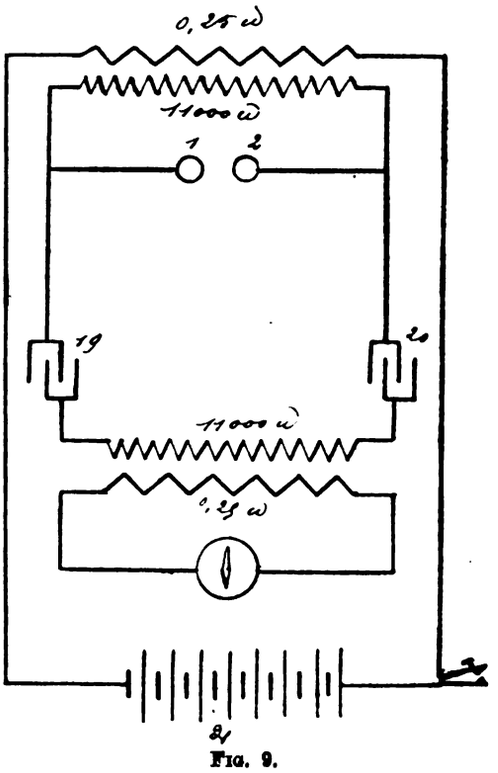

FIG. 9.

of these small sparks. In fact, the sparks play the part of an exceedingly rapid interrupter. Looking into this question more closely, one finds that before the source of electrical energy is connected in the circuit no current is able to pass in it, but as each connection with the source of electricity is made the first small spark appears, and the circuit is closed. A current traverses this circuit in the meanwhile, and there is an extra current on closing. When the first spark extinguishes itself the circuit is broken, and there is produced an extra current due to the break. The same phenomena are repeated for each successive spark.

One knows that the extra current on closing lasts much longer, and that the E.M.F. is more feeble than the current which is produced on rupture, which lasts an exceedingly short time and has a very high E.M.F. These extra currents behave differently according as R is smaller or greater than $\sqrt{\frac{4L}{C}}$; R, L, and C being respectively the coefficients of resistance, self-induction, and of the capacity of circuit. If R is less than $\sqrt{\frac{4L}{C}}$, the curves 7, 8, 9, and 10 in Fig. 3 are able to represent the current which traverses the bobbin during the appearance of the first spark. The portions of the curve between 7 and 8 corre

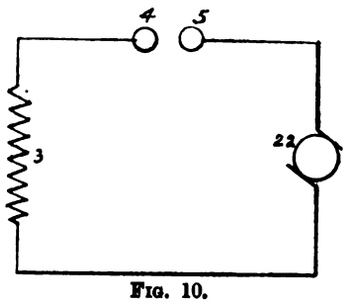

FIG. 10.

spond to the variable period during which the circuit is closed. The portion 8 to 9 represents the more permanent condition, and the portion between 9 and 10 the variable period during which the break takes place. If one considers the extreme rapidity of the phenomena, one is able to calculate that the steady state is of exceedingly short duration, and that the curves 7, 9, and 10 (Fig. 4) really represent the current corresponding to the interruption of the spark. For a succession of small sparks we should thus get something like as shown in the diagram (Fig. 5). Supposing, now, that we wind a second wire on the bobbin of Fig. 2, this wire would be traversed by an induced alternating current of the wave form, which is represented in 12, Fig. 5. If R is greater than $\sqrt{\frac{4L}{C}}$, the extra current on making the circuit, which is a growing current, represents the inertia

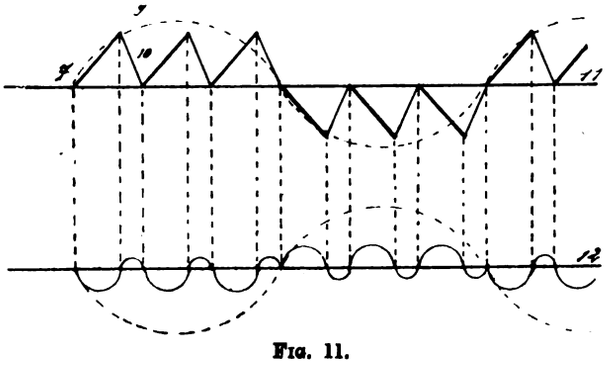

FIG. 11.

to be overcome, and is transformed completely into heat, following the Joule effect. In this case the constant *régime* is instantly established. The diagrams shown in Figs. 3, 4, and 5 now become those of Figs. 6, 7, and 8, in which one sees that in the induced circuit a succession of very rapid currents in the one direction takes place. It is not what one could call an even current, but it is a current which is able to produce the same effect as a continuous current, much in the same way that in a good cinematograph the exceedingly rapid succession of figures on the retina gives the effect of a continuous movement. This same succession of exceedingly rapid impulses of current in the one direction produces the effect of a continuous current. The result is easily explained if one considers the diagram in Fig. 8. One there sees that the variable period when the circuit is closed and the permanent period disappear in the inducing circuit. The period of induction corresponding is necessarily suppressed, and there is only the period which corresponds to the breaking of the circuit which appears in curve 17. There only thus

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exists one period of the induction in curve 18. Expressed as a law, the previous experiments may be condensed as follows: if one renders intermittent the inducing current in the circuit, and if one suppresses the extra current due to the closing of the circuit by transforming it into heat according to the Joule effect, by the insertion of a very great resistance, one obtains in the induced circuit a current producing the voltaic effect.

Second Experiment.—By the aid of a key the author closed the circuit of the electric source of energy indicated by 21 in the diagram (Fig. 9). He introduced this key in the primary circuit of a Ruhmkorff coil, the secondary of which worked an oscillator, shown by 1 and 2. The rest of the arrangement is much the same as shown in Fig. 1. In working the first coil, the needle of the galvanometer

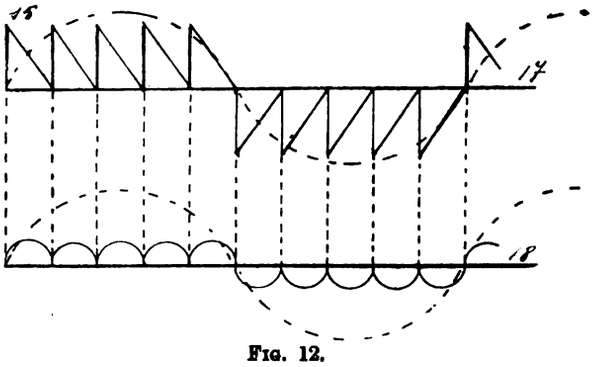

FIG. 12.

inserted in the thick-wire circuit of the second coil was not permanently deflected, but a frequent and rapid oscillation indicated the passage of an alternating current. The author's explanation of this is that in Fig. 10 coil 3 is formed, as in Fig. 2, of several layers of insulated metallic wire, with its extremities also terminating in a spark-gap (4 and 5). In this circuit, however, the alternator, 22, was introduced. This current is able to be considered as formed from successive alternating currents positive and negative, from each of which we are able to adduce the following: If for the first phase, during which the current is in the positive direction, for example, we obtain the diagram of Fig. 4 or

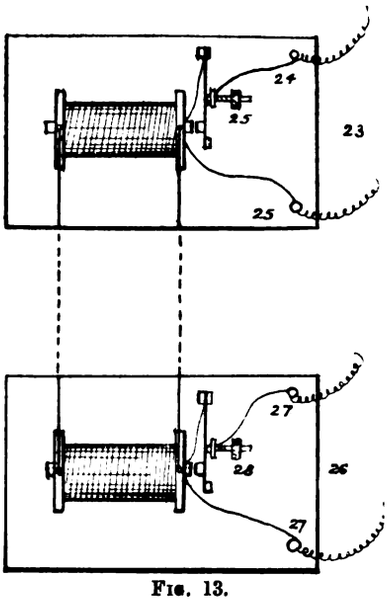

FIG. 13.

Fig. 7, according as R is less than or greater than $\sqrt{\frac{4L}{C}}$, then for the small sparks which succeed each other during these phases the diagrams will be respectively those in Fig. 5 or Fig. 8. For the next phase, during which the current is in the negative direction, we should get the same diagrams, but reversed. In short, for these two successive phases of complete periods of alternating current we should have the curve of Fig. 11 if R is less than $\sqrt{\frac{4L}{C}}$, or Fig. 12 if R is more than $\sqrt{\frac{4L}{C}}$. The outline of the curves figured represent what would happen with ordinary alternating currents. The author's conclusion is that if by any arrangement whatever one renders intermittent the alternating current flowing in an inducing circuit, and if one suppresses the extra current on making the circuit by transforming it into heat, following the Joule effect by the insertion of a great resistance, one obtains in the induced circuit a series of impulses which change in direction with the changes in the principal current.

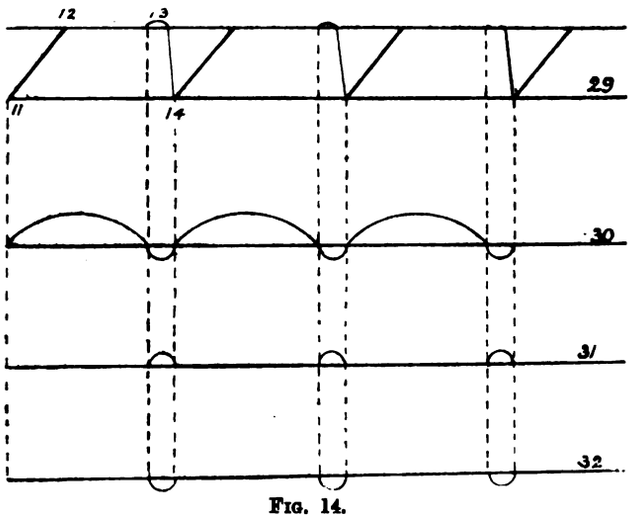

FIG. 14.

Third Experiment.—The author repeated the experiments of M. Bichat, described in the *Annales de Physique et de Chemie*, vol. vi, 1875. The primary circuit (Fig. 13) of the coil as receiver at the terminal marked 24, is the current of a battery rendered intermittent by the vibration of the interrupter, 25. The induced current of high voltage is produced in the fine-wire circuit of this coil. This high-tension current is taken to the thin-wire circuit of a second induction coil independent of the first. From the low-tension winding of the second coil one gets a current of small voltage and of a certain strength. In this experiment the vibrator, 28, of the second coil should be screwed up hard. The author's theory of this occurrence is that explained higher up. Fig. 14 represents what happens in the four conductors of these coils. The diagrams 29, 30, 31, and 32 of this figure represent

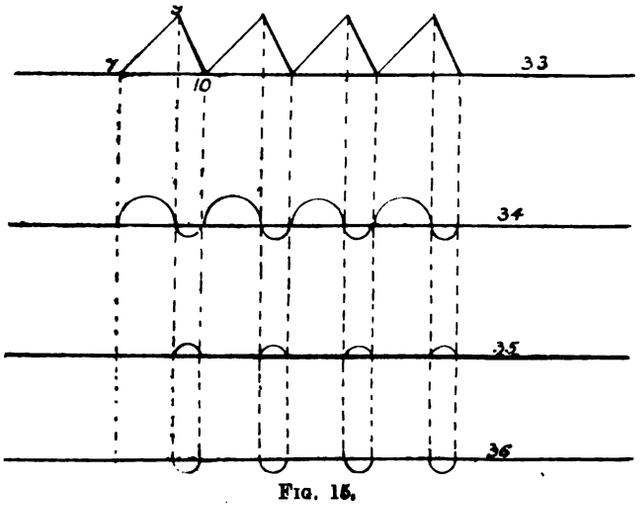

FIG. 15.

respectively the primary and secondary waves of the coil 23 and the primary and secondary waves of the coil 26. If we suppose that the interruptions produced in the coil 23, not by an interrupter, but by the spark which would pass between two small metallic spheres, then the curve (Fig. 3) which is used in the diagrams (Fig. 14) would be replaced by the curve in Fig. 4, and Fig. 14 would then be replaced by Fig. 15. In this last case the diagram represents the redressed alternating current, and the variable current is as in a Gramme machine. The author concludes from this that if one makes the current intermittent in the primary circuit of a Ruhmkorff coil by any arrangement whatever, and if one connects secondary to

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secondary of another induction coil in the primary thick-wire winding in this last coil, one obtains a current capable of producing the same effects as a continuous current if the conditions in the secondary of this last coil are such that R is greater than $\sqrt{\frac{4L}{C}}$. It results from this experience of M. Bichat that the Ruhmkorff coil is reversible, and that the current of a battery is able to be transformed into a high-tension current, and this high-tension current is able to be retransformed into a current of low voltage, and of a certain value, producing all the effects analogous to those produced by the battery serving to excite the first Ruhmkorff coil.

Fourth Experiment.—The author attached the terminals of a small dynamo-electric machine for continuous currents (shunt-wound with a Siemens armature) to the thick-wire primary of an induction coil, and introduced a galvanometer into the secondary circuit of the same. In

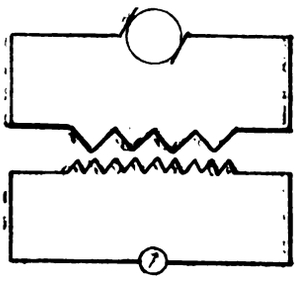

FIG. 16.

starting up the machine the galvanometer vibrated rapidly, due to the passage of an alternating current in the secondary of the coil. The author's theory is that the primary of the induction coil is traversed by impulses in the same direction (Fig. 17). The current is great, but the E.M.F. relatively low. It sets up a valuable magnetic field such as is shown in 37 and 38 (Fig. 17). In virtue of the fundamental law of magnetic induction, $E = -\frac{dN}{dt}$. When the current in the thick-wire winding increases, the E.M.F. which is induced in the secondary is negative. When the magnetic field of the thick-wire winding—that is to say, when dN becomes negative—the E.M.F. induced in the secondary is positive, and the current changes sign. The author concludes that if one sends in the primary of the induction coil impulses of current of the same sense as exist usually

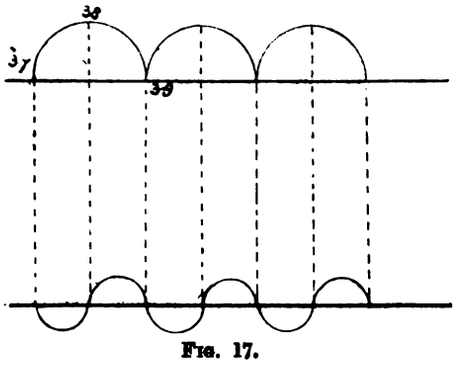

FIG. 17.

in continuous currents, and if the current is large, but of small voltage (the electric field being very small), it produces round itself a variable magnetic field, which generates in the secondary circuit an alternating current.

Fifth Experiment.—The terminals of the small dynamo experimented with above are attached to the thin-wire winding of the induction coils, and the galvanometer is placed in the thick-wire winding (Fig. 18). The current which circulates in the circuit of the fine wire is very small, but the voltage is relatively high. The needle of the galvanometer inserted in the secondary is deflected to the left or the right according to the sense of the current traversing the fine-wire circuit, and this vibration always shows a current in the opposite direction to that which passes through the inducing circuit. The author's theory is that the current traversing the fine-wire circuit, while extremely small, but of relatively high voltage, induces round it an intense electric field, but the magnetic field is negligible. The variable electric field only results in variations in the E.M.F., which from a zero value mounts up to the maximum value (a), afterwards falling back again to zero, as shown in Fig. 19. In the induced circuit E.M.F. is produced in the contrary direction, which increases and decreases in the same way as the inducing current. In other words, X B = X' B', X A = X' A', etc. The author's conclusion is that if one sends through the primary of the induction coil impulses of current of the same sense, and if the current is very small but of relatively high intensity, the magnetic field is negligible, and it generates round itself an electric field which is variable and produces in the second circuit a current capable of producing the same effects as a continuous current. This current is in the opposite direction to the primary current.

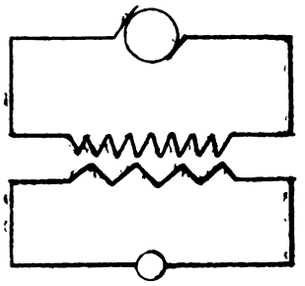

FIG. 18.

General Theory.—The author states that a variable current in the same direction passing through the primary of an induction coil sets up round itself a magnetic field and an electric field. The magnetic field is a function of the current strength, and the electric field is a function of the voltage. The magnetic field increasing or decreasing induces in the secondary an alternating current. The electric field induces in the secondary a current capable of producing the same effects as a continuous current. The current traversing the secondary is the result of these two fields. Finally, first, in the case of a current of very great strength and small voltage in the secondary, one has an alternating current; second, in the case of a current of small amount, but of great voltage, one has in the secondary a current capable of producing the same effects as a con-

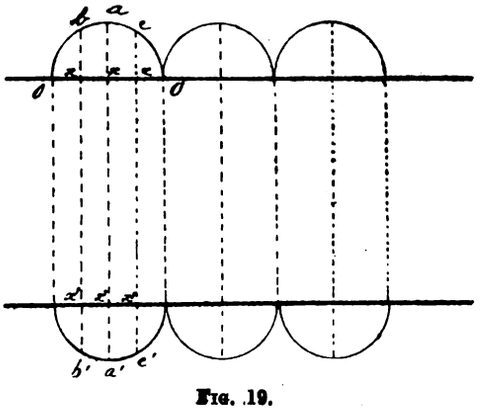

FIG. 19.

tinuous current. In conclusion, the author states that the currents, which we call continuous, but which in his opinion should better be called variable currents in one direction, are able in predetermined circumstances to have the same advantages of transformation as alternating currents. For instance, they can be transformed from high voltage to low voltage in static transformers instead of in rotating transformers.

We are indebted to Mr. E Guarini for the above particulars of his interesting researches, but should have been pleased to have some idea from him as to the efficiency of the suggested means of transforming continuous currents by static transformers. The effect seems to us to be largely due to the wasting of a considerable portion of the energy transformed into heat, which would make the process only of scientific interest.

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DIRECT-CURRENT GENERATORS.*

BY SIDNEY H. SHORT.

Some months ago I received through Dr. Hopkinson your kind invitation to read a paper before this society. The letter expressed a desire that the paper be of a character to induce discussion by the members present. I have therefore selected the subject "Direct-Current Generators" with the view to considering the feasibility of more nearly standardising this class of electrical machinery. I will not consume much time with the paper itself, but will take part in the discussion to follow. You will pardon me if I call to mind some well-known facts with reference to the construction and operation of dynamo-electric machines, which I find it necessary to do in order that I may indicate the changes which are taking place in the design of these machines, and to foreshadow the probable modifications which will produce better results in the future. We are all familiar with the original types, the first of which were made just 50 years ago. The pioneer designers produced dynamos which differed widely in the arrangement of their several parts as well as in the construction of the armatures and field magnets. Clark, who was the first to put into execution Faraday's great discovery of induction, used permanent magnets for the field, and an armature core provided with projections, each projection being wound with a coil of insulated wire, the ends of which were connected to commutator bars in the usual way. Gramme, on the other hand, used a ring of soft iron wire for an armature core, the coils of insulated wire being wound spirally around the section of the ring with branches at intervals leading to the commutator. This form is known as the Gramme ring, and for many years was a favourite with generator designers, but is fast going out of use. Early in the history of dynamo construction, Siemens devised the well-known drum winding, the coils of insulated wire being wound lengthwise and over the ends of a cylindrical armature core, with their terminals joined to the commutator strips. This winding in an improved form is now coming into general use, and promises to be the final one. All of the earlier machines were bipolar, with their armatures revolving at a high rate of speed between the two poles of a single U-shaped magnet. They were mostly belt-driven, especially in America, and to some extent in this country, but here the direct-driven high-speed generator made its first appearance in commercial form owing to the splendid engines available.

When the commercial value of the dynamo became apparent as a source of power for electric lighting, for operating motors, and for the many uses to which large electric currents are put, there sprang up a demand for machines of larger and larger capacity. The two-pole machines were increased in capacity until a limit of distortion was reached, where it was found impractical to further augment their dimensions. The next step, therefore, was the adoption of the multipolar type. In these machines there are two or more magnetic circuits formed in the same core by arranging two or more pairs of field magnets around the periphery of the armature. You are familiar with the advantages of this type of machine. A four-pole machine containing the same quantity of active material as two bipolar dynamos will have their combined output at half their speed. The ease with which these machines can be ventilated, owing to the large internal diameter of the armature, makes them run much cooler than the bipolar type. The arrangement of a number of sets of brushes around the periphery of the commutator permits the use of very short bars rendering the mechanical construction most perfect. As direct-driven slow-speed generators having many poles are usually specified for our modern power stations, you will be interested in the details of their construction. The magnet frame is a ring of large diameter usually with a rectangular section, having two feet or brackets cast integral with it, to support it in a vertical plane upon a masonry foundation. The width of the face and the cross-section of this frame do not differ very greatly in machines of different speeds and capacities, except for the very small ones, but the diameter depends on the capacity and number of poles. Some makers prefer to cast this frame in iron, others in steel; each have their advantages and disadvantages. On the whole, I prefer the cast-iron frame, because, while it is nearly twice as heavy as the steel one, it is more rigid and costs less. However, when very large machines are required to be shipped to great distances, it is necessary to use the steel castings, because of the smaller weight. The frame is always divided into two half rings, with finished joints, where they are bolted together. This division is usually on the horizontal plane, but one or two makers divide the ring vertically. On the inner periphery of the magnet frame at intervals are fastened an even number of pole-pieces, projecting radially towards the centre. These pole-pieces are always made of good soft steel, sometimes rectangular in section and sometimes round. The area of the cross-section is about equal to that of a cast-iron yoke, but considerably greater than that of a steel yoke. The radial length of these poles, which does not vary greatly with the capacity of the machine, is from 12in. to 15in. When the frame is made of cast iron, these pole-pieces are composed of steel plates riveted together to make a nearly square section, and cast into the ring in the proper positions. If the frame is made of cast steel this method of attaching the poles cannot be advantageously used, but they must be bolted to finished surfaces, prepared for them, on the inner surface of the magnet ring, which is a much more expensive process. I must not neglect to explain, however, that when the pole-pieces are bolted to the steel frame they may be cast in steel, with a round section, and provided with a suitable pole-shoe to fit the armature face, while with the laminated pole the shoe must be fitted to its inner end. On the whole, however, the laminated pole cast in the frame is cheapest, and lends itself to ease of manufacture. The pole-pieces are provided with spools, upon which are wound the magnet coils. These coils are connected in series, and the exciting current traversing them produces alternate positive and negative poles at their free ends.

This completes the essential parts of the stationary portion or field magnet of a multipolar generator. We will next turn our attention to the construction of the armature, with its commutator, which we will find more intricate. The engine shaft carries, besides its flywheel, a massive cast-iron armature hub, keyed to it securely. This hub is provided at its periphery with a flange bolted to the flywheel, thus relieving the shaft and keys from the torsional strain due to the interchange of energy between them. The armature hub is provided with a number of radiating arms, the ends of which are dovetailed parallel with the shaft for a length equal to the width of the pole-pieces. Into these dovetailed grooves are fitted the key pieces formed on the inner edges of the armature laminations. The laminations which form the magnetic portion of the armature ring are made from thin sheet steel of the softest quality. They are in the form of segments of a circle with notches in the outer edges. These segments are built on to the ends of the spokes of the armature hub, lapping joints, until a complete rim or core is formed equal to the width of the pole-faces. Occasional radial ducts are left so that the air may circulate freely through the core to carry away the heat produced by hysteresis and eddy currents. This mass of thin sheet segments are clamped firmly between two end rings of cast iron, held together by bolts passing between them just inside the lamination. The notches in the edges of the sheets register perfectly, so that slots are formed across the face of the armature to receive the armature windings. An extension of the armature hub carries the commutator support, which is much like an ordinary spoked pulley. At each end of its face clamping rings are provided to secure the commutator bars. These strips are hard-drawn copper of the best quality, and should have a width at the face of the commutator of at least $\frac{1}{4}$in. The mica which separates them should never exceed $\frac{1}{32}$in., and must be of a very soft quality, so that it will wear more easily than the copper. The bars are bevelled or notched at the ends to receive the mica insulating and clamping rings, which secure them to the face of the hub. The commutator is always smaller

* Paper read before the Manchester Section of the Institution of Electrical Engineers, Jan. 29, 1901.

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in diameter than the armature core. In fact, it must not have a peripheral speed of more than 2,500ft. or 2,600ft. per minute. With higher-surface speeds it is difficult to prevent sparking. To each bar at the end nearest to the armature core is riveted and soldered a copper strip, projecting radially to the same diameter as the armature core, where it connects with the ends of the armature coils. The armature coils are simple in construction. Ribbon copper, usually ½in. by $\frac{1}{10}$in., is cut into pieces long enough to make a complete coil. This strip is bent on edge in the middle, making the two halves parallel with each other and about ½in. apart; it is then bent flatwise around a former into a rectangular coil, with V-shaped ends, joining the two parallel sides, the angle of the V at one end being formed by the terminals of the coil, which are afterwards soldered to the commutator leads. The coils are carefully taped with combination insulation made from paper, mica, and linen webbing. They are saturated with insulating compound and baked before being placed in the armature slots. The coils span a segment of the periphery of the armature core equal to or slightly less than the pitch of one pole, one of the parallel sides being fitted into the bottom of a slot, while the other side occupies the top of another slot; two and sometimes more of these coils are placed side by side in the same slot, but it is not best to multiply the number. These coils overlap each other, making a closed circuit spiral winding around the face of the armature with each turn connected to a commutator bar. After the winding is completed, the coils are held in place by banding wires at intervals across the face of the core. The windings are connected to balancing rings placed conveniently between the armature core and commutator, each ring connecting at points of equal potential, ensuring uniform pressure between all the units making up the multipolar machine. It only remains to provide a support for the brushes which collect the current from the face of the commutator. Four brackets are bolted to the end of the frame, and in these the brush rocker rotates through a limited angle. This rocker carries a brush-holder and set of carbon brushes for each pole-piece. They are carefully insulated from the rocker and from each other, but all the positive brush-holders are connected to one massive ring, and all the negative holders to another. These cross-connecting rings form the terminals of the generator from which the leads pass to the working circuit.

The mechanical construction of direct-current generators has, as you can see, been very well developed, and there remain apparently very few improvements to be made in it. We will, therefore, have to look in other directions for changes which will improve their operation and diminish the cost of their manufacture. Until recently multipolar generators were constructed with a limited number of poles, and to accommodate them to the various speeds and increasing capacities required their proportions were distorted, as in the bipolar machines, with the unfortunate consequences always attendant on poor design. Recent machines are being built with an increasing number of poles, and generators of 1,000 kw. with 14 poles, 1,600 kw. with 16, and 3,000 kw. with 24, are in successful operation with speed ranging from 75 revolutions per minute for the larger size to 90 revolutions for the smaller. It is apparent that modern design is tending to a greater number of magnets in the direct-current generator, and it is interesting to see that, on the other hand, the modern alternating-current machine is being made with fewer and fewer poles. The frequency in modern direct-current generators is about 15 cyles per second, while in alternators for power transmission the frequency is as low as 25 cycles per second. Even in the mechanical construction and general appearance these two classes of machines are approaching each other with this difference, that for the direct-current the armature must revolve to carry on the process of commutation, while in the alternator the field magnets are made to revolve. How far are these changes in design to be carried, and what are the causes acting to bring them about? Experience has taught us that there are certain mechanical, electrical, and magnetic values, which, when strictly adhered to in the design of direct-current generators, produce the best working results. We will apply the best average working values to a unit dynamo with one pair of poles, and for greater capacities add two or more of these units together in the form of multipolar machines to determine the best relation between speeds and capacities. The capacities of these machines thus made from unit dynamos will be fixed, depending on the capacity of the unit and the number of these units used in its design. The speed of these machines will also be established, as we have in the unit dynamo adopted certain values depending upon speed. I have taken for the unit dynamo a surface speed of 3,300ft. per minute for the armature; for the commutator a peripheral speed of 2,500ft. per minute. The teeth on the face of the armature have a pitch of 1in. The commutator bars (550-volt generator) are ·377in. wide, and the pressure between them is 10 volts. Every inch of the periphery of the armature face carries at full load 500 amperes; 10·3 million magnetic lines pass through the magnetic circuit in this unit dynamo. The density in the poles at full load is fixed at 95,000 lines per square inch, in the air it is 80,000, while in the teeth it reaches 120,000 lines. In the armature core the flux is reduced to 65,000 lines per square inch. A fair average frequency for direct-current generators is 1,600 alternations, or 800 cycles per minute; therefore, this unit must run when made into a bipolar machine 800 revolutions per minute and deliver 137½ kw. The performance of this machine will in every way be good, for the various values taken are those most satisfactory. Without making any changes in the dimensions of the parts or in the electrical and magnetic values, we will put two of these units together in the form of a multipolar generator. There will now be four poles, but they will have the same section and the same magnet spools. The armature will be doubled in circumference, also the slots and armature coils, commutator bars, brushes, brush-holders, and various other parts, all being interchangeable with those of the unit machine. This four-pole machine will deliver 275 kw., and the speed will be 400 revolutions per minute. Applying these unit dynamos in the construction of an eight-pole machine, we find that it runs 200 revolutions per minute and has an output of 550 kw. A 10-pole machine will run 160 revolutions per minute and deliver 687 kw.

The accompanying table gives the speeds, capacities, and general dimensions of machines up to 30 poles, and in all of them we have not varied from our original data established for the unit dynamo.

UNIT DYNAMO-ELECTRIC MACHINE.

Mechanical Data.		*Magnet Data.*	
Pole pitch	25in.	Induction air	80,000 L.
Peripheral speed arm.	3,300ft.	,, teeth	120,000 ,,
Tooth space	1in.	,, armature	65,000 ,,
Peripheral speed com.	2,500ft.	,, poles	95,000 ,,
Thickness bar	·377in.	,, yoke	35,000 ,,
Section pole-piece	125 sq. in.	Alternations per min.	=1,600
,, yoke	150 sq. in.		

Electrical Data.

Kilowatt capacity	137
Amperes per inductor	125
Volts per bar	10
Pressure of machine	550 V.

Poles.	R.P.M.	Amps.	Kilowatts.	Arm. dia. Feet.	Com. dia. Feet.	Kw./100 revs.
2	800	250	137½	1·3	1·0	17·2
4	400	500	275	2·7	2·0	68·8
6	267	750	412½	4·0	3·0	154
8	200	1 000	550	5·3	4·0	275
10	160	1 250	687½	6 7	5·0	430
12	133	1 500	825	7·9	6 0	619
14	114	1 750	962½	9 2	7·0	844
16	100	2 000	1 100	10·6	8·0	1,100
18	90	2 250	1,237½	11·9	9·0	1,375
20	80	2,500	1 375	13·2	10·0	1,720
22	73	2,750	1,512½	14·6	10·9	2,070
24	67	3 000	1,650	15·9	11·9	2,460
26	61	3 250	1 787½	17·3	12·9	2,930
28	57	3 500	1,925	18·6	13·9	3,380
30	53	3,750	2,062½	19 9	14·9	3,820

A study of this table reveals the fact that when we have established certain running values to be used in the construction of multipolar generators, we must let the speed of the machine depend upon the output. In making up this table of speeds, the unit dynamo adopted works out

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well for capacities up to 1,000 kw. or 1,200 kw. For the larger machines, however, it is possible to load the armature with 600 or even 700 amperes per inch of periphery, thus lowering the number of poles, decreasing the diameter of the armature, and increasing the speed. A considerable variation in speed for a given output may be secured by varying the section of the magnetic circuit of the unit dynamo and the number used; the range through which this change in speed can be made is, however, limited. The advantages of a standard system of design as outlined here will be appreciated by manufacturers as well as by users of electrical apparatus, because of the interchangeability of parts and the certainty of uniformly perfect operation of every machine regardless of capacity. In all sizes of machines the same size pole-pieces would be used. The magnet spools would all be interchangeable. The armature coils would all be alike. The brushes, brush-holders, and all the connecting parts would be made after the same patterns. The slots in all the armature laminations would have the same width and depth. These conditions, if existing, would greatly cheapen the cost of manufacturing dynamos, therefore the prices charged the purchaser. The steam-engine stands in the way of accomplishing these results. The speeds and capacities of engines have been established by their makers without reference to the best conditions for the successful operations of the generators they are to drive. For the smaller dynamos, as you will see by the table given above, speeds of from 300 to 800 revolutions per minute are permissible and entirely proper, but when the larger capacities are reached the speed must be lowered in order to obtain good performance, especially for traction generators. I hope, therefore, that the builders of engines and the manufacturers of direct-current generators will co-operate in establishing a satisfactory scale of speeds and capacities for steam dynamo sets.

DISCUSSION.

Mr. M. Marie congratulated the author on his paper, and expressed his approval of the proposed reduction of speed of large direct-current generators. There was no doubt that 250 revolutions were much too high for a 1,600-h.p. dynamo. This speed was asked for by consulting engineers, and engines had been designed to give the output; he held, however, that the economy in first cost in consequence of a high speed was not a true economy as an inferior machine was the result. It was a false idea that the factor of safety of the commutator was the thing which limited the speed. The real point was that the peripheral speed of the commutator must not exceed a certain limit, as otherwise sparking would ensue. It was, in fact, impossible to satisfactorily commutate the current at excessive speed. Unfortunately, while the leading manufacturers had proved that this was so, there still remained firms who, without experience in large machines, were ready to undertake the manufacture of these machines to run at high speed. In consequence of this, the consulting engineers continued to ask for high speed machines, and with the large range of engine speeds, makers were compelled to have in stock a very considerable number of patterns. He thought that Prof. Short's suggestion as to the standardisation of the various parts of direct-current dynamos was a good one. He would have been glad if the author could have given them more particulars of the rings for cross-connecting the armature circuit at equal potential points.

Major P. Cardew said that he must admit that his previous ideas had been that increased speed affected the engines more than the dynamos. He then referred to the progress made in dynamo design since the early days, when the types of machines were so constantly being changed. He thought that large machines would be the rule in the future, and that those responsible for the laying down of new plants should not hamper the undertaking by commencing with too small units, which so frequently had to be abandoned after the first two or three years of working.

Mr. E. S. Giles said that from the method adopted by consulting engineers when specifying the output of dynamos, these had to be made considerably larger than would be expected at first sight. For instance, a 1,000-kw. plant would be specified to give its full output at any voltage from 450 volts for lighting up to 550 volts for electric traction. Overloads were also variously specified as from 25 per cent. for three hours up to as much as 100 per cent. for any period. As a rule the specifications contained no statement as to the voltage at which the overload was to be applied, and he thought that consulting engineers should make their specifications much more definite in this respect. He agreed that the commutator was the greatest source of trouble in the design of large machines. As regards the author's proposal for using standard poles and field winding for a number of different machines, he thought that there might be trouble over the bore for the armature.

Prof. Short here explained that the pole-pieces were always made quite flat, and were afterwards bored out in position to suit the radius required by the armature.

Mr. Giles also added that the standard would be varied with a variation in the voltage, which would alter both the copper bars and also the slots in the iron core.

Mr. Cooper thought that consulting engineers might leave the overload clauses out of their specification, and fix, say, a maximum allowable temperature rise of 60deg. F. The engineer, when he had the machine delivered, could then try for his own satisfaction what overload it would stand. As regards the sparking of the commutator, he thought it was best to so design the brush-holders that only the light blocks of carbon were moved in consequence of slight inequalities on the commutator surface. If the carbon blocks were fixed to the brush-holders, the increased inertia made matters worse.

Dr. E Hopkinson, the chairman, said that he should also like to hear from the author more particulars of the cross-connecting copper rings which had been shown in the diagrams, and of the effects they produced in the smooth running of the plant. There was also a question of the slot, which apparently was left in the centre of the poles, and he should like to hear from the author as to how far this slot was useful in practice.

Prof. S. Short, in reply, said that the diagram had misled Dr. Hopkinson. There was now no slot left in the centre of the poles, as such slots had been found to be of little service in practice. What looked like a slot in the illustration projected on the screen was the clearance between the two halves of the pole pieces, which were clamped on to the laminated poles by means of bolts passing through both halves. As regards the cross-connecting rings, he first noticed what was called in America the "bucking" of direct-current generators in 1893. A 1,500-kw. machine was erected in the Chicago Exposition in that year, and on the first run round it broke away from the foundations. An explanation of the phenomena was not obtained until the machine had been secured again and started up slowly. It was then seen from the pulsation of the sparking at the brushes that, owing to the extremely low reluctance of the magnetic circuit, there was a regular surging of the magnetic field, which resulted in the magnetisation and demagnetisation of certain poles. This was only found in machines of low reluctance, and was enhanced by the low resistance of the armature circuit as cross-connected. The same thing occurred in rotary converters, but it was then termed hunting. It could be prevented or minimised by cross connecting the armature winding at equal potential points. An alternative was to place heavy copper bars between the pole-pieces. As regards the winding of the proposed standard machines, it would be easy to adopt the same slots for a 220-volt winding as for a 440 volt. It would mean that a single bar could be put in each slot instead of two side by side. Another alternative would be to use the same bars with two independent parallel-wound circuits. The speeds he had given were the ideal speeds, but they, of course, could be varied on either side of the values listed. He thanked them for the kind vote of thanks which they gave the paper.

The Chairman then stated that the next meeting announced on the programme would not be held but that on May 7 they would hold the last meeting of the present session, at which the officers and council for the next year would have to be elected. It was proposed to have a council of 12, and he appealed to those present to send in nominations and to see that only those men who were prepared to work actively in the interests of the Manchester branch of the Institution of Electrical Engineers were elected. Dr. Hopkinson added that an informal discussion on some topic of interest would be held after the formal business on May 7, and the meeting they adjourned.

ELECTRIC LIGHTING ENQUIRY.

Question of Increased Pressure.

The Board of Trade enquiry into this matter, presided over by Sir Courtenay Boyle, was concluded at the Westminster Town Hall last Friday.

Mr. E. MOON first addressed the Court on behalf of the Chelsea Electric Lighting Company. The real matter of controversy was as to the relative efficiency of the 100-volt and the 200-volt lamps. The evidence showed that the 200-volt lamp was the lamp which was generally adopted now, and the 100-volt lamp was only used by exceptional consumers. So far from the position being as it was in 1896, when there was no lamp in the market which could be used for 200-volt current, at the present time this pressure was used wherever new installations were put up, and in the vast majority of cases it had taken the place of the 100-volt supply. Then, with regard to the contention that the consumers were entitled to some monetary concession for the change because they were changing to a more expensive system of supply, the evidence proved nothing of the kind. He submitted that to lay it down as a direction to the arbitrator, as was contended for by the County Council, that the undertakers must give some kind of compensation for the alleged inferiority of the 200-volt lamp, would not be fair. He was perfectly willing to accept the risk of an open arbitration, but he objected to having any such conditions on the arbitrator's discretion. He appealed to the Board of Trade to say whether it would not be unfair if a consumer had wired his house insufficiently that he should be paid the whole cost of the new wiring which would be necessary with the 200-volt supply. With regard to the Metropolitan Company, he did not intend to call any evidence. The only change proposed to

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be made in their case was from 50 to 100 volts, and nobody could say anything against the efficiency of the 100-volt lamp.

Mr. R. CUNNINGHAM GLEN, for the borough of Paddington, argued that the evidence proved that there was greater economy with the 100-volt lamps than the 200-volt, and that being so it must be to the detriment of the consumer to force him to use in all cases 200-volt lamps, especially as there was so much controversy as to whether the lamps were really trustworthy or not. It might be indirectly for the benefit of the consumer whose installation required changing, but the proof was in the evidence that on the whole the consumer was not benefited; and, moreover, they had it admitted by Prof. Kennedy that there was no difference in the light that was obtained from the change to the higher pressure. In the event of the Board of Trade deciding to withdraw the necessity for the consumer's consent, he submitted that the consumer should not be required to pay any of the costs of arbitration with the supplier, especially where that arbitration was forced upon him by the action of the insurance company.

Mr. DANCKWERTS, K.C., who appeared for the Corporation of London, referring to the evidence, said Mr. Drake, Prof. Ayrton, and Major Cardew had all told them distinctly that the 200-volt lamp was not yet procurable of a good character, that with the same consumption of energy you did not get as much light as from the 100-volt lamp, and that, as a matter of fact, the consumption of energy by the latter was less than that of the 200-volt lamp. Again, short of perfectly fresh installation, in many cases it would be impossible to be certain you had got safety, and yet Mr. Balfour Browne had argued that the consumer was to bear that cost. His contention was that the companies alone benefited by the increase in pressure, and that benefit consisted of a mere saving of capital. On the question of insurance, the companies should certainly undertake to satisfy every insurance company that had insured the premises where the change occurred. Moreover, the person who was compulsorily changed over to the higher pressure ought to have indemnity for the lesser efficiency of the lamps, and the only possible way of doing that was by giving him a reduction in price in the shape of a discount, say 10 per cent. He was instructed by the Corporation to press upon the Board of Trade that in every case, if the company insist upon going to arbitration, they ought to pay all the costs.

Mr. J. ROSKILL, on behalf of the City of London Electric Lighting Company, argued with regard to the suggestion that the arbitration clauses of the Lands Clauses Act should be made applicable to the present case, that it was an unheard-of thing to apply an Act of Parliament which only dealt with a vested right in the absence of a vested right. Any disadvantage that the consumer might conceivably suffer from inefficient lamps would be amply provided for by the fact that the arbitrator would take into consideration that, incidentally to the cost of the change, the question arose as to whether the 200-volt lamp was really efficient or not. He reminded the Court that the local authorities here represented did not directly represent the consumers in any way. Not a single argument by any one of their witnesses had met the contention that this change was right and inevitable. He submitted that the clause which the president had drafted met every objection which could reasonably be urged against the change.

Mr. H. J. SMITH, town clerk for the borough of Lambeth, said he quite agreed with what had been said by other counsel representing local authorities—viz., that if the change were authorised, it should be made on the fullest compensation to the consumers, and that the consumers should be placed in certainly as good a position when the change had been made as they were when they were subject to the original voltage.

The PRESIDENT having expressed his obligation to counsel for the way in which the enquiry had been conducted, the proceedings closed.

YORKSHIRE POWER BILLS.

At the meeting of the Leeds Chamber of Commerce on Tuesday, Mr. Robert Hudson (director of the Yorkshire Electric Power Company) met the Chamber by arrangement to further discuss the Bill before Parliament promoted by the company, and explained that the Bill had already passed its second reading, and would come before a committee of the House of Commons about the middle of April. Many of the local authorities throughout the area affected by the Bill had been afraid of one clause (Clause 40), which gave power of appeal to the Board of Trade against the local authorities if they were unreasonable in withholding their consent to the company coming into a district. A resolution expressing approval of the Bill generally was adopted.

There was also a meeting of representatives of rural and urban district councils in the West Riding at the Hotel Metropole, Leeds, for the purpose of investigating the South Yorkshire Electric Power Bill. Amongst the councils represented were Hunslet Rural, Horbury, Ardsley (East and West), Saddleworth, Selby, Ardsley, Doncaster Rural, Farsley, Burley-in-Wharfedale, Otley, Gomersal, Rawmarsh, Bolton-on-Dearne, Queensbury, Liversedge, Gildersome, Hebden Bridge, Sandal Magna, Tadcaster Rural, Wath-on-Dearne, Royston, Thornhill, Wakefield Rural, Calverley, Ravensthorpe, Birkenshaw, South Crosland, Cleckheaton, Worsborough, Oxenhope, Springhead, Silsden, and Mytholmroyd. Mr. S. V. Clirehugh, of Manchester, the engineer to the scheme, said both the companies who were seeking powers proposed to sell it to local authorities and other consumers at about 1½d. per unit. The cost of distribution to the local authority would not exceed 1d., so that in the near future they might distribute electricity in the smallest village and make a profit for themselves out of it at a price not exceeding 3d. per unit. If so, they would certainly confer an enormous benefit on the community. The two competing schemes had very much in common, but they differed chiefly with regard to price. The Yorkshire Company would, he admitted, be in a position to supply the larger consumer cheaper than his own company, but if the smaller local authorities took their terms they would, he claimed, be penalised for 20 years, because their demands would never grow sufficiently during that time (so far as they could humanly see) to get their prices into line with those charged under the South Yorkshire scheme. Mr. Hopkins, in moving a vote of thanks at the close, said it would probably be the best thing that could happen to the local authorities if both schemes were sanctioned by Parliament, but of that there is little probability.

A special committee of the Halifax Chamber of Commerce appointed for the consideration of the Yorkshire Electric Power Bill and the South Yorkshire Electric Power Bill have reported as follows: "Your committee, having considered the above Bills, recommend the council of the Chamber to support neither of them, believing that the maximum charges in each Bill are too excessive, and they do not desire to commit the council to either scheme, but if the council decide to support one of the schemes, your committee recommend the South Yorkshire Bill as tending to benefit the smaller industrial concerns."

At the last meeting of the Mirfield District Council, the Clerk reported attending a further meeting called by the promoters of the South Yorkshire Electric Power Bill at Huddersfield. Various points were discussed, and the company agreed to amend their Bill in certain particulars to meet with the views expressed by those who support they desired to obtain.

FORTHCOMING EVENTS.

FRIDAY, MARCH 29.

Electro Harmonic Society.—Smoking concert at St. James's Restaurant, W.

North-East Coast Institution of Engineers and Shipbuilders.—At 7 15 p.m., general meeting at South Shields. Mr. F. W. Jennings will reply to the discussion on his paper on "The Ventilation and Heating of Ships"; the discussion on Mr G. M. Brown's paper on "Some Attempts to Increase the Efficiency of Marine Boilers" and on Mr. Walter Scott's paper on "The Commercial Organisation of Shipyards," will be resumed; paper on "Water-Tube Boilers," by Mr. Edwin Griffith, Wh.Sch.

SATURDAY, MARCH 30.

North-East Coast Institution of Engineers and Shipbuilders.—Graduates' Section, at 7 30 p.m., general meeting at Newcastle-upon-Tyne. Mr. A. Q Carnegie will open a discussion on "Condensers—and the Re-cooling of Water for Electric Power Stations."

Royal Institution.—At 3 p.m., Lord Rayleigh on "Sound and Vibrations."

MONDAY, APRIL 1.

Society of Engineers.—At 7.30 p.m., ordinary meeting. "The Production of Metallic Bars and Tubes under Pressure," by Mr. Percy F. Nursey, past-president.

Royal Institution.—General monthly meeting.

TUESDAY, APRIL 2.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "The Burrator Works for the Water Supply of Plymouth," by Mr. Edward Sandeman.

WEDNESDAY, APRIL 3.

Institution of Junior Engineers.—At 8 p.m., "Works Management," by Mr. A. H. Barker, Wh.Sch. (lecture V.).

THURSDAY, APRIL 4.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper on "The Proportions of Cylinders for Multiple-Expansion Engines," by Mr. A. Hanssen.

SATURDAY, APRIL 6.

Glasgow and West of Scotland Scientific Society.—General meeting.

Westminster.—The Westminster City Council yesterday unanimously elected Mr. James Wm. Bradley to the appointment of city engineer and surveyor. Since 1895 Mr. Bradley has occupied the same position under the Corporation of Wolverhampton.

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THE
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TO CORRESPONDENTS.

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MUNICIPALITIES AS EMPLOYERS.

A few days of east wind ought sometimes to be esteemed "a boon and a blessing to men," in that it provides an adequate excuse for grumbling. It may not be believed, because the necessities of life lead to the probability of grumbling rather than praising, but we are altogether in favour of praise. Yet how can you praise actions that, upon the face of them, savour of injustice, or neglect to chronicle them in favour of some detail that affords a chance of praise? Municipal employers in the "loomp" are fairly good, but there are many exceptions to the rule—exceptions that cause men to live a life of slavery and deceit. The one great fault of municipalities is that they pay too little and expect too much. They seem to have no sense of proportion, paying a man who has little or no responsibility as much as the man who has responsibility, and upon whose efforts and knowledge success or failure depends. Municipalities, again, do not always realise the fact that upon the ability and experience of a man in one of the great spending departments depends the whole question of economical or expensive work. We do not wish to restrict our remarks altogether to electric light or tramway engineers, in that specific examples might be taken as tending to personalities. It is easy to see, however, that very much depends upon the design of a sewage scheme, for example, if it is to be constructed and maintained economically. A poor design means greater initial expenditure and greater cost for maintenance. Quite recently a well-known engineer designed a water-supply scheme, and reported in favour of a tender not the lowest. The report was based upon a careful examination of the working expenses, as well as the initial cost, and the former were much less with the apparatus supplied by a contractor whose tender was not the lowest than by the contractor whose tender was lowest. The council concerned, impressed with the outcry of not accepting the lowest tender, and not strong enough to act for themselves, to save responsibility called in another eminent engineer, whose report fully bore out that of their own engineer, so we suppose the contract will be given in accordance with the original report. This brings us back to the point we desire to mention. A municipality should, in the first place, be sure that it employs a competent consulting engineer, and when he is employed let him have a free hand, and give him full and complete confidence. It is necessary for someone to enter an emphatic protest against a plausible action which is gaining ground, the criticism by rival consultants of the plans of the consultant employed. The whole question is difficult, in that an incompetent scheme ought to be nipped in the bud, but when a rival merely disagrees with a scheme that a competent engineer has designed, he ought not to be heard. Great harm has been done and is being done by these irrepressible critics. The individual members of councils are not experts, and the position of a consulting engineer is not an envious one if his employers are brought into that frame of mind which makes them doubtful of his every action and suggestion. The only other point we have room to mention is the

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disastrous policy of procrastination. An official doing good work and giving every satisfaction is largely underpaid. Naturally, he knows his work, and seeing a position of greater remuneration open, goes for it and possibly gets it. The result may be a total reorganisation of the department, and the increase of expenses double or treble what would have kept the experienced official. The reorganisation, too, is frequently disastrous, duties being put into the hands of the wrong man, and generally an enormous addition of clerical work, red-tape, and inefficiency. Those who run may read.

ELECTRIC RAILWAYS.

BY MAJOR P. CARDEW.

The concluding lecture of this series of Cantor lectures was delivered by Major Cardew at the Society of Arts on Monday last. The first portion of the lecture was devoted to the consideration of the advantages and disadvantages of the direct-current system and of the polyphase system. The balance of advantages was held to be in favour of the polyphase system. It was pointed out that in the equipment of the transformer stations on the different systems the three-phase system had the advantage that no moving machinery was required, whereas with a direct-current system, not only static transformers, but usually rotary transformers, were employed, the static transformers having, of course, no moving parts, but the rotary converters have. The latter are generally used to obtain a direct current for the motors actuating the cars. Such apparatus can be made very efficient, but it requires skilled attention. Accumulators, too, might be used with the direct-current system, and by their means the fluctuating demand required by the motors could be supplied, although the machinery at the generating station would get a more uniform load. References were made to Mr. Grindle's recent paper read before the Manchester branch of the Institution of Electrical Engineers. A direct-current system is essentially a two-wire system, thus having an advantage over the polyphase, which is a three-wire system. Then, again, with a direct current and the use of a battery the plant both at the generating station and at the sub-station would be of less capacity. Further, with a direct current there is no idle current, while the polyphase probably has to be allowed a generation of 15 per cent. more than is wanted. In the machinery required for a constant-current plant the clearance in the machines may be less. On the whole, as we have said, the summing up was in favour of a polyphase system, and especially as it requires a simpler plant equipment, particularly in the sub-stations, thus reducing initial cost and also working expenses, in that no attendance would be required, for instance, in the sub-stations. A voltage up to 3,000 could also be used, and as a line would be overhead, and there would be no trouble about bonding, the sub-stations might be further apart. The speed of the train would be governed by the periodicity, and the return energy would be greater in the polyphase than with the direct-current system, so that altogether it was more suited to full-sized railways.

The latter part of the lecture was devoted to the consideration of a practical example. The lecturer took for his example a circular railway adapted for large suburban traffic, connected with the main line, some 50 miles long, ending at a large town where there was also some local traffic. It was assumed the train should run on the suburban lines for 15 minutes and on the main line for half an hour, the express trains to stop twice on the main line between what may be termed the two termini, there being on the main line a number of smaller stations to be served otherwise than by the express trains. The weight of the trains was also assumed, and it was shown how many trains would be required for such a service, the power and energy that would be required, and the differences that would arise when a 60-mile-per-hour rate was adopted on the main line, with the alternative of a 40-mile-per-hour rate or a 30-mile-per-hour rate on the suburban lines. The conclusion was that, while a 30 mile-per-hour rate might be a little more economical, it would be less popular, and that the greater popularity of faster trains would make the faster service preferable.

We can only refer thus generally to this exceedingly interesting lecture, because for its full value it would be necessary to give the complete figures. These will be published in due course. The lecturer concluded with a rough estimate as to the cost at the present prices of materials for a scheme such as that disclosed by the author. He estimated the generating stations to cost £325,000, sub-station £62,000, mains £160,000, line equipment £228,000—total £775,000. The rolling-stock, if new, would come to about £424,000.

Prof. AYRTON moved a vote of thanks to the lecturer for his course of lectures upon one of the most interesting subjects and one of the most important at the present time that could come before the society. The vote was carried by acclamation.

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 373.)

5.—House Services and Installations.

The work of making house services always belongs to the mains engineer's department, but it is usually only on the smaller supply systems that he has also the installation work. On the larger systems there is an installation inspector, who takes over all the work beyond the meters. It would seem to be a better arrangement that the mains engineer should have the direction of the installation work on all systems, whatever their size, as when an installation is connected to the mains it becomes a part of the mains; therefore if the mains engineer has the direction of testing installations, he is in a better position to say exactly how his mains stand for insulation and for load. This is particularly the case with regard to three and five wire networks, where good balancing plays an important part in the general good working.

Many chief engineers do not trouble themselves much about the installations which they connect to their mains beyond the one test for insulation to earth. They say that it is nothing to them what sort of work a consumer pays for so long as the insulation is good. This, however, is quite a wrong notion for any engineer to hold, as he must or ought to realise that he would get more consumers were he to exert himself on the behalf of people likely to come on. Such people know very little about electrical installations, and would often be made very happy if they knew that a competent official was watching the work and material put in by their contractors; such engineers would certainly watch the work and material where free wiring was in practice. If the work is watched by the supply officials it might tend to raise prices a little, but as every contractor in one town would be similarly treated, one would not suffer more than another.

If the installation is not watched in its entirety, there are at least four points which must have the attention of the supply officials: (1) The installation must be made to conform to the rules laid down by the fire insurance office in which the intending consumer is insured. The consumer should be distinctly told this before he has any work started—the responsibility for seeing that it does so conform may then be left to him. (2) After the installation is complete and before fuses are finally inserted, the P.D. should be tested at the farthest lamp with all the lamps switched on. (3) The insulation resistance of the whole installation to earth should be tested with no lamps in, but with all switches on. It is of no use to insert lamps for an insulation test, because the insulation resistance of lamps between filaments and collars varies very much indeed, so that although an excellent test might be obtained with the first batch of lamps, yet, after only one lamp had been changed, providing it was a bracket or other fixed lamp, a test giving no insulation resistance to earth might be obtained. (4) The type and capacity of the main switch should be absolutely decided by the engineer. We all of us know the thing called a five-

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ampere main switch, so often used by wiremen on installations of about six lights, where there are no restrictions—things which fall to pieces after six months' use; which hardly ever make contact, even enough to carry five amperes, without overheating; and which are always liable to cause a short on account of their wretched little binding screws being so close to each other (in many cases not more than $\frac{1}{16}$in. divides their heads). It may be remarked here that it is not always the man who is a *bo'd fide* electrical wireman who puts in the best work. Very often better work will be obtained from an ironmonger or plumber, simply because the latter people do not know how to do bad work, and would be afraid to do it if they did. They therefore take special care until they, too, become learned in scamping.

There is very little else which need give the engineer much trouble on any installation, for the very good reason that there are now so many people engaged in perfecting electrical accessories. One point which perhaps needs special attention is the method employed to fix the lampholders on outside lamp fittings. These lampholders should always be insulated by means of porcelain or ebonite rings or bushes from the bracket or fitting. If the wiring is at all watched, the use of those small bits of casing called "crossing-over blocks" should be insisted on. These blocks are let into walls and ceilings flush wherever a joint is made on the wires, thus preventing the tapping from touching plaster, etc Sometimes the crossing over is done on the front of the main casing, but is extremely unsightly. These blocks are used only for instal lations carried out in casing. Wiring in casing on the surface is to be preferred to any other system of single-conductor work, and can be made to fit in so well with the decorations as to be anything but an eyesore Probably the very best system of wiring yet invented is Mr. Sam Mavor's concentric system so far as safety goes, but this system, with an earthed outer, could hardly be allowed on installations connected to public supply mains, and thus is of more use to owners of small private plants. If the engineer at any time draws up specifications for the wiring of his consumers' premises, he should certainly specify wiring from distribution boards, thus saving many joints. On some very large and excellent installations the use of distribution boards is carried so far that every single lamp has a circuit to itself, fed from a double-pole board. This, of course, materially increases the initial cost of an installation, but results in a first-class job.

The insulation test to earth is generally specified to be so much per 8-c.p. lamp, whether there are many lamps grouped or whether they are single lights; this is not right, and is hardly fair to the contractor, as it will easily be seen that it is much more difficult to get so good a test in the latter case as in the former. The insulation test for motors again requires a separate table. The insulation between the windings of a motor and its frame or shaft very often comes out very low, and it is usual on some supply networks to insulate the frame or bed-plate of the motor from earth to get the required test. This should not be allowed, especially now that the use of 400 volt motors is allowed. With these motors the frame should in all cases be directly connected to earth. Starting resistances for motors should always be insisted on, to obviate as much as possible the flickering of the lights caused by suddenly switching on a motor, which is more perceptible on alternating than on continuous current networks For connection to three or five wire networks the installation should be evenly balanced, and as many pairs of wires brought to the main cut-outs as there are circuits. According to the number of circuits—two, three, or four—so will be the number of meters required and the number of conductors from the supply mains.

Turning to the question of the service, which belongs to the supply company, we have to consider the service joint-box, the service cable, the main fuses, and the meters; also, for high-pressure services, the transformer. The service joint box should always be of a disconnecting type, not by means of fuses, but by means of links coming fairly near the top of the box. Such disconnecting boxes are very useful when it is desired to test a length of main at night-time, as it would not otherwise be possible to separate the conductors in the main owing to transformer windings and meter shunts, and without this separation not much testing can be done. Service cable should always be concentric in form, the outer conductor being the neutral and sometimes earthed wire. If single-conductor is used, more especially if it is also armoured, there is great risk of burning holes in gas and other metallic pipes inside the building. Such burning of metallic pipes inside buildings could occur if the insulation of one of the service conductor cables, other than an earthed conductor, broke down charging its own armour, which would be insulated somewhat if laid solid, the charged armour then sparking to any pipe which it touched. If this sparking should occur between the armour and a gaspipe on the main side of the gasmeter, disastrous results would probably ensue. The use of concentric cable would go far to eliminate such occurrences. At any time, however, it is best, but not always easy, to keep away from gas and water services.

The armoured service cable should, as soon as possible after entering the building, be taken into an iron fuse-box, the armour of the cable being taken right into the box, thus preventing as far as possible the tapping of the service on the main side of the meter. Probably the best description of armouring for service cables is in the form of plaited steel wire. This form ensures easy bends. The cable should also be lead-covered if it is not laid solid, but should not be lead-covered if used for continuous-current work. The main fuses should be enclosed in an iron box capable of being sealed. The binding terminals should be provided with sweating thimbles, and the binding screws for the fuses should be amply large and strong, all screws and nuts being made of brass or gunmetal. The box itself should be divided into compartments by means of insulating bridges to prevent sparking across the poles; or separate boxes should be provided, one for each pole. The fuse box or boxes are best mounted on a hardwood board, so as to obtain some additional insulation from earth. The board should be painted with asbestos paint, and on this same board the meters can be fixed.

Of meters there are many, but not so many that do not give considerable trouble. Those that are excellent in an electrical way fail mechanically, and *vice versâ*. Also meters that have permanent magnets go wrong, because the magnets lose their magnetism, thus giving a large plus error. The meters that give the best results, and which are mostly in use, are the Aron meter, the Chamberlain-Hookham meter, the Westinghouse meter, the British Thomson-Houston meter, and Messrs. Johnson and Phillips's new meter. The first and the last named are clockwork meters, and, in the writer's opinion, give the best results electrically, although they do not conform to simplicity of design mechanically. The Chamberlain and Hookham continuous-current meter is decidedly good, and, as there is very little friction, starts easily with a very small current—a thing greatly to be desired.

For alternating currents, the Westinghouse and British Thomson-Houston meters give excellent results, and if the writer had many meters to instal at the present time he would use these two, and of these two giving the preference to the Westinghouse, on which reliance can always be placed. Simplicity of design and absence of many working parts are points to be sought after, and inventors would do well to turn their attention into this channel. The maximum demand meter is another most useful meter, and must not be left out of consideration, but seems to be rather an excessive cost in a service. The demand meter should certainly be included in the same case with the watt-hour meter. Messrs Johnson and Phillips have gone some way towards this end by providing an ammeter scale in their new meter, but it is not recording. All meter cases should be provided with a small glass window opposite the meter discs or other moving parts, so that the working of the meter can be easily seen without having to remove the case.

All meters before being fixed on the circuit should be tested at the supply works, as, although each meter has its test sheet sent with it, yet in many cases they arrive with large errors, in some cases 35 per cent. out, either minus or plus. Most meters can be set to record within 2·5 per cent. from light load to half load, and from half load to full load, the error at light load being minus, and at full load plus. Meters should be tested with a good standard wattmeter in circuit, and the test can be made on meters with revolving discs by counting the disc revolutions during a certain time, using also the constant of the meter which is supplied by the makers. Other meters have to be tested by front dial

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readings, and should be allowed to run for some considerable time to eliminate error as far as possible. When installing meters, they should be secured to a seasoned hardwood board; as many meters are sent out with bad insulation between their windings and case. The hardwood board will thus give additional security. Three and five wire meters do not give good results unless all circuits are in use at the same time.

For a high-tension service from an alternating supply, the service cable must be concentric, must be well protected, and must not show inside the building. Where the service cable enters the building, a small firebrick chamber should be built to contain the transformer, and the service cable should enter this chamber direct. Transformers can be obtained in iron cases, with the cases specially designed for leading in a concentric cable, division being effected inside. This is a good arrangement if the service joint-box on the mains is of switch type, but if not, the cable must enter some sort of switch-box before passing into the transformer, otherwise the transformer could not be handled. It is an easy matter to design a suitable switch-box for this purpose. At the time of laying the service cable an earth wire stranded $^7/_{16}$ must be laid also, one end of it being attached to the water-main in the road and the other end to the transformer case. A Cardew earthing device must also be fixed inside the brick chamber and connected to one lead of the secondary winding of the transformer and to earth. The secondary leads then pass out of the brick chamber to the main fuses and the meters in the ordinary way. The brick transformer chamber should be provided with an iron door, which must be padlocked and the key removed.

(To be continued.)

THE SIEMENS ENGINEERING SOCIETY.

The annual conversazione of the above society was held on Wednesday last at the Charlton Assembly Rooms, which were tastefully decorated for the occasion. According to the rules of the society, only members of the staff of the well-known firm of Messrs. Siemens Bros. and Co. are allowed to take part in the meetings of the society, at which papers are read and discussed on engineering subjects. This rule is always suspended for the conversazione, and the council of the society invite a number of old friends who, by holding positions in other firms, are no longer eligible for membership. In consequence of this, the conversaziones are most pleasant reunions, and the one held last Wednesday was, if anything, more successful than its predecessors. The good programme of music was interspersed with an exhibition of the cinematograph by Mr. J. Peschek, and two exhibitions of conjuring by Mr. C. Volcard. Amongst the scientific exhibits was a thermo-magnetic motor, which illustrated clearly how the magnetic properties of iron disappear at high temperatures. It consisted of a thin ring of iron passing in front of two poles of a small electromagnet. The part of the ring between the two poles was, of course, magnetised. A blowpipe flame was applied to the ring opposite one of the poles, with the result that the ring moved, the direction of motion being from the pole at which the heat was not applied towards the flame. This motion was, of course, slow, as it took an appreciable interval of time to heat up the thin ring to a temperature at which it became non-magnetic. A number of interesting alternate-current experiments were arranged, but an interruption in the supply current to the assembly rooms prevented these from being on view for a considerable portion of the evening. The other attractions in the way of scientific experiments included Röntgen rays, the harmonograph, a number of pendulum experiments, including one which showed the reaction of one pendulum on another near it having the same periodic time. A number of gyrostatic experiments were performed, while one member of the staff showed himself exceedingly proficient in blowing bubbles. Amongst the art exhibits were a number of Japanese swords and sword guards, and some relics from the Boer war were also on view. The Siemens Engineering Society are certainly to be congratulated on the most enjoyable evening's entertainment provided, which was fully appreciated by all present.

Personal.—Mr. C. H. Wordingham, who has acted as borough electrical engineer since the commencement of the electrical supply in Manchester, is now taking up work as consulting engineer, and will open offices at 19, Brazennose-street, Manchester, on April 1, where we trust he will meet with every success.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

Questions.

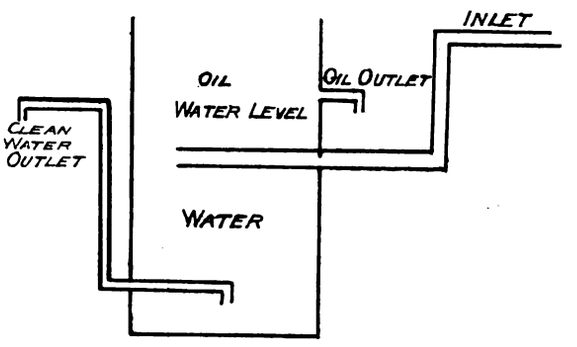
363. In wiring an installation we had 11 lights in a row, the first light on one switch and the remaining 10 on one switch. We wired the 10 lights, each light a loop off the previous one, and the first light we looped one pole and brought a switch wire from the other. On switching on the first light it lights perfectly, but on switching on the 10 lights it goes out, and on putting the 10 off it relights. The current is continuous and the pressure 100 volts. Please explain this.—A. H.

364. A four-pole, steel-clad, ventilated motor is capable of giving 20 b.h.p. continuously, without the temperature rise exceeding 80deg. F. at 800 revolutions per minute at 400 volts. What power will it be capable of giving continuously for six hours if entirely enclosed and airtight for working among explosive gases?—T. R.

Answers.

Question No. 357.—Can any reader recommend a thoroughly reliable feed-water filter which will take out all oil from surface condensed water? The condensed water as it leaves the air-pump has a very milky appearance, the oil being very intimately mixed with it. The oil is a mineral oil drawn up the low-pressure piston rods by the vacuum.

Best Answer to No. 357 (*awarded* 10*s.*).—To free water entirely from all kinds of oil is not a very simple problem, because water can dissolve a small percentage of some oils, but with a purely mineral oil there is very little difficulty. However, mineral oil can so easily dissolve vegetable oil, etc., that it is not easy to say for certain that a sample of mineral oil is pure. My own experience in the matter of purifying boiler feed waters is that the best way to get rid of the oil is by taking advantage of the action of gravity. This I do by means of the simple apparatus illustrated in section below. The tank must be large enough to allow



the mixture of oil and water to remain quiet and free from any agitation, so that the water may collect at the bottom and the oil float on the surface of the water. The inlet pipe must be fairly large, so that the incoming stream may have very little or no force. The side of the tank acts as a baffle plate, and separation begins at once, the oil naturally floating to the surface. The outlet as shown collects the cleanest water, and, being bent up outside the tank, maintains the proper level inside by hydrostatic action. The layer of oil on the top of the water may be drawn off by means of the oil outlet.

The oil outlet should be provided with a tap. In some cases the above apparatus is all that is necessary, and the water will come out clean and bright, while the oil may

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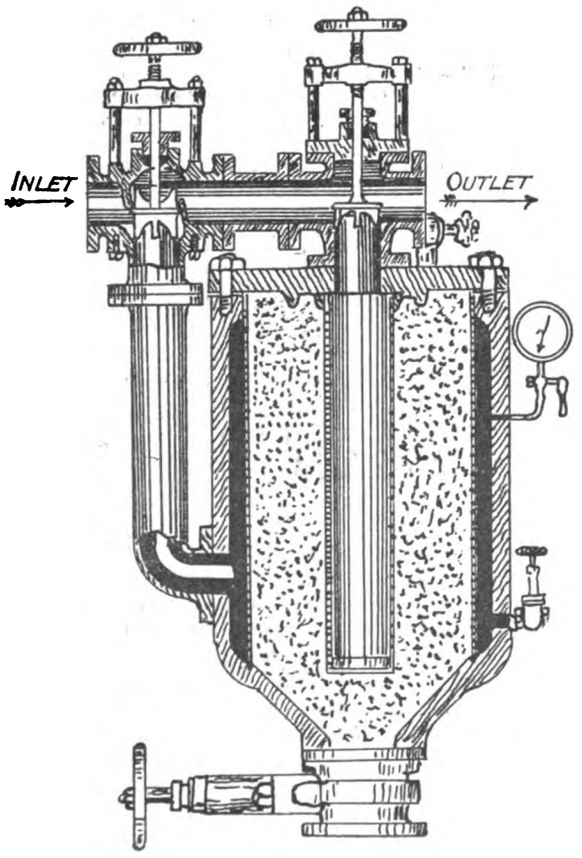
be collected as convenient and used again, but in other cases the water is not bright. If perfect clearness is required, the water must be filtered through flannelette, the inside surface (or upper surface) of which has been carefully and thoroughly smeared with wet light carbonate of magnesia. Filtration through this is very rapid and effective, and the materials of the filter are cheap, but, of course, they must be kept clean and occasionally renewed.

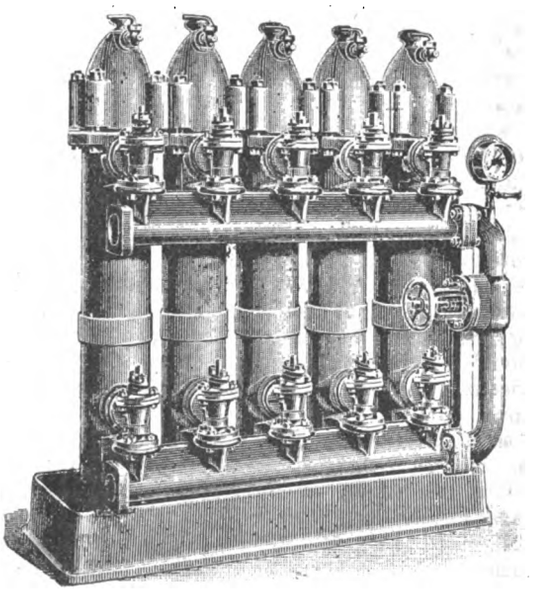
If any vegetable or fish oil should be present, it will probably be decomposed by the heat of the steam into glycerine and a fatty acid. The glycerine is perfectly soluble in water, but the fatty acid is not. It would, therefore, be easily separated from the water by the above treatment. As filtering is always more or less tedious and troublesome, I would just mention before leaving the subject that often a dirty water may be clarified by adding to it some insoluble powder—such as sand or carbonate of lime—stirring all intimately together, and then allowing time for settling, when it will be found that in falling the heavy particles have taken the lighter ones with them to the bottom, and so have left the supernatant liquid quite bright.—F. G. A.

Answer to No. 357 (*awarded* 5*s.*).—The latest type of Reeves feed-water heater is one of the best in the market, and is in use in many stations throughout the kingdom, and in several cases repeat orders have been the best testimonials the makers could receive of its successful working. The filtering material is coarse sawdust. A section of the filter is seen below. There is a perforated pipe placed inside a cast-iron cylinder having a part of the space



between the tube and cylinder filled with compound sawdust. It will be seen that there is on top an arrangement of valves which serve as a by-pass, and permit the water, if desired, to be passed direct from pump to boiler without passing through the filter. The water passes from the inlet valve to an annular space inside the cylinder formed of a thin Muntz metal perforated partition lined internally with wire gauze. The gathering tube is fixed centrally, and consists of a perforated open-ended steel cylinder covered externally with wire gauze. The entire space between the inside of the internal perforated cylinder and the gathering tube is completely and tightly packed with coarsely granulated softwood sawdust, through which the feed water slowly percolates. The caked sawdust entirely absorbs all oil, the purified water alone passing to the boiler. No pressure, other than that resultant from boiler pressure, will be indicated by the pressure gauge attached to the filter until the filtering medium becomes fully charged with oil and other impurities, when, the pressure commencing slowly to rise, the sawdust requires changing. When it is required to change the sawdust, the slide valve at the bottom of the filter is opened, the inlet and outlet valves closed, and the two small valves on the top of the filter, which are connected to pipes leading to the water space in the water, are opened. The pressure of the hot water gradually forces the dirty sawdust out of the filter and thoroughly cleans it. These valves and the bottom sluice valves are then closed, and the filling-hole covers on the top of the filter taken off. Into these holes fresh sawdust, mixed with water until it is the consistency of thin porridge, is poured until the filter is full. These covers are then readjusted, and the filter is then ready for use.—A. B.

Answer to No. 355 (*awarded* 5*s.*).—The Pulsometer Engineering Company manufacture a "grease filter" which gives excellent results in connection with surface condensers. It consists of a number of iron cylinders arranged in parallel with each other, through which the water is forced on its way from the pump to the boiler. On reference to the sketch it will be seen that the feed water can be by-passed, if desired, by the arrangement at the side. The water flows along the pipe at the top of the filter through the vertical cylinders and out at the lower horizontal pipe. Each of the vertical cylinders is filled with a bag containing some suitable filtering material, which, when the filter



has been in use some time, can be easily withdrawn and removed by diverting the water from the filter, unscrewing the tops of the vertical cylinder, and taking out the bags of spent material and renewing them with others. In this type of filter it is possible to get a very large filtering surface, and at the same time a slow rate of flow of water through the filter itself.—F. B. A.

Question No. 358.—In power transmission work is there any advantage in generating two-phase currents and transforming them up to three-phase for transmission? Also again transforming down and to two-phase current for distribution? Give a diagram of the transformer connections.

Best Answer to No. 358 (*awarded* 10*s.*).—The problem can best be considered along the following lines: (*a*) what the advantage would be of transforming two-phase currents to a high tension, transmitting them over a distance at this tension, and transforming them down again for distribution; (*b*) whether any further advantage would be gained by so arranging the transformers that a three-phase current was produced for transmission, this being reconverted to two-phase at the further end of the line.

With regard to the first point, there are the opposing considerations of the first cost of transformation—both in prime cost of apparatus and loss of power in conversion—

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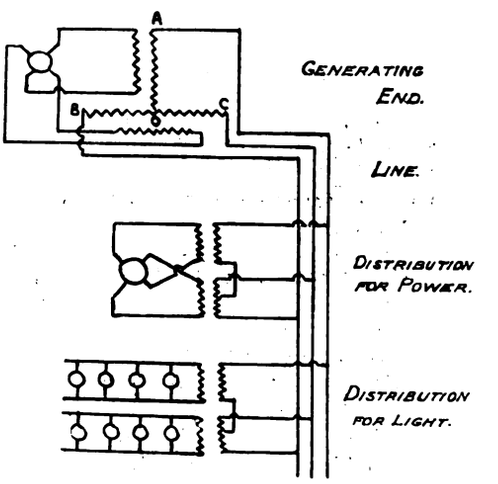
TABLE A.

System.	Two-phase four-wire.		Two-phase three-wire.		Three phase three-wire.	
Conditions.	Effective pressure, 5,000 volts. Line loss 10 %	Voltage drop 10 %	Effective pressure, 5,000 volts. Line loss 10 %	Voltage drop 10 %	Effective pressure, 5 000 volts. Line loss 10 %	Voltage drop 10 %
Effective volts at motor	5,000	5,000	(a) 3 550 (b) 5,000	(a) 3 550 (b) 5,000	5,000	5,000
Effective volts at power station	5,500	5,500	(a) 3 962 (b) 5,590	(a) 4 050 (b) 5 500	5,288	5,500
Line loss in watts	5,000	7,100	(a) 5,000 (b) 5,000	(a) 6,050 (b) 4 270	5,000	8,700
Drop to volts	500	500	(a) 412 (b) 590	(a) 500 (b) 500	288	500
Ratio of weights of copper	1·0	1·0	(a) 1·478 (b) 0 737	(a) 1·204 (b) 0·853	0·755	0·435

opposed to cost of copper conductors and loss of power due to C^2R effects. The actual initial costs of the two alternatives are determined by the conditions of each scheme considered. Chief among these are the length of line of transmission and the method of carrying the conductors. If underground cable is used, the comparative cost of conductors will be made of three factors: (1) a practically equal amount in both cases for trench work; (2) the cost of the manufactured copper; (3) the cost of insulation round the copper, which may vary widely in the two cases. If the conductors are carried overhead, it must be remembered that in addition to the difference in price of the copper wire in each case due to the difference in section, the weight of the heavier conductors will necessitate stouter posts, insulators, and stay wires, and possibly more of them due to shorter spans being necessary. The actual comparative cross-sections of the wires, with and without transformation, depend eventually on the price of power at the generating end. For example, if free water power is available, then a great amount of waste can be allowed in transmission with financial advantage, whereas if coal and water have to be paid for, the losses in transmission must be as small as possible; and in such cases a 90 per cent. efficiency of transmission is not an unusual stipulation to make. Yet another consideration may affect the comparative values of transforming or otherwise. It may be desirable to keep a high and constant voltage at the distributing end of the system. In this case it is necessary, first, that the voltage drop along the line at full load should not be great, say 5 per cent.; and, secondly, that adequate engineering precautions be taken to avoid breakdown along the line due to high voltage, and to secure safety to machinery and life if a breakdown does happen. All these considerations point to the probability that in long-distance transmission of power it is a distinct advantage, so long as the limits of safety are not exceeded, to transform up to the line and reconvert down again for distribution. The correctness of this belief was first demonstrated in 1891 by the success of the Frankfort-Lauffen three-phase transmission scheme, and since then a large number of installations for long-distance work have been completed, both on the Continent and in America. Their financial success proves the first point we are considering.

With reference to the question of phase transformation, it is necessary first to discuss the relative values of two-phase and three-phase machinery for power purposes. As regards generators and motors, two and three phase machines have about the same efficiency, weight, starting torque, and apparent watt consumption for the same output. Possibly the two-phase type is simpler in winding details. If the transmission scheme is strictly for power purposes at the distributing end, then the three-phase system is as good as the two-phase as regards pressure regulation between the phases, as the load will certainly be equally distributed. But if it is required to distribute for lighting also, the two-phase system is better, because if the two circuits are kept separate, they are as easily dealt with as single-phase circuits. As far as the line is concerned, however, the three-phase system is better. This can be seen from the following comparative figures, which have been abstracted from a valuable table compiled by Mr. A. T. Snell. A concrete example has been taken—the transmission of 50,000 watts (at receiving station) under the conditions of constant effective pressure at the receiving station with either a constant line loss of 5,000 watts (10 per cent.) or constant drop of 500 volts. Three systems are here compared: (1) two-phase, with four transmitting wires; (2) two-phase, with three wires—*i.e.*, the currents of both phases flowing through a common lead on one-half of their circuits; (3) three-phase, with three equal wires. The comparative weights of copper are given in Table A.

In the two-phase three-wire system the comparison will be altered if we consider the effective pressure to be 5,000 volts (*a*) with respect to the working pressure in each circuit, or (*b*) with respect to the component pressure in the common lead, which, of course, will be subjected to wider fluctuations of pressure than the two other leads during each period. Both these cases are shown.



It appears, then, that so far as distribution for power and lighting purposes is concerned, the two-phase system is superior; while for transmission alone, a three-phase line is better. Hence if we can combine the two systems as suggested in the question, we secure the advantages of both and eliminate the drawbacks. This has been done in the Niagara-Buffalo transmission scheme, in which power is generated at 5,000 volts (two-phase currents), transformed up to 11,000 volts and carried in the form of three-phase currents overhead for 15 miles, and then transformed down and back again to two-phase currents for distribution for power and lighting; with only a 5 per cent. voltage drop on the line and a power factor throughout the day of 95 per cent. (the load is very constant). The arrangement of transformers is due to Mr. Scott, chief electrician of the Westinghouse Company, and is as shown: The device for transforming two-phase into three-phase consists of two transformers, one connected to the middle point of the other. The former has 87 turns, as compared with 100 turns of the latter. Hence the arms, A O, B O, C O, would have E.M.F.'s in the ratio $50\sqrt{3}$, 50, and 50, if the impressed voltages were in the same phase. But since A O receives its impressed E.M.F. a quarter period earlier or later than B O and C O, the practical effect is that equal voltages are induced in the three arms, differing equally in phase between themselves; hence a three-phase current is produced. The reverse action takes place in the trans-

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formers at the other end of the line, reconverting into two-phase currents.—J. A. S.

CATALOGUES.

We have received from the General Electric Company (1900), Limited, a tenth edition of their "S" catalogue, which includes

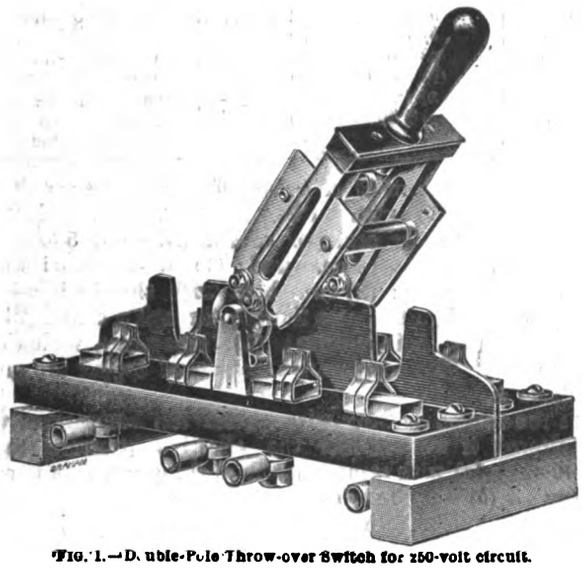

FIG. 1.—Double-Pole Throw-over Switch for 250-volt circuit.

switchboard accessories and incandescent lamps. There are in this new edition a large number of novelties which we are obliged to pass over without even a casual reference. We note, however, that special features are made of new types of switch gear for carrying heavy currents on high-voltage circuits. In Fig. 1 we illustrate one of these, which would be used for throwing over the load from one supply company to another. In this "Peel" switch the contact bar is not rigidly connected

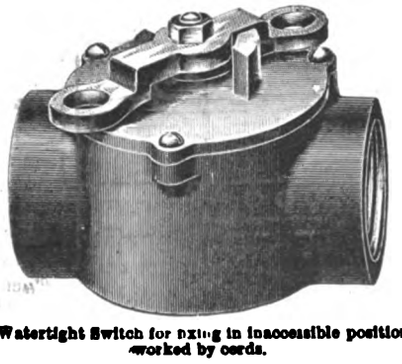

FIG. 2.—Watertight Switch for fixing in inaccessible positions, to be worked by cords.

to the handle, and is quite insulated from it. The spring between the handle and the contact bar serves to give a quick break when interrupting the circuit. The various parts of the switch are well proportioned, the conductivity being such that it is equivalent to a density of about 800 amperes per square inch in pure copper. These switches are mounted in both single and double pole, and can be combined with fuses for the main switchboards of installations taking their supply from the public mains. They are standardised for all currents from 30 up to 1,000 amperes. Amongst other new switches we find a rectangular battery-regulating switch listed in four sizes, from 8 to 20 ways, and a high-tension 10,000-volt switch, having only the lever accessible, whilst the contacts, which work in an insulated tubular air chamber, can be placed at any distance away. A new watertight switch for incandescent lamp-posts is shown in Fig. 2 for five and ten amperes, mounted in a cast-iron case, tapped to take the barrel, and provided with a lever arm for manipulation from the pavement; also four new arc lamp-post switches for various functions. Turning to smaller things, we notice a new pressel, readily manipulated with one hand; a dust-proof floor socket, with automatic arrangement for closing the holes on removal of the plug; a china adaptor, fitted with fuse terminals; "loop-in" ceiling roses; a new "side-contact" ceiling rose, with double-potential fuse terminals; high-tension distributing boards, with "lined chamber" fuses; and an excellent series of watertight house service and tramcar cut-outs for 110 volts and 500 volts.

We notice amongst the accessories for arc-lighting work the "isolating" switch (shown in Fig. 3), which both isolates the lamp from the circuit and at the same time introduces a resistance, so that the conditions of the circuit are not varied to cause interruption in the working of the rest of the lamps. This switch is mounted in a cast-iron case, and can also be fixed high up on the poles, so that it is not easily tampered with by the man in the street. Amongst the new types of cut-outs we find the one shown in Fig. 4. In this case the fuse consists of an ordinary fuse wire, which is wound in a spiral groove on a china core. In the middle of this core is a chamber, which is so arranged that the cooling of the fuse is least in this space. In consequence, when an excess current passes, the rupture always takes place in the middle. The large amount of cooling surface then prevents the arc from being maintained. The china core and fuse wire are contained in a glass tube for the smaller sizes,

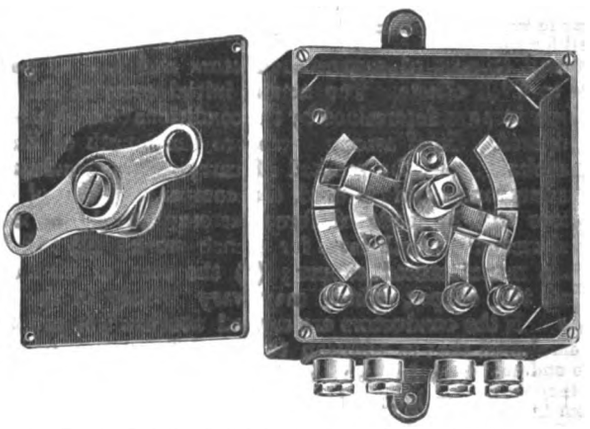

FIG. 3.—Isolating Switch for Arc Lamps for Street Lighting.

and in a heavier tube of china for fuses for larger currents. The illustration (Fig. 4) shows one of these new cut-outs in a cast-iron case such as would be required when bringing a 500-volt supply from the street mains into a motor. The last portion of the catalogue is devoted to the lampholders manufactured by the firm, and to the "Robertson" lamp. At the present time this lamp is so well known that any detailed reference to it would be superfluous. The fact that the Robertson Lamp Company have recently added a large wing to

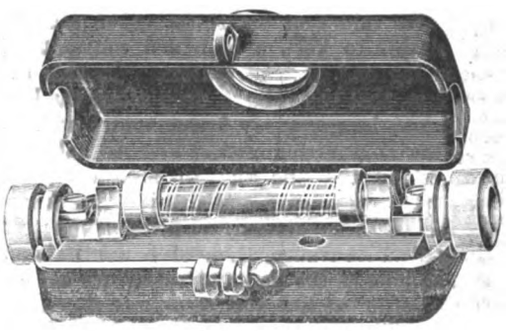

FIG. 4.—500-volt Cut-Out in Cast-Iron Case.

their lamp factory is sufficient evidence of the good qualities of the lamps supplied.

COMPANIES' MEETINGS AND REPORTS.

HOVE ELECTRIC LIGHTING.

The annual general meeting of the shareholders was held on Monday at the Cannon-street Hotel, Colonel A. J. Filgate presiding.

In moving the adoption of the report, the **Chairman** expressed a hope that the shareholders would be satisfied with the result of the past year's working to Dec 31 last. Another Babcock and Wilcox boiler had been ordered for erection this summer, and with this addition the directors hoped to be able successfully to meet the demand for electric current during the ensuing winter. It had for a long time been clear to them that the resources of the present station would at no distant date prove insufficient to meet the rapidly growing business of the Company, and timely steps had been taken by the Board to select a site for a new station. After considerable enquiry they found a suitable piece of land immediately adjoining the railway. The plans for the new station were now matured, and the directors hoped to lay them forthwith before the Corporation of Hove. When the latter's approval was received it was at once intended to place the work in hand. A considerable tract of land had been acquired, and the station was so designed that it could be enlarged to such extent as might be necessary to meet the requirements of the undertaking for

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a number of years. The scheme would involve considerable outlay, but not more than the progressive nature of the business demanded. When the new station was in working order they would be able to meet any demand likely to arise, and would then have to consider what reduction they could make in their charges As he stated last year, the directors agreed to supply customers on the 220 volt pressure at 7d. per unit for the first hour instead of 8d , and this had led to a good number of customers changing over from the 110 volts. The Corporation of Hove had steadily opposed the alteration, and apparently had done a good deal to prevent the Company's customers from changing to the higher voltage; indeed, recently they had refused to allow any such change, although more than four years ago they authorised the Company to take on future consumers at the 220 volts. Why the Corporation had adopted this course he could not say, and if it were continued it would probably tend to prevent the Company from reducing their charges sooner than would otherwise be the case. The directors would, no doubt, have to issue fresh capital this year in some form. The continued increase in the business spoke well for the Company's prospects.

Colonel H. Wood having seconded the motion, the report and accounts were adopted.

IMPERIAL TRAMWAYS.

The annual meeting of the shareholders was held on Saturday at Bristol.

Mr. George White presided, and, in moving the adoption of the report, said he believed that a sale of the Darlington tramways would shortly be made upon terms which would be mutually agreeable to the Corporation of Darlington and to the shareholders of the Imperial Tramways Company. With regard to the Reading tramways, the Board of Trade had appointed Sir Frederick Bramwell to determine the price to be paid by the Corporation for the undertaking, but in the meantime the Corporation had enquired if they were willing to suggest some reasonable price for agreement in order to obviate the necessity for an arbitration. He need hardly say that the directors were giving that subject consideration. Turning to the Middlesbrough, Stockton, and Thornaby electric tramways undertaking, the receipts were exceedingly satisfactory, and anyone comparing the number of passengers with the amount of money earned would readily perceive that they were giving the public of these three towns a wonderfully cheap service. They were constructing the extension of the Middlesbrough line to Clarence Ferry, and would open it in May. It was not a lengthy piece of line, but it would serve the Tees ferry connecting Middlesbrough and Port Clarence, where there were no less than 5 000 people passing to and fro daily, and he had no doubt the extension would prove a useful feature of the general system, and that they would obtain a fair return upon the outlay of their additional capital. He would now like to refer to the London United Tramway Company's undertaking, in which the Imperial Company had taken a further interest during the past twelvemonth. On the whole, without going into the details of the exact position at this moment, they might take it from him that they had good grounds for believing that they would be able to give to Londoners the benefit of an important electric traction scheme in their western suburbs during the next few weeks. In summing up the position of the Imperial Company, he thought he might fairly say that during the past 12 months they had more than held their own upon a normal state of things, whilst now that their anticipations from London were so nearly approaching realisation, they might fairly look forward this year to another distinct advance

Mr. H. C. Godfrey seconded the motion, which was carried unanimously.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

At the ordinary meeting of the proprietors held on Tuesday **Mr. Aymer H. Sandersen**, who presided, said he was glad to be able to state that the Board of Trade had refused to grant the order applied for by the Bournemouth Corporation in respect of private lighting, but they had granted an order enabling the Corporation to supply the public lighting. As, however, the Company had not supplied any public current, they had not been prejudicially affected. The secretary (Mr. H. B. Renwick) had prepared a valuable table showing the progress of the Company since 1891. This showed that they had a most progressive business, and the directors felt convinced that there was a bright future for the undertaking. The contract which they had entered into for the supply of current to the Poole and District Electric Traction Company would provide their own Company with what was so necessary for an electric lighting undertaking—a day load. During the year the Richmond Company had opened up an entirely new district, and carried their mains into Kew. In regard to the provisional order held by their own Company for the lighting of Poole and Branksome, the directors had hitherto delayed carrying it out for reasons which he need not mention, but they now proposed to consider this matter seriously, as they felt sure that there was in the neighbourhood in question a large and remunerative field for business.

The motion for the adoption of the report and accounts was seconded by **Mr J. A. Hooker.**

The **Chairman**, in answer to a question, said the directors quite agreed in the opinion which had been expressed, that the Company could supply current to the public lamps more cheaply than the Corporation of Bournemouth, who, however, like other corporations, had preferred to supply themselves.

The motion was carried unanimously.

BRITISH COLUMBIA ELECTRIC RAILWAY.

An extraordinary general meeting of the proprietors was held on Monday at the Cannon-street Hotel to consider a resolution for altering the articles of association by inserting a clause to the effect that upon any offer of shares to the public for subscription the Company or the directors on behalf of the Company may pay a commission at a rate not exceeding 10 per cent. to any person in consideration of his subscribing or agreeing to subscribe, whether absolutely or conditionally or procuring or agreeing to procure, subscriptions, whether absolute or conditional, for shares in the Company.

Mr. A. C. Mitchell Innes, who presided, observed that the enterprise was a prosperous and progressive one, and in view of the great strides which the business had made and their large number of customers, they would not, he thought, be surprised that the directors were asking for more money. The result of last year's working showed a substantial advance in the gross earnings, but the net earnings were a few hundred pounds less, there having been a material increase in the working expenses in consequence of exceptional circumstances. The net earnings would otherwise have been considerably more. Two extraordinary storms entailed a loss on the Company of about £1,500, and they had also suffered from the non-delivery of machinery. Throughout the summer they had been collecting customers for the electric light, and steps were taken to increase the machinery and plant in order that when the winter came the Company might be able to supply the increased demand. As the machinery was delayed the Company were put to considerable expense, and they had not been able to satisfy their customers as they had desired to do. He was glad to say that they had now ample machinery for their purposes, and before the winter the Company would be able materially to increase the supply. There had been a considerable increase in the railway business, and it would be necessary to have additional rolling-stock. It was calculated that the new money would yield more than the 5 per cent. preference interest upon it.

The resolution was carried.

BRUSH ELECTRICAL ENGINEERING.

Directors: J. B. Braithwaite, jun., M.I E.E. (chairman); C. E. Hodgkin; E. A Hopkins; J. Slater Lewis; J. S. Raworth; Reginald Ryley; R. Percy Sellon. Consulting engineer: J. S. Raworth.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1900:

The profit and loss account shows an available gross profit of £61,732 8s. 9d. After deducting maintenance, general charges, interest on debenture stock, and interim dividend on preference shares for the half-year ended June 30 last, there remains a balance of net profit of £24 070 0s. 8d. The directors recommend that this sum be applied as follows: dividend at the rate of 6 per cent. per annum on preference shares for the half-year ended Dec. 31, 1900, £5 948. 3s. 6d.; dividend at the rate of 5 per cent. per annum on ordinary shares for the full year ended Dec. 31 1900, £9 521. 8s. 9d.; bonus payable to employés under profit sharing scheme, £2,098. 1s. 7d.; depreciation reserve fund, £5,000; balance carried forward, £1,502. 6s. 10d. Capital expenditure to the extent of £68 087. 2s. 11d. has been incurred during the year. The extensive additions to the Company's works and plant at Loughborough, which have been in progress during the past three or four years, are now virtually complete, and the directors anticipate that the Company will reap the benefit of the large expenditure that has been made on capital account in the increased facilities for economical manufacture which the works now afford. Complete electric cars, comprising trucks, motor equipments, controllers, and car bodies are now being manufactured at the Company's works, and the directors continue to look for a large and increasing business in connection with electric traction. In order to provide for the expenditure on capital account the directors have decided to offer for subscription 12 500 preference shares of £2 each and 20 000 ordinary shares of £2 each, particulars of which will be announced shortly. The Company's profits have been prejudicially affected during the past year by the high price of coal and materials generally. In pursuance of the agreement dated Jan. 3, 1901, between the Company and the British Electric Traction Company, Limited, adopted by the shareholders in general meeting on Jan. 14, 1901, Mr. A. Ayres, Mr. A. H. Sanderson, Colonel F. G. Stewart, and Mr. E. Woods resigned their seats on the Board, and Mr. C. Shirreff B. Hilton and Lord Vaux of Harrowden, nominees of the British Electric Traction Company, were elected as directors. Mr. R. Percy Sellon also resigned his position as general manager of the Company, and was elected to a seat on the Board. The offer of the British Electric Traction Company, Limited, to issue ordinary shares in exchange for ordinary shares of the Brush Electrical Engineering Company, Limited, on the terms set out in the agreement of Jan. 3, 1901 (above referred to), has resulted in their acquiring 15 584 ordinary shares of the Company. In consequence of an informality, the appointment of Lord Vaux of Harrowden and Mr. C. Shirreff B. Hilton as directors of the Company has become void. Mr. E. A Hopkins and Mr. Reginald Ryley have been elected to fill the casual vacancies thus occurring on the Board, and Lord Vaux of Harrowden and Mr. C. Shirreff B Hilton will be proposed to the shareholders for re-election at the general meeting. The retiring directors are Mr. J. B. Braithwaite, jun., and Mr. C. E. Hodgkin, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire and offer themselves for re-election.

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Dr. BALANCE-SHEET.	£	s.	d.
Authorised capital—150,000 6 per cent. preference shares of £2 each	300 000	0	0
180,000 ordinary shares of £2 each	360,000	0	0
	£660,000	0	0
Capital issued—111,751 6 per cent. preference shares of £2 each	223 502	0	0
105,731 ordinary shares of £2 each	211,462	0	0
	434,964	0	0
Less calls unpaid	10,352	10	0
	424,611	10	0
4½ per cent. perpetual first debenture stock, secured by debentures	125,000	0	0
4½ per cent. perpetual second debenture stock, secured by debentures	125,000	0	0
Loan from bankers against securities *per contra*	48,000	0	0
Sundry creditors: head office, £72,998. 5s. 11d.; Australian branch at Oct. 31, 1900, £2,405. 0s. 11d. Bills payable: head office, £6,185. 4s. 10d.; Australian branch at Oct. 31, £258. 9s. 10d.	81,847	1	6
Depreciation reserve fund, £17,500; less amount applied during year, £1,967. 15s. 7d.	15,532	4	5
Workmen's Compensation Act insurance fund	1,000	0	0
Balance of profit and loss account, £29,581. 4s. 5d.; less interim dividend on preference shares, £5,511. 3s. 9d.	24,070	0	8
	£845,060	16	7

Cr.	£	s.	d.
Freehold and leasehold factories, including plant and machinery (as per last account), £197,291. 16s. 6d.; additions during the year, £68,067. 2s. 11d.	265,358	19	5
Patents and goodwill (as per last account)	181,397	8	9
Goods in hand, in process of manufacture, work in progress, and materials, £134,638. 12s. 6d.; Australian branch at Oct. 31, £14 072 18s. 8d.	148,711	11	2
Sundry accounts, less reserve for doubtful debts: head office, £122,291. 14s. 5d.; Australian branch at Oct. 31, 1900, £6,952. 10s. 5d.; Australian branch, balance of items in transit and invoices rendered, less cash received from Oct. 31 to Dec. 31, 1900, £6 768. 13s.	136,012	17	10
Bills receivable: head office, £5.512. 15s. 9d.; Australian branch at Oct. 31, 1900, £148. 16s. 9d.	5 661	12	6
Cash at bankers and in hand	2,816	2	1
Shares and debentures at or below cost price	87 602	4	10
Depreciation reserve fund	17,500	0	0
	£845,060	16	7

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
General charges—viz.:			
Directors' fees, exclusive of consulting engineer's fee	1,500	0	0
Auditors' fee	150	0	0
Salaries	6,668	8	0
Law charges	129	5	1
Insurance	1,172	1	1
Actual expenditure incurred under Workmen's Compensation Act	275	13	2
Postage, stationery, and printing	755	3	10
Rent, rates, and taxes	1,627	14	1
Advertising and London office expenses	1,832	12	3
Debenture stock, trustees' fees and expenses	428	15	8
	14,539	13	2
Maintenance of buildings and plant	5,627	5	11
Maintenance of patents	327	0	3
Interest on perpetual first debenture stock	5,625	0	0
Interest on perpetual second debenture stock	5,258	9	6
Interest on redeemable second debenture stock	366	10	6
Half of cost of redeeming £16,290 redeemable second debenture stock	407	5	0
Balance, profit carried to balance-sheet	29,581	4	5
	£61,732	8	9

Cr.	£	s.	d.
Balance brought forward from last account	5,030	1	5
Gross profit on trading, after making a reserve for doubtful debts	50,135	19	2
Profit realised from sales of and interest on securities	6,496	9	6
Transfer fees	69	18	6
	£61,732	8	9

WOOLWICH DISTRICT ELECTRIC LIGHT.

The annual meeting of this Company was held at Broad Sanctuary-chambers, Westminster, on Monday.

Mr. J. A. Findlay, chairman, in moving the adoption of the report, pointed out that compared with the previous year, while the sale of current had nearly doubled, jumping from £3,372 to £6,109 the expenditure had only gone up by a little over £700, and that if the price of coal had remained the same last year as it was the previous year these expenses would have been £500 less. In the past the Company had passed through a number of lean years; now they had entered on something more in the way of fat years, and there was every prospect of the improvement continuing.

Mr. Gripper seconded the motion.

Mr. Whale pointed out that Woolwich was in a much better position to take the electric light now than it had been in the past owing to the extensive rebuilding of the main streets.

The motion was then put and agreed to.

The **Chairman** afterwards moved a special resolution: "That the capital of the Company be increased to £50,000 by the issue of 25,000 shares of £1 each." When the shares were issued, he remarked, there would be sufficient to pay off the amounts due to the contractors, and leave sufficient in hand for this year's capital expenditure. He might inform the shareholders that they had been approached by the Council of the borough of Woolwich with reference to the sale of their undertaking, and that if they were made an offer by the Council which they considered reasonable and a suitable one, they would call the shareholders together to consider it. Having got a very sound concern, they were not by any means inclined to part with it, except at its full mercantile value.

The resolution was adopted.

SOUTH LONDON ELECTRIC SUPPLY.

At the ordinary meeting of the shareholders on Wednesday, held at the offices, Bengeworth-road, Loughborough Junction, S.W., **Mr. George Ellis**, who presided, said that the profit shown by the accounts would have been much larger but for the abnormal price of coal during the period under review. The actual number of lamps added to the circuit had been 17 697 of 8 c.p., and to-day the total number stood at 45,863, besides which they held applications for a further 3,552. Had this increase been spread over the whole of the past year, the effect of it upon the revenue would have been much greater, and as the demand for additional lamps still kept up, the prospects for the future appeared likely to satisfy them all. In March, 1900, the price for current used for lighting purposes was reduced from 6d. per unit to 5½d., and that for power and heating from 4d. to 2d. per unit, the meter rentals being also slightly revised. The Board had also introduced a scheme for installing six lights on consumers' premises absolutely free of all cost to them, and at the present time there were 205 customers wired under this scheme, and in addition to the six lights installed these customers had added many lights at their own expense. The Company's customers were fairly evenly distributed over the whole area in which the Company had powers, and this, notwithstanding that a large portion consisted of small shops and residences which were necessarily but small consumers of current, led the Board to hope that the normal increase would be as steady and widespread as the work had been up to now. The Company had in the last three years been passing through the unproductive period which had characterised the progress of every electric lighting undertaking, but the directors hoped that on the current year's working a dividend would be shown.

Mr. Jacob Atherton seconded the motion for the adoption of the report and accounts, which was carried.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

Directors: The Right Hon. Lord Rathmore (chairman); J. B. Braithwaite, jun. (deputy-chairman); Frederick W. Reynolds; Aymor H. Sanderson; Francis E. Savory; Joseph Shaw; R. Percy Sellon, M.I.E.E. Chief engineer: Charles P. Sparks, M.I.C.E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1900.

The capital expenditure during the year on account of the Company's London districts amounted to £174,481. 3s. 4d., making the total expenditure in respect of those districts up to Dec. 31 last £892,677. 2s. 3d. This expenditure was met in part by the issue in July, 1900, of a further £100,000 4½ per cent. debenture stock, at a premium of £8 per cent. The premium received on the above-mentioned issue has been placed to reserve for depreciation, repairs, and renewals. The balance from last account after payment of the final dividend on the preference shares for the half-year ended Dec. 31, 1899, less income tax, and of the dividend of 4 per cent. on the ordinary shares for the year ended Dec. 31, 1899, less income tax, amounted to £12,594. 2s. 8d., and the balance from revenue account, after payment of directors' fees, rent, taxes, general establishment and other charges, wages and proportion of salaries, to £27,367. 19s. 7d., making a total available revenue for the year 1900 of £39,962. 2s. 3d., from which must be deducted the following items: interest on debenture stock, including interest on instalments paid in advance, £9,606. 14s. 10d.; interim dividend on 20 000 6 per cent. preference shares for half-year ended June 30, 1900, less income tax, £5,750; interim dividend on 40 000 ordinary shares at 4 per cent. per annum for half-year ended June 30, 1900 less income tax, £7,666. 13s. 4d., leaving for further distribution £16 938. 14s. 1d. The directors recommend (*a*) that payment of the interim dividend on the 20,000 6 per cent. preference shares for the half-year ended June 30, 1900, less income tax, be confirmed; (*b*) that pay-

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ment of the interim dividend on the 40,000 ordinary shares at the rate of 4 per cent. per annum for the half-year ended June 30, 1900, less income tax, be confirmed; (c) that a further dividend on the 20,000 6 per cent. preference shares for the half-year ended Dec. 31, 1900, less income tax, be declared; and (d) that a further dividend on the 40,000 ordinary shares for the half-year ended Dec. 31, 1900, at the rate of 4 per cent. per annum, less income tax, be declared, and that the same be paid to all proprietors registered at March 19, 1901. This will absorb £13,300, and leave a balance of £3,638. 14s. 1d. to be carried forward. Notwithstanding the high price paid for fuel during the greater part of the year, the profits derived from the City-road station have risen from £8,707. 7s. 9d. in 1899 to £17,239. 0s. 3d. in 1900, being an increase of 98 per cent., while at the Wandsworth station the profits have risen from £11,136. 10s. in 1899 to £15,624. 8s. 5d. in 1900, an increase of 40 per cent. The equivalent number of 8-c.p. lamps applied for during the year was 102 003, as against 58,523 for 1899; and the units sold were 2,990,138, against 1,766,515 for the previous year. The directors are glad to report that, as a result of this satisfactory progress, they are this year enabled to recommend a dividend out of the earnings of the Company's London stations without assistance from the further realisation of any of the Company's investments. These results reflect great credit upon the chief engineer, the secretary, and the Company's staff. The retiring directors are Mr. F. E. Savory and Mr. Joseph Shaw, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

London Stations.

St. Luke and Clerkenwell, Eastern Holborn, Western Holborn and St. Giles.—The balance to credit of revenue for the 12 months ended Dec. 31, 1900, amounted to £17,239. In these districts, the total applications to Dec. 31 last, including power, represented the equivalent of 143,195 8-c.p. lamps, of which 119,076 were then connected to the mains. The applications for the year represented an increase of 62,272, and the connections an increase of 57,888. At the same date 165 users of motors, aggregating 1,171 h.p., were supplied from the Company's mains, showing an increase of 796 h.p. for the year, and further applications have since been received, raising the total to 214 applications, representing 1,941 h.p. The special plant erected for the generation of continuous current for power purposes will shortly be insufficient, and further machinery has been ordered to meet the rapidly increasing demand. Additional plant for the lighting supply has also been ordered for delivery in time for next winter. The Board of Trade granted a competing order, which was confirmed in the last session of Parliament, to the local authorities in the Company's East-end districts, and your directors have accordingly lodged the Company's claim for compensation as provided for under the order referred to.

Wandsworth District (including the parishes of Putney, Wandsworth, Clapham, Streatham, and Tooting) *Camberwell, and St. George-the-Martyr, Southwark.*—The balance to credit of revenue for the 12 months ended Dec. 31 last amounted to £15,624. In these districts the total applications to Dec. 31 last represented the equivalent of 96,607 8-c.p. lamps, of which 90,472 were then connected to the mains. The applications for the year represented an increase of 39,731, and the connections an increase of 35,825. In order to meet the increasing demand in these districts, additional plant has been erected at the Company's station on the Wandle.

Investments in Provincial Electricity Supply Companies.

Bournemouth and Poole Electricity Supply Company, Limited.—This Company continues to make satisfactory progress. The directors have recommended the payment of a dividend on the ordinary shares of the Company at the rate of 6 per cent. for the year ended Dec. 31, 1900, less income tax, as against 5 per cent. for the previous year.

Dover Electricity Supply Company, Limited.—This Company has made satisfactory progress during the past year. The balance from revenue account for the year ended Dec. 31 last has allowed the payment of a dividend on the share capital of the Company at the rate of 3½ per cent. per annum, as against 3 per cent. for 1899.

Scottish House-to-House Electricity Company, Limited.—Satisfactory terms have been arranged for a transfer to this Company of the electric lighting order for the adjoining borough of Airdrie, and an agreement has been entered into with the Airdrie Corporation for both public and private lighting. The Company has also acquired the interests of the Airdrie and Coatbridge Tramways Company in the Airdrie and Coatbridge Tramways Act, 1900, and is promoting a provisional order in the present session of Parliament, under agreement with the Coatbridge Corporation, for the construction of tramways in Coatbridge.

Dr. General Revenue Account.	£	s.	d.
Directors' fees, rents, taxes, insurance, etc.	5,480	4	4
Printing, stationery, and postage	666	2	11
General charges and travelling	822	13	11
Legal expenses	91	2	8
Trustees' fee	105	0	0
Auditors' fee	157	10	0
Reserve for bad debts	50	0	0
Depreciation of office furniture	182	1	4
Interest paid on temporary loans	3,593	5	11
	11,148	1	1
Balance carried to net revenue account	27,367	19	7
	£38,516	0	8

Cr.	£	s.	d.
Gross profits, derived from rents, discounts, etc.	1,708	9	5
Transfer fees	48	2	6
Interest and dividends receivable, less income tax	3,896	0	1
Balance from revenue accounts	32,863	8	8
	£38,516	0	8

County of London (North) Electric Lighting Order, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	1,901	12	4
Coal and other fuel	7,400	8	7
Oil, waste, water, etc.	581	18	5
Stores and works expenses	248	3	2
Repairs to buildings, plant, etc.	1,295	0	3
Distribution—Engineers' salaries and wages	706	5	1
Repairs	116	0	6
Rents payable	853	6	8
Rates and taxes	1,123	12	3
Insurance	134	11	7
Stationery and printing	172	11	10
Auditor's fee—Board of Trade	52	8	6
General charges and travelling	125	11	7
Legal expenses	23	11	10
	14,735	2	7
Less repairs and renewals	1,411	0	9
	13,324	1	10
Balance carried to general revenue account	13,207	4	10
	£26,531	6	8

Cr.	£	s.	d.
Sale of current, less abatements	25,421	6	11
Rental of meters	734	9	5
Rents receivable	375	0	4
Testing fees	0	10	0
	£26,531	6	8

County of London (Northern Extensions) Electric Lighting Order, 1897.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	391	13	4
Coal and other fuel	1,480	1	8
Oil, waste, water, etc.	91	15	5
Stores and works expenses	49	10	5
Repairs to buildings, plant, etc.	261	13	4
Distribution—Engineers' salaries and wages	167	17	10
Repairs	36	0	0
Rents payable	167	10	0
Rates and taxes	257	0	7
Insurance	26	15	5
Stationery and printing	13	0	11
Auditor's fee, Board of Trade	10	9	7
	2,953	8	6
Less repairs and renewals	297	13	4
	2,655	15	2
Balance carried to general revenue account	2,628	10	4
	£5,284	5	6

Cr.	£	s.	d.
Sale of current, less abatements	5,122	8	6
Rental of meters	161	17	0
	£5,284	5	6

Holborn and St. Giles Electric Lighting Order (No. 1), 1898.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	80	10	8
Coal and other fuel	296	0	4
Oil, waste, water, etc.	18	7	1
Stores and works expenses	9	18	1
Repairs to buildings, plant, etc.	51	18	8
Distribution—Engineers' salaries and wages	193	13	8
Repairs	2	5	9
Rents payable	33	10	0
Rates and taxes	69	5	7
Insurance	5	7	1
Stationery and printing	66	8	2
General charges	27	12	4
Auditor's fee—Board of Trade	2	1	11
	856	19	4
Less repairs and renewals	54	4	5
	802	14	11
Balance carried to general revenue account	1,403	5	1
	£2,206	0	0

Cr.	£	s.	d.
Sale of current, less abatements	2,122	18	9
Rental of meters	83	1	3
	£2,206	0	0

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WANDSWORTH ELECTRIC LIGHTING ORDER, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	1,528	3	2
Coal and other fuel	3,526	4	8
Oil, waste, water, etc.	462	10	9
Stores and works expenses	87	9	8
Repairs to buildings, plant, etc.	1,289	8	6
Distribution—Engineers' salaries and wages	964	4	4
Repairs	281	10	8
Rents payable	149	7	6
Rates and taxes	362	1	8
Insurance	106	9	10
Stationery and printing	162	9	11
Auditor's fee—Board of Trade	53	4	0
Legal expenses	12	13	4
General charges and travelling	90	11	3
	9,076	9	3
Less repairs and renewals	1,570	19	2
	7,505	10	1
Balance carried to general revenue account	12 467	0	2
	£19,972	10	3

Cr.	£	s.	d.
Sale of current, less abatements	18 940	10	7
Rental of meters	963	3	2
Rents receivable	64	5	0
Testing fees	4	11	6
	£19 972	10	3

CAMBERWELL ELECTRIC LIGHTING ORDER, 1896.

Dr. *Revenue Account.*	£	s.	d
Generation—Engineers' salaries and wages	412	0	6
Coal and other fuel	927	15	10
Oil, waste, water, etc.	122	12	1
Stores and works expenses	22	2	2
Repairs to buildings, plant, etc.	339	4	3
Distribution—Engineer's salaries and wages	223	13	3
Repairs	71	0	4
Rents payable	53	2	0
Rates and taxes	140	19	10
Insurance	27	15	10
Stationery and printing	62	7	7
Auditor's fee—Board of Trade	14	0	0
General charges	73	15	0
	£2,490	8	8
Less repairs and renewals	410	4	7
	2,080	4	1
Balance carried to general revenue account	2,669	17	4
	£4,750	1	5

Cr.	£	s.	d.
Sale of current, less abatements	4,579	3	10
Rental of meters	170	17	7
	£4,750	1	5

SOUTHWARK ELECTRIC LIGHTING ORDER, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	82	8	0
Coal and other fuel	185	11	2
Oil, waste, water, etc.	24	10	5
Stores and works expenses	4	8	10
Repairs to buildings, plant, etc.	67	15	2
Distribution—Engineers' salaries and wages	33	6	6
Repairs	3	13	1
Rents payable	10	10	1
Rates and taxes	33	7	0
Insurance	5	11	2
Stationery and printing	2	18	6
Auditor's fee—Board of Trade	2	16	0
	456	15	11
Less repairs and renewals	71	8	3
	385	7	8
Balance carried to general revenue account	487	10	11
	£872	18	7

Cr.	£	s.	d.
Sale of current, less abatements	849	2	11
Rental of meters	23	15	8
	£872	18	7

CITY OF LONDON ELECTRIC LIGHTING.

The ordinary meeting of this Company was held last Friday at Cannon-street Hotel.

In moving the adoption of the report, **Sir David L. Salomons** said he trusted the statement he had to make respecting the affairs of the Company would be regarded as reassuring, notwithstanding the small amount of profit made in the past year. The main point which called for remark in the report was the table of figures given under the heading "average price per unit obtained." It would be observed that the average price had steadily gone down, till last year it reached 4·09d. per unit. This figure, combined with two other circumstances, had rendered the payment of a dividend on the ordinary share capital impossible on this occasion. Looking a little ahead at their prospects for the year now passing, he stated that with the new tariff a considerable increase in the receipts should ensue. Coal had already begun to fall in price. He pointed out that 1d. per unit was equal to £50 000 on an output of 12,000,000 units—an output they almost reached last year, or, say, about 7 per cent. on the issued ordinary share capital. Referring to the recent litigation in the Court of Appeal as to the validity of certain contracts, the chairman stated that from the nature of this latter judgment it appeared desirable to appeal no further, for by this decision the Corporation were bound to the contracts in the eastern part of the City, which was equal to about half the whole of the City, and therefore the City could not under any circumstances enter into competition with them, either by buying up the Charing Cross Company or by obtaining an order for themselves for a given period. He specially asked the shareholders to bear in mind that for private lighting their position remained the same, since their provisional orders were untouched by the contracts being upset. The general business of the Company was not touched in any way whatever. His own individual view was that the shareholders had to encounter their worst enemy in the fact that the public placed complete confidence in the honesty and integrity of the City, and it was only natural that the shares of this Company should be registered as a first-class holding. He considered that they had been treated most unfairly in the matter of rating, and they had appealed against the enormous increase that had been made. The additional machinery which had been placed in the works was for the production of continuous current, which simplified the working to a great extent, and was very efficient besides.

Colonel Martindale seconded the adoption of the report.

In an answer to questions, the **Chairman** said that although they were advised at present not to appeal against the judgment of the Court of Appeal, if the Corporation did not come to reasonable terms it might become necessary to do so. He admitted that the lowering of the rate had proved to be a mistake, but the rate had again been changed to a figure which he believed would pay the Company.

The report was then adopted.

The **Chairman** announced his retirement from the Board on grounds of health. He stated that now the corner appeared to him to have been turned in the position of the Company, he felt perfectly free to take that course.

Much regret was expressed at the chairman's announcement, and a vote of thanks to him was unanimously passed.

The retiring directors were re-elected.

DIRECT SPANISH TELEGRAPH.

On Tuesday the Marquis of Tweeddale presided at the meeting of the shareholders held at the offices, Winchester House.

The **Chairman** said there had been two rather serious interruptions during the year; but it was satisfactory to learn that the Bilbao cable was found in excellent order, except just where the faults occurred, and he had reason to believe that, owing to the change in position of this line and the thoroughness of the repairs it would give no more trouble for some time to come. Since the beginning of the year the Barcelona-Marseilles cable had been interrupted, and, owing to the bad weather prevailing in the Mediterranean, it had been impossible as yet to repair it, but in all probability it would be at work again in a few days. The cost of this and other repairs would make a considerable inroad on their reserve, which would probably be depleted to an extent of not less than £10,000; but so long as they continued to maintain the fund efficiently and keep it at a substantial sum, there was no reason to fear.

Mr. J. Denison Pender seconded the resolution, which was carried.

NATIONAL ELECTRIC WIRING.

Directors: R Stewart Bain, Esq., C.A. (chairman); B. Bernheim, Esq.; W. R. Davies. Esq.; G. Ellis, Esq., J.P.; J. T. Jervis, Esq., M.I.C.E., F.R.G.S.; J. W. Swan, Esq., F.R.S. Manager and secretary: W. B. Cownie.

Report of the directors for the year ended Dec. 31, 1900:

The gross profit for the period under review is £9 636. 0s. 2d., from which has to be deducted expenses of administration, allowances on contracts, etc., amounting to £5 642. 4s. 8d., leaving a balance of £3 993 15s. 6d. To this has to be added the balance carried forward at Dec. 31, 1899—viz., £281. 1s. 5d.—making a total of £4,274. 16s. 11d. The directors recommend that this amount be dealt with as follows: to pay a dividend at the rate of 4 per cent. on the paid up capital for the year, £2 499. 11s 8d.; provision for further allowances, depreciation, etc., £1 390 19s 6d.; to carry forward, £384 5s 9d. The directors have pleasure in stating that the increase in the business during the year has been very satisfactory. The orders taken from Jan. 1 of the current year to date of this report show that the increase has been more than maintained. Several large contracts have been secured by the Company, involving the complete equipment of plant necessary for power and lighting. During the year 2,240 installations with an aggregate of 57,519 lamps of 8 c.p., have been completed, of which 777 installations, with an aggregate of 19 973 lamps of 8 c.p., were free wiring, and 1,463 installations, with an aggregate of 37,546 lamps of 8 c.p., were contract, while the orders in hand at the close of the year were 590 installations, with an aggregate of 33,084 8-c.p. lamps.

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Free wiring contracts have been entered into with the Corporation of Swansea, the borough of Poplar, and the Scottish House-to-House Electricity Company, Coatbridge. Mr. R. Stewart Bain and Mr. B. Bernheim in accordance with the articles of association, retire at this meeting but are eligible, and offer themselves for re-election. Messrs Monkhouse, Sconeham, and Co., the auditors, also retire at this meeting, but offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT	£	s.	d.
Management expenditure at head office and branches	4,415	16	9
Directors' fees, £1,200 ; less relinquished, £600	600	0	0
Auditors' fees	52	10	0
Allowances on contracts, bad debts, etc.	573	17	11
Balance carried down	3,993	15	6
	£9,636	0	2
Depreciation provisions, etc.:			
Allowances on contracts and doubtful debts	300	0	0
Free-wired installations	582	18	10
Fixtures, fittings, plant, and tools	244	1	6
Advertising	150	19	3
Preliminary expenses	112	19	11
	1,390	19	6
Balance	2 602	16	0
	£3 993	15	6

Cr.	£	s.	d.
Revenue from free-wired installations	2 120	0	9
Profit on contracts and sales	6 864	5	2
Interest discount, and commission	508	4	7
Sundry receipts	137	12	2
Transfer fees	5	17	6
	£9 636	0	2
Balance brought down	£3 993	15	6
	£3 993	15	6

WILLANS AND ROBINSON.

Directors: Mark Robinson, Esq. M.I.C.E (chairman); Sir Gilbert A. Clayton East, Bart. (deputy-chairman); Captain H. Riall Sankey; Lieut.-General Sir Richard H. Sankey; Thomas O. Lazenby, Esq.

Report of the directors (with abstract of accounts) for the half-year ended Dec. 31 1900:

After writing off as depreciation from plant patents, etc., the sum of £5 855. 15s. 8d. and paying interest upon debenture stock the balance to the credit of profit and loss account at the end of the half-year (including £6 757 2s 11d. brought forward) is £39,360. 19s. 10d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares and 10 per cent. per annum upon the ordinary shares and that a bonus of 2 per cent. be paid upon the ordinary shares for the year 1900 the whole amounting to £20 761 16s 11d. The amount payable to the original directors, in accordance with the articles of association being £5 685 16s 5d., the balance available is £12 912 6s. 6d. From this the directors propose to carry £2,000 to the debenture redemption fund and £3 500 to the reserve fund, leaving a balance of £7 412 6s 6d. to be carried forward. The auditors having questioned the propriety of investing the debenture redemption fund (the creation of which is a voluntary act on the part of the Company) in the names of the trustees, and thus placing it beyond the control of the Company, the directors have taken counsel's opinions, and are advised that future investments should be in the Company's name. The necessary alterations have been made in the accounts. The opinion of counsel, and of the auditors, has also been taken, as promised at the last meeting, upon the questions then raised as to the appropriation of share premiums. Copies of the opinions and of other papers relating thereto have been circulated among the shareholders. It will be seen that counsel and the auditors consider that the proposed applications of the premiums (which they say are profit and not capital) to meeting various exceptional expenses, are in accordance with the articles of association. The proposal to carry a portion of the premiums to the reserve fund is in accordance with general practice and under ordinary articles of association such profit may lawfully be divided among the shareholders. But in view of the special wording in one of this Company's articles, counsel think that the distribution of premiums as dividend is open to question. This opinion is consistent with carrying premiums to the reserve fund as proposed, it being only necessary to take care that any amount so carried shall not be distributed. It will be seen that a further question arises as to the remuneration of the original directors, and (as regards a certain limited period) the remuneration of the staff. Under the circumstances, the balance of the share premiums account amounting to £27 440. 2s. 4d., is again carried forward. The growth of the business in the past two years has largely diverted to more pressing uses the additional capital intended for new buildings and plant. Between December, 1898, and December, 1900, while the value of buildings and plant increased by about £78,000, the floating capital of the business, including the sums locked up in stock of all kinds, in work in progress, and in balances owing by debtors, increased by no less than £115,000. In the opinion of the directors, this growth is only the natural consequence of the increased volume of the Company's trade, and is justified by the increased profits of the same period. But it results that if the extensions of premises and plant, which are more than ever necessary, and to which the Company is, in fact, committed, are to be properly carried out, and especially if the new boiler works near Chester are to start upon the scale plainly desirable, the capital of the Company must be increased. With this object a resolution will be submitted authorising the creation of new shares (in equal proportions of preference and ordinary shares) to raise the share capital from £500 000 to £750,000—to be issued not necessarily at once, but as may be required. The first portion of the extension works at Rugby is nearly completed Work has been commenced in the new part of the foundry, and the fixing of tools in the new machine shops will begin shortly. The boiler works at Queensferry make good progress. The Admiralty has ordered Niclausse boilers to be fitted in the new armoured cruiser "Suffolk," of 22 000 h.p., and in a sloop of 1,400 h.p. The directors consider that the interim report of the Admiralty Boiler Committee, recently published, is likely to have favourable results upon the future of the Niclausse boiler. Captain H. Riall Sankey, R.E. (retired), and Mr. Thomas Orger Lazenby retire from the Board, in accordance with the provisions of the articles of association, but are eligible, and offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, but are eligible for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rents, rates, and taxes	641	4	6
Interest on debenture stock	2 125	0	0
Salaries, including directors' remuneration	6 452	4	9
Contingent salaries to employés	1 724	8	2
Fire insurance	184	15	10
Fire insurance fund	400	0	0
Legal and professional charges	21	16	10
Advertising	556	10	6
Books stationery, and printing	865	5	5
Postage and telegrams	267	13	0
Travelling, hotel, and general charges	569	4	2
Auditors' fee and expenses	97	18	4
Company's subscription to sick club, doctor's club, and benevolent fund	291	1	1
Allowances to reservists' families and subscriptions to works' war relief fund	156	1	11
Depreciation of property, plant and machinery, and patents	5 855	15	8
Balance carried down	32 603	16	11
	£52 812	17	1
Contingent share of profits to directors, as per articles of association	£5 686	16	5
Balance available for dividend or reserve	26 917	0	6
	£32 603	16	11

Cr.	£	s.	d.
Gross profit for the half-year	50,935	13	7
Royalties	400	0	0
Interest on investments, etc.	1,453	11	6
Transfer and registration fees	23	12	0
	£52.812	17	1
Balance profit (half-year), brought down	£32 603	16	11
	£32 603	16	11

APPOINTMENTS VACANT.

Electrical Engineer, capable of designing and superintending the construction and installation of dynamos, motors, etc. Details in our advertisement columns.

Switchboard Attendants, Southend-on-Sea Corporation, 35s. per week, April 1. Details in our advertisement columns (last issue).

Improver Wanted in an electric light works, must have had previous experience, £1 per week. Details in our advertisement columns.

Inspector of Motormen, etc., Southend-on-Sea Corporation, 35s. per week, April 1. Details in our advertisement columns last issue.

Clerk of Works, Bristol Corporation, to extend the construction of the superstructure of the Avonbank station. Particulars will shortly be advertised.

Clerk and Canvasser, Bermondsey Borough Electricity Department, £140 per annum, April 15. Details in our advertisement columns.

Mains Superintendent, South Shields Borough, take charge of all outside work, £130 per annum, April 10. Details in our advertisement columns.

Assistant Engineer, Borough of Hammersmith, to take charge of an eight-hour shift, £130 per annum, April 4. Details in our advertisement columns.

Junior Assistant, Hammersmith Borough, mains department, 30s. per week, April 4. Details in our advertisement columns.

Engine Driver, Tunbridge Wells, accustomed to Willans engines. Details in our advertisement columns.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Burnley.—Tenders are invited for accumulators, boilers, and economisers by April 9.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the electric lighting of the town for 30 years. Tenders by April 25.

Sunderland.—The Corporation invite tenders for the supply of 104 arc lamp pillars, lamps, and accessories. Tenders by April 3. Details in our advertisement columns.

Halifax.—The Tramways Committee invite tenders for trolley wire. Particulars can be obtained from Mr. H. F. Street, borough electrical engineer. Tenders by April 4.

Ploesti (Roumania).—The Municipality invite tenders for the laying down and working of electric tramways for 30 years. The provisional deposit is £2,000. Tenders by April 3.

Kirkcaldy.—The Corporation invite tenders for engines and dynamos, storage battery, and overhead travelling crane. Tenders by April 15. Details in our advertisement columns.

Salford.—The Corporation invite tenders for wiring for motors, dynamo leads, engine-room and switchboard connections, etc. Tenders by April 9. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for the supply and erection of various plant for electricity works. Full details in our advertisement columns. Tenders by April 11.

Halifax.—The Electricity Committee invite tenders for the supply of steel steam-piping. Particulars can be had from Mr. H. F. Street, borough electrical engineer. Tenders by April 11.

Motherwell.—The Electric Light Committee invite tenders for steam dynamo and switches, and steam, feed, and exhaust pipes, etc. Tenders by April 29. Details in our advertisement columns.

Colwyn Bay.—The Urban District Council invite tenders for a water-tube boiler, feed pump, injector, steam, exhaust, and feed pipes, etc. Tenders by April 13. Details in our advertisement columns.

Paris.—The Post and Telegraph Department invite tenders for 270,000 kg. bronze or copper wire and 30,000 copper connections, in eight lots. Particulars may be obtained at Rue de Grenelle, 103, Paris.

Zagazig (Egypt).—The Local Commission invite tenders for the electric lighting of the town. Specifications, etc., may be obtained from the Public Works Department, Cairo, where tenders may be addressed until April 15.

Dublin.—The Lighting Committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane, and workshop equipment. Tenders by April 22. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for arc lamp carbons, cast-iron pipes, pavement and road box frames, and covers, etc., for their electricity supply stations for the year from May 15. Tenders by April 20. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply, delivery, and erection of a combined motor balancer and boosters, with switch gear for same, at their electricity works, Bolton-road, Bradford. Tenders by April 3. Details in our advertisement columns.

Gross-wardein (Austria).—Tenders for electric lighting are required. The town has a population of 51,000, and 1,220 lamps, averaging 2 000 hours per year, will be guaranteed. Particulars may be obtained from the Municipal Authorities. Tenders by March 30.

Portsmouth.—The Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, economiser, steam, feed, and other pipes, chequer plating, and sundry ironwork. Tenders by April 16. Details in our advertisement columns.

Eastbourne.—The Corporation invite tenders for the building of nine large and six small underground transformer chambers, to be constructed of brick or cast-iron. Specification, etc., can be obtained and drawings inspected at the office of the Borough Electrical Engineer. Tenders by April 3.

Metropolitan Asylums Board.—The Board invite tenders for the supply and erection of a complete electrical generating plant and a complete boiler plant for heating at the asylum now in course of construction at Tooting Bec., S.W. Tenders by April 24. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply of steel tramrails (girder section), fishplates, bolts, nuts, and washers, anchor joint and sole plates, points and crossings, drain rails, etc. Specifications, etc., can be obtained at the office of Mr. S. S. Platt, M.I.C.E., borough surveyor, Town Hall. Tenders by April 1.

Farnworth (Lancs.).—The Urban District Council invite tenders for taking up and removing existing pavement, excavation, concreting, and paving (labour) in connection with the laying of about four miles of tramway, single track. Particulars may be obtained from the engineer, Mr. W. J. Lomax, A.M.I.C.E., 11, Fold-street, Bolton. Tenders by April 8.

Leeds.—The Lighting Committee invite tenders for steam, feed-water, exhaust, overflow, blow-off and other pipes, valves, hot-wells, feed-water pumps, economiser, etc., in connection with engines of 4,000 i.h.p. Specifications, etc., may be obtained from Mr. H. Dickinson, manager of the department, Whitehall-road, Leeds. Tenders by April 15.

Bradford.—The Corporation invite tenders for the supply, delivery, and erection of one 100-kw. motor-generator, with switch gear for same, at their electricity works, Valley-road, Bradford. Specifications, etc., may be had on application to Mr. R. A. Chattock, M.I.E.E., city electrical engineer, Town Hall, Bradford. Tenders by April 3.

Middlesbrough.—The Electric Lighting Committee invite tenders for boiler-house plant—one 30ft. by 8ft. 6in. Lancashire boiler and accessories; engine-house plant—one 300-kw. high-speed steam dynamo and accessories, together with steam, exhaust, and feed pipes, etc.; condensing apparatus—ejector condenser, with circulating pumps. Tenders by April 30. Details in our advertisement columns.

Palencia (Spain).—Tenders are invited for the installation and working of a telephone system for not more than 20 years; 10 per cent. of the annual receipts will have to be paid to the Government. Tenders may be addressed to the General Post and Telegraph Department by April 21. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

RESULTS OF TENDERS.

Dublin.—The tender of J. and W. Stewart, Belfast, for building and chimney shaft at the Pigeon House Fort has been accepted.

Croydon.—The County Council have accepted the tender of Mr. E. Danks for the supply and erection at the electricity works of two dry-back boilers at £1,630.

Battersea.—The Works Committee have accepted the tender of Mr. E. B. Mitchell for the supply and fixing of four copper tape lightning conductors at the central electric lighting station at £64.

Aberdeen.—The Gas and Electric Lighting Committee have accepted the tender of Messrs. Gall and Walker, builders, at £2,897, for the erection of a plain circular chimney stack in connection with the electricity station at Dee Village.

Bradford.—The Corporation have accepted the following tenders for the works required to be done in erection of a generating station at the electricity works, Valley-road, Bradford: T. Obank and Sons, Thackley, masons etc.; Wilkinson and Dawson, joiners, etc.; L. Roberts and Co., Limited, Cutler Heights, smiths and ironfounders; Hill and Nelson, slaters; R. Townend, plumber and glazier; Bradley, Krischke, and Co., plasterers; T. H. Hewitt, painter.

Eastbourne.—The Town Council have accepted the tender of Messrs. Walter F. Glover and Co., at £7,663, for underground mains for private and public lighting, etc., and of the British Electric Transformer Company for £2,600. 10s. for transformer sub-stations and equipments. The following tenders have been received for arc lamps and posts, the carbons to burn for 45 hours—viz., Messrs. Gilbert and Co., £1,830; Messrs. Oliver and Co., £1,784. 8s.; and Messrs. Crompton and Co., £1,770.

Cardiff.—The Corporation have received the following tenders in connection with the erection of a chimney shaft, etc. (160ft. high from floor line), for the electric (tramway) power station at Roath, Cardiff:

W. Symonds and Co., Cardiff (accepted)	£1,626	12	1
Clark and Co., Cardiff	1,565	1	5
Alphons Custodis Chimney Company, Sheffield	1,600	0	0
Chubb and Co. Cardiff	1,732	0	0
Knox and Wells, Cardiff	1,770	0	0
Walters and Johns, Morriston	2,072	18	7
R H. B. Neal, Plymouth	2,540	0	0

Poplar.—The Borough Council have received the following tenders for the supply of an electric crane to lift a maximum load of five tons, with a return block, the electricity supply being continuous current at 460 volts:

Carrick and Sons, Dalry Ironworks, Edinburgh (accepted)	£780
Marshall, Fleming, and Jack, Dellburn Ironworks, Motherwell	780
Crompton and Co., Mansion House-buildings, E.C.	821
Chatteris Engineering Company, Chatteris, Cambs	821
J. Booth Bros., 75A, Queen Victoria-street, E.C.	845
Wimshurst, Hollick, and Co., Rochford	895
T. Smith, Rodley, Leeds	902
Jessop and Appleby, 22, Walbrook, E.C.	915
Higginbottom and Mannock, 25, Victoria-street S.W.	1,000
J. Whitley and Co., Bramley, Leeds	1,022
Carrick and Ritchie, Waverley Engineering Works, Edinburgh	1,027
Mather and Platt, Manchester	1,035
Stothert and Pitt	1,355

BUSINESS NOTES.

TRACTION.

Newcastle.—The work of laying the new tramways has been begun on Jesmond-road.

Sheffield.—The public service of electric tramways to Broomhill was inaugurated on Monday.

British Guiana.—An electric tramway of over 10 miles in length has just been opened for traffic in Georgetown.

Penge.—It is proposed to construct an electric tramway in direct communication with Croydon and the Crystal Palace.

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Poole.—The official inspection of the tramways from Poole to the County Gates was carried out by Major Pringle last week.

King's Norton Tramways Bill.—The House of Lords Committee presided over by Lord Stanmore have passed the preamble of this Bill.

Brighton.—The engineer's plans and specification for the erection of a car-shed and offices at an estimated cost of £9,360 have been approved.

Leeds.—Electric cars have been run for the first time between Beeston Hill and Woodhouse-street. The new line comprises a length of nearly 3½ miles.

Hampstead.—The Works Committee will recommend the Council to spend £1,500 in the purchase of motor-vans for street cleaning and watering purposes.

Hammersmith.—The Law and Parliamentary Committee have approved the amended agreement between the Borough Council and the London United Tramways Company.

Kinver.—The electric tramway was inspected on Friday by Colonel Yorke on behalf of the Board of Trade. The line will be opened immediately the official certificate is received.

Wednesfield.—The Urban District Council have decided to send a deputation to the Wolverhampton Corporation to urge the extension of the Corporation tramways to Wednesfield.

Private Bills.—The London County Council (Tramways and Street Widenings) and the Notting Hill Electric Lighting Bills were read a second time in the House of Commons on Tuesday.

Scarborough.—A company is being promoted to introduce a motorcar service into the town. In the winter months the cars will be converted into omnibuses, and used for a regular public service.

Aberdeen.—The Tramways Committee have been requested to report as to the propriety of having the tramway stations indicated on the street lamps along the various routes, so that the stations may be known at night.

Tramway Receipts.—The following are the latest traffic receipts: Buenos Ayres and Belgrano Electric (to Feb. 24), £604 increase; Perth Electric (to March 22), £302 increase; Brisbane Electric (to Feb. 6), £49 increase.

West London Tramways.—The difficulties between the Kew Observatory authorities and the London United Tramways Company are evidently at an end, as we are informed that the line will shortly be open to the public.

Stoke-on-Trent.—The Light Railway Commissioners have granted the application of the Potteries Electric Traction Company for light railway extensions in the borough, and have fixed the limit of time for purchase at 31 years.

Kingston-on-Thames.—The Tramways Committee have had an interview with the representatives of the London United Tramways Company, and plans of certain street widenings in connection with the scheme are being considered.

Hendon.—The Urban District Council have given their consent to the Charing Cross, Euston, and Hampstead Railway and the Finchley and Hendon Tramway schemes, subject to the incorporation of certain approved clauses in the Bills.

Willesden.—Of the 21 newly-elected members of the District Council, nine are supporters of the tramway scheme and 12 opponents. For the most part the residential districts have voted against the scheme, and the artisans in favour of it.

Nottingham.—The work of constructing the Bulwell section of the electric tramways is progressing favourably, but at least another four months must elapse before electric cars can run between the Great Market-place and the Bulwell terminus.

Merthyr Tydfil.—If the Board of Trade certificate be received this week, it is possible that electric cars will commence to run for passenger traffic to-morrow. The traffic superintendent is arranging a time-table, including provision for workmen's cars.

London's Underground Railways.—The following peers have been appointed to serve on the Joint Committee to examine into the subject of underground railway communication in the Metropolis: the Earl of Lauderdale, the Earl of Rosse, Viscount Knutsford, Lord Windsor, and Lord Herries.

Rochdale.—The Tramways Committee have decided to give out orders for six cars, each of different construction. The public will thereby have an opportunity of showing which type or types of car they prefer. It has also been decided to take steps to procure 1,400 tons of steel rails, sufficient to lay about eight miles of track.

Folkestone.—Major Pringle has held an enquiry as to the application of the Corporation for a provisional order giving power to construct tramways within the borough. The Light Railway Commissioners will open an enquiry on April 1 into the provisional order of the Folkestone, Sandgate, and Cheriton Company for the same purposes.

Bath.—At the Town Council meeting last week, the Electric Traction Committee reported that there were many variations in the agreement between the Corporation and the promoters of the electric tramway scheme, and that they proposed to give way on the question of the right to purchase at the end of 14 years on the payment of an annual wayleave.

Lytham.—The local authorities have approved, subject to minor alterations, a scheme for a light electric railway from Lytham to Preston. A syndicate is negotiating for the purchase of the Blackpool, Lytham, and St. Annes tramway, and it is proposed to have an electric line right through from Preston, *viâ* Lytham, St. Annes, and Blackpool, to Fleetwood.

District Railway.—According to the *Daily Mail* the Bill for the electrification of the Metropolitan District Railway, asking for powers to provide the necessary plant, is not likely to be proceeded with. A change in the plans of the company makes such a course necessary, though this does not imply the abandonment of the project. On the contrary, it is likely to be expedited thereby.

Cardiff.—At Monday's meeting of the joint Lighting and Tramways Committees it was decided to locate the chief offices and storeroom for these departments above the fish market. The sub-committee appointed to enquire into the tramcars have been asked to complete their work and report at the earliest possible minute. The borough engineer has submitted proposals for the alteration of the existing lines.

Richmond.—The result of the postcard poll on the question of the London United Tramways Company's scheme up to the present is 3,130 in favour, 101 against. Fresh negotiations between the Town Council and the company have now been opened. It is reported that the outcome of a private meeting of the Tramways Committee was of such a nature that appeared likely to give satisfaction to both sides.

London County Council.—On Tuesday the Council unanimously passed a motion instructing the Highways Committee, *inter alia*, to report what extensions were required to perfect the London tube or underground railway system at the earliest possible date. It was also decided to instruct the Parliamentary Committee to take steps to have the views of the Council placed before the Joint Committee of Parliament dealing with these matters.

Shildon.—The United Kingdom Tramways Electrical Syndicate are considering the question of laying down tramways in the Shildon Council's district. It will be remembered that they recently obtained parliamentary powers on similar lines to those which they suggest for Shildon for the north-east portion of the county of Durham. It is proposed to run a quick service of cars, including workmen's cars, night and morning, and to use the overhead electric system.

Burnley.—The Tramways Committee have decided to reduce the tram fares both outside and in for certain stages. It has also been decided to run a 15 minutes service daily, except on Sunday, when a half-hour service will be run until one o'clock noon, followed by a 15 minutes' service in the afternoon. The Tramways Committee have decided to recommend the Town Council to appoint Mr. H Mozley, of Burnley, as manager of the Corporation tramways. The salary is £350 a year, rising to £400.

Tramcar Collision.—An electric tramcar accident of a serious character occurred at Ewood, Blackburn, shortly after 7 o'clock on Wednesday night. It appears that a car from Blackburn overran the points at Ewood, with the result that another car proceeding in the opposite direction, from Darwen, came into violent collision with it. The front of the Darwen car was smashed by the impact, the driver and a conductor off duty, who was riding with him, sustaining severe injuries. Several of the passengers of the Darwen car also were more or less injured.

Walker.—At the monthly meeting of the District Council the Tramway Committee reported upon the Tyneside Tramways Bill, stating that the committees of the Lords and Commons had dispensed with the Standing Order respecting the non-consent of the local authorities, and allowed the Bill to proceed, provided that the Tramway No. 3 be struck out. This had been done, and the Bill would be read a second time and go before the committee in due course. The Council's petition against the Bill had been presented, as also petitions by the Newcastle Corporation and the Northumberland County Council.

Huddersfield.—At the monthly meeting of the Town Council, the Tramways Committee reported that the accounts for the 11 months ended Feb. 28 showed a deficiency of £10,885 17s. 3d., of which £2,560. 4s. 2d. arose upon the steam-power working and £8,325. 13s. 1d. upon the electrically-worked section, but this latter sum includes £7,776. 2s. 1d. for interest and sinking fund. The receipts for February for the steam traction sections were £1,904 1s. 11d., and from the electrically-equipped lines were £620. 17s. 7d. The Council decided that the inside fares shall be the same as the present outside fares on all routes from the 1st prox. for three months.

Blackpool.—The *Blackpool Times*, after announcing that the Blackpool and Lytham tramways have been purchased by a syndicate, states that the line will be doubled without delay, equipped with electrical plant, and provided with the most luxurious cars. The paragraph further states that the line will be continued from Lytham to Freckleton, and then as a light railway to Preston. It has been decided to make an advance of 2s. a week all round on the wages of the tramway employés of the Corporation. Thus drivers will commence at 26s. a week, and length of service and good conduct will eventually entitle them to 30s. Guards are to commence at 24s., rising to 28s. An additional inspector is to be appointed, and preparations are being made in various directions for the inauguration of the new service round Marton.

Halifax.—The traffic report of the Corporation tramways for the past fortnight for the first time this year shows a balance of receipts over expenses, the former amounting to £1 538. 11s. 9d. and the latter to £1 527. 14s. 6d. At the meeting of the committee last week the question under discussion was as to the delivery of 2 000 tons of rails, purchased with a view to tramway extensions *viâ* the proposed lift at Salterhebble to Rishworth and Elland. On the motion that the rails be stored some members wanted to know why, if the rails were not to be used, the contracts for their purchase had been sanctioned. The reply given

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was that the time had arrived for the exercise of caution in regard to tramway developments. Within the next month the Northowram line, it is expected will have been completed to Stocks Arms, the Queensbury line into Queensbury village, and the Hebden Bridge line to the Congregational church at Luddenden Foot.

New Issue.—The Tynemouth and District Electric Traction Company Limited, announce that their share capital will be £80,000, divided into 8,000 5 per cent. cumulative preference shares of £5 each, and 8,000 ordinary shares of £5 each. The whole of the ordinary shares have been issued and paid up. The company was formed to buy up the North Shields and District tramways, and to replace the steam traction by electric traction. The old lines have been considerably extended. They now run from the New Quay, North Shields, through Tynemouth, along the Marine Parade, past Cullercoats, to Whitley Bay. The electric trams are now running upon this route. It is estimated, when the lines are in full working order, the total annual revenue will be £10 440, and the working expenses £5 590, leaving a surplus of £4,850 The dividend on the present issue of preference shares will absorb £1,500 leaving £3 350 for depreciation and dividend on the ordinary shares. The estimated population to be served is 60 800.

Isle of Thanet.—Some successful running trials have already been made in the neighbourhood of St. Peter's with the cars to be used on the new light railway, and it is officially stated that next week cars will go over the whole line. It is expected that the tramways will be ready for traffic at Easter. The power-house at St. Peter's contains two 320-h.p. Allis horizontal engines direct coupled to two 200-kw. generators, and two Bellis and Morcom vertical three cylinder compound engines, 520 h.p., direct coupled to two three-phase generators. There are two batteries of boilers by Babcock and Wilcox, and the surface condensers and cooling tower, which is capable of cooling 35 000lb. of steam per hour, are by the Wheeler Condenser Company. The storage battery of 530 cells is by the Tudor Accumulator Company and the switchboard, generators, and sub-station, electrical equipments, and car motors have been supplied by the British Thomson-Houston Company. A suite of offices for the company's officials is attached to the main building, and detached offices for traction purposes are situate near the entrance to the works. A large car shed with repair shop has been built to hold 40 cars. A siding has been laid direct to the power-house which will give ready access for receipt of coal, etc. For the efficient working of the system, and with a view to future development, sub-stations have been erected at Margate and Ramsgate, to which the current will be sent at high tension, and there transformed for traction and lighting purposes. A track has been laid on the quay at Ramsgate Harbour for the conveyance of coal, etc., over the tramway. The cars, which were built by the St. Louis Car Company, are of the upper deck style, having an enclosed vestibule. Twenty are of the bogie type, and carry 72 passengers. Mr. Arthur A. Tyler is the general manager of the system.

LIGHTING AND GENERAL.

Bristol.—The continuous-current main is to be extended to Milk street.

Imperial Tramways Co.—The directors have declared a dividend of 8½ per cent.

Bournemouth and Poole Electricity Supply Co.—The directors have declared a dividend of 6 per cent.

Bath.—Mr. Francis Teague has been appointed electrical engineer for a further period of three months.

Removal.—Mr. A. R Bennett, Glasgow, has removed from 55 West Regent-street to 65, Renfield street.

City of Birmingham Tramways Co.—A dividend of 5 per cent and a bonus of 5 per cent. have been declared.

Share Market.—There was very little business in electric shares during the week, and prices are practically unchanged.

Globe Telegraph and Trust Co.—The directors have declared an interim dividend of 2s. 6d. per share on the ordinary shares.

Grimsby.—A cable is to be laid down Pasture-street. The cost will be £77, and it is expected that it will pay over 20 per cent.

Llandudno.—The District Council have decided to apply for sanction to a loan of £1,027 for a new feeder from the works to South-parade.

Battersea.—Application is to be made to the London County Council for a further loan of £10,600 in connection with the electric lighting of the borough.

Stoke-on-Trent.—Messrs. Peers and Trentham, electrical engineers, Manchester, have been engaged to make a report upon the proposed electric light installation.

Newport (Mon.).—Colonel Luard has held an enquiry into the application of the Corporation for sanction to borrow a further sum of £23 000 for electric lighting.

Wellingborough.—The draft agreement between the National Telephone Company and the Urban District Council has been referred to the Highway and Lighting Committee.

London Gazette.—An adjudication order has been made out *re* A. J. Greenberg (carrying on business as the Midland Electrical Company), 20, Arthur-road, Erdington, Birmingham.

Stockton.—The Sanitary, Park, and Electricity Committees and the Bridge Board estimate their requirements for the coming year at £14,336, or £290 above their expenditure of this year.

Hart Accumulator Co.—This Company have opened an office, owing to the increase of their business in the Midlands and the North, at Temple-chambers, 33, Brazennose-street, Manchester.

Stock Exchange.—Application has been made to the Stock Exchange Committee to grant a quotation to the British Electric Traction Company's further issue of ordinary shares of £10 each.

Direct United States Cable Co.—The directors have resolved upon an interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum for the quarter ending March 31.

Haslingden.—We understand that the tender of Messrs. Meldrum and Co. for a destructor has been adopted. The borough surveyor is preparing plans and estimates of a destructor and electric lighting station.

Gillingham.—We understand that at the next meeting of the Council it will be proposed that an expert be employed to advise the Council with regard to the proposed purchase of the electric light undertaking in the district.

Buxton.—It is proposed to establish a line of telegraphs between Sheffield and Buxton in order that communication may be improved. The National Telephone Company have decided to commence the laying of underground wires forthwith.

Eastern Telegraph Co.—The directors announce a dividend of 3½ per cent. per annum on the preference stock for the quarter ending 31st inst., and an interim dividend of 1½ per cent. on the ordinary stock for the quarter ended Dec. 31 last.

Cannock.—An arrangement has been made between the Telephone Company and the Postmaster-General by which he delegates his rights to the Telephone Company. These rights have been confirmed by the Urban District Council.

Penge.—The consideration of the question of the supply of electric light for the district has been referred to a committee of the whole Urban District Council, with directions to obtain further expert opinion on the whole question and to report thereon.

Bilston.—At the next meeting of the District Council the terms offered by the Midland Electric Corporation, Limited, for the public lighting of the town will be considered. It is proposed that the Council enter into a contract from Dec 25 next.

Sleaford.—With reference to a note in our last issue, we are informed that the Board of Trade granted the provisional order to the Sleaford District Council last year. Plans have been prepared and tenders have been accepted, and the works are now being actively carried out under the supervision of Messrs. E. Bremner-Smith and Bremner, electrical engineers to the Council.

Dublin.—The Corporation on Monday adopted the report of the Lighting Committee, recommending the acceptance of a number of tenders in connection with the municipal scheme of electric lighting By this action the Corporation has committed itself to a vast undertaking, involving the expenditure of £250 000 The Corporation's action is still bitterly opposed in the local Press.

Personal.—We are informed that Mr. S Thos. Pemberton, at present representative engineer and electrical expert of the Blackman Ventilating Company, is transferring his services on the 1st prox. to Messrs. John Gibbs and Sons ventilating, electrical, and consulting engineers Duke-street, Liverpool. We wish Mr. Pemberton every success in his new sphere of usefulness.

Winding-up.—The petition of C. E. Foster and others for the compulsorily winding-up of the London Electrical Cab Company, Limited, was before Mr. Justice Wright on Wednesday. His Lordship, in dismissing the petition with costs, said he had decided that there were no misfeasance assets to come in, and the official receiver had satisfied him that there were no tangible assets There had been charges of fraud insisted on, and therefore he should allow the costs.

Arbroath.—The Corporation have, as we announced some time ago, resolved that the electric lighting scheme shall be carried out by themselves. However, an agitation amongst shopkeepers and others against this decision resulted in a meeting which was held on Wednesday, and at which the following resolution was carried: "That this meeting is of opinion that before committing the ratepayers finally an opportunity ought to be given by means of a *plébiscite* of saying whether they consider it in the public interest for the Corporation to carry out the provisional order or to hand it over to a company on the best conditions obtainable."

Bradford Workhouse.—Mr. F. H. Bentham, chairman of the Board of Guardians, on Wednesday formally started the steam turbo-dynamo which is to run the electric plant that has been installed at the union workhouse. The installation has been effected from plans and specifications prepared by Mr. A. Bernstein, of Bradford, who has acted as consulting engineer to the Board. The plant consists of a Parsons steam turbo-dynamo of a capacity of 75 kw., equal to 112 h.p., which is capable of maintaining 1,250 incandescent lamps of 16 c.p. at one time. If required, an extra 10 per cent. can be put on that for a period of two hours, while space is reserved in the engine-house for an additional engine should it be required. There is also a smaller dynamo driven by the old laundry engine, and suitable boosting arrangements are made to charge a storage battery of 128 cells, capable of maintaining 300 lamps of 16 c.p for a period of four hours. The new engine was supplied by Messrs C. A. Parsons and Co., of Newcastle-on-Tyne; the dynamo booster, and switchboard by Rosling Appleby, and Fynn, Limited, of Bradford; the cables by Mr. G. A. Steinthal, Bradford; and the battery by the Electrical Power Storage Company, Limited, London. The engine-house has been built from plans prepared by Mr. F. Holland, Bradford.

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Sedbergh.—The District Council have rescinded their resolution passed at the meeting held on Feb. 20: "That the question of electric lighting be left to the new Council," and confirmed the resolution passed at the last meeting that expert advice be obtained on the electric light question.

Norfolk.—Various applications for leave to erect telegraph poles on the sides of main roads have been granted by the County Council; also an application from the National Telephone Company for leave to erect poles on main road from Coltishall to junction of road to Stratton Strawless Hall.

Kensington.—The Council have refused sanction to the laying of an armoured cable under the footway on the north side of Brompton-road by the Kensington and Knightsbridge Electric Lighting Company. The objection was that the whole street would have to be disturbed when the cable was worn out.

Shannon Electric Power Bill.—The conference of representatives of the County Councils of Limerick and Clare which was to have met in the offices of the Limerick County Council, George-street, on Monday, has been adjourned to next Saturday, owing to the failure of a sufficient number of members attending.

Weybridge.—An application of the National Telephone Company for the Council's consent to their laying underground cables from their exchange in High-street to Thames-street and Walton-lane, and near Weybridge Lock, following Church-street and Bridle-road, is before the Highways Committee of the Urban District Council.

Maidstone.—An alteration has been made in the plan of the electric light station by substituting a slate roof for the galvanised iron one provided for in the original scheme. The additional cost is estimated at £90, and ought to be well worth the money considering the accentuation of both heat and cold caused by galvanised roofs.

Statistics.—The National Telephone Company keep a record of the number of telephone messages sent and received by their subscribers, and up to the last report the total for the year amounted to 682,857 864—in other words, if the entire population of the British Isles made use of the telephone it would mean 20 messages per head per annum.

Ham.—At the meeting of the District Council on the 21st inst the Clerk formally reported that at the Board of Trade enquiry the scheme of the Richmond Electric Lighting Company to supply electricity to Ham and Hampton Wick had fallen through. Mr. J. Clifton Robinson wrote that the London United Tramways Company were prepared to supply electric light to Ham at a price not exceeding 4d per Board of Trade unit.

Acton.—At the last meeting of the Urban District Council a hope was expressed that the question of the electric light for the district would be taken up promptly and dealt with by the new Council. Messrs. Neville and Co. wrote stating that they would be glad to know if there was any prospect of a public supply of electric lighting for the district in the near future, as it would influence them as regards fitting up their factory.

Croydon.—At the last meeting of the County Council the Borough Electrical Engineer reported that he had obtained prices for the erection of a generating panel with necessary equipment at the works, and expressed the opinion that this can be efficiently executed, and at less cost, by means of the staff at the station, and suggested accordingly. The Council decided that the work should be carried out by the staff in the manner suggested.

Dunstable.—The Town Council are getting alarmed at the increased number of telegraph wires running through the town. Twelve months ago they made an application for all the wires to be put underground, and received an assurance from the Telegraph Department that no additional wires should be put up, but it appears that now a considerable increase is being made. They have decided to write again, protesting against that increase. Only 12 miles away, at St. Albans, all the wires are underground, and that Council refuse to have an overhead wire in the city.

Gutta Percha Corporation.—Mr. H. Brougham, official receiver, on Monday mentioned the affairs of this Corporation to Mr. Registrar Hood in the Bankruptcy Court. The Registrar, at the previous hearing, said that having regard to Mr. Shenton's evidence he would give Prof. Ramsay an opportunity of submitting himself for examination if he so desired. Mr. Brougham now said he was informed that Prof. Ramsay did not see that any material advantage was likely to be gained by the shareholders, or that his own interests would be served by his giving evidence in the matter.

Heating of Show Windows.—An apparatus is just being placed upon the market by the Allgemeine Elektricitäts-Gesellschaft, Berlin, for the heating of goods exposed in show windows, for the prevention of the settling of steam or ice on the window panes. It consists of an iron frame, in which a number of wires are fixed in such a manner as to prevent short-circuit. The heating resistance is so calculated as to exclude superheating even by maximum load. The contrivance has the advantage that it is not necessary to disturb the goods when lighting or extinguishing it, as this may of course be done by means of a switch fixed anywhere in the shop. It is also less dangerous than the open gas-burners used for this purpose at the bottoms of some windows.

Newbury.—The Town Council recently submitted to the Board of Trade their objections to the Urban Electric Supply Company's application for an electric lighting provisional order. The Board of Trade replied that, regard being had to the failure of the Corporation to give effect to their order, the Board were of opinion that it was desirable that the provisional order now applied for should be granted, and that they proposed to dispense with the consent of the Corporation. The Board further intimated that should the Corporation desire to make any further representations in the matter they would be prepared to arrange for an interview. A deputation has been appointed to wait upon the Board of Trade, and press upon the Board the claims of the Council to their consideration and support.

Sheffield.—At last week's meeting of the council of the Chamber of Commerce it was resolved that the Chamber, having considered the Bill of the Electric Power (Yorkshire) Company, and having regard to the fact that the rights of the Sheffield Corporation have been provided for and saved under the new fortieth clause of the Bill, do hereby declare that in their opinion the company's Bill is conceived in the best interests of the commerce and industry of the locality, and that it must be of great advantage to traders generally that central power stations should be established for the generation and distribution of electric power for motive and general manufacturing purposes at the lowest possible cost, and the Chamber is prepared to support this principle by evidence before the Parliamentary Committee if this be deemed necessary.

Leeds.—At the last meeting of the Gas and Water Committee the Clerk stated that he had communicated with Mr. Medhurst with regard to the price which they inserted in their electric lighting order. Section 1, and the charge for any amount up to 20 units was 13s. 4d. and for each unit over 20 8d. The Board of Trade had passed a general rule, not applying to this order in particular, but to all orders, that the first 20 units had to be 11s. 8d., and all over 7d. per unit. If they objected to that they could oppose it. Mr. Medhurst, however, had based his report on 6d., and therefore he did not object to this. Messrs. Graham then wrote to him, saying that they did not think that the proposed reduction in the maximum price to 11s. 8d. need be objected to, and therefore they could inform the Board of Trade that the Council approved of the rule.

Brighton.—Application is to be made for sanction to borrow a further sum of £850 for electric lighting works. The Lighting Committee have decided to take up and relay about 150 yards of electricity mains in Grand parade so as to allow of the necessary concrete for the wood paving of the tramway route to be laid. The cost of the work is £200. They have also accepted the quotations of Messrs. Babcock and Wilcox for the supply and fixing (exclusive of brickwork) of two additional water tube boilers, to be used in connection with the tramway electric lighting plant, for the sum of £2 150; also for the necessary steam, feed and other piping in connection therewith, for the sum of £643. The amended draft, conferring upon the Council the power to carry on telephonic business within the Brighton telephone area, fixes May 1 as the date for the commencement of the term. Mr. H. H. Law has held an enquiry into the application of the Town Council for sanction to the borrowing of £19 600 for purposes of electric lighting.

Bromley.—The Bromley Urban District Council have informed the Rural District Council that they had had under consideration the question of obtaining cheaper terms for telephone communication with the district, and with that view they had considered the question of applying for a license from the Postmaster-General. As, however, the district was within the metropolitan area and as it was understood that the Post Office authorities proposed to provide a system themselves, they would be glad if the resolution passed by them were brought before the Rural District Council, to ascertain whether they would be prepared to make a joint application to the Post Office authorities, with a view of such installation being laid as soon as possible. The resolution passed was to the effect that all parishes within the Bromley Union that are situated in the metropolitan district be asked to unite with the Council in approaching the General Post Office with a view of an installation being commenced by them in the district at the earliest possible moment. It was decided to accede to the request of the Bromley authority.

Tunbridge Wells.—We learn that Mr. H. Boot is pushing forward with the extensions, and hopes to have the new engines running next week. Mr. Boot will then be in a position to meet all demands. On Wednesday last a deputation from Brighton, including the Mayor, were conducted over the works, and they expressed themselves highly delighted with what they had seen. On the same day, says the *Kent and Sussex Courier*, the wind blew one of the arc lights out of position, and this somewhat interfered with a circuit of about 20 other lamps. It was at once detected, and the incandescent lamps were switched on. The arc lamps were then put out a few minutes before the usual time. The incident was immediately telephoned to a Press agency in London, and on the following day a paragraph appeared in the halfpenny London papers of a most sensational character, stating that there had been a failure of the electric supply, and that the town was placed in darkness. The paper is justly indignant, because such slipshod reports are most damaging to the town and its officials. Mr. E. A. Sandford Fawcett has held an enquiry into the application of the Corporation to borrow £10,000 for the establishment of a municipal telephone system in the borough and surrounding districts.

Eastbourne.—Mr. E. A. Sandford Fawcett has held an enquiry into applications for sanction to an additional loan of £50 362 on account of extensions of the electric light undertaking. The Town Clerk gave particulars of the application stating that loans of £36,635 for the purchase of the electric light undertaking and £2,000 for subsequent extensions had been previously sanctioned and raised. It was understood at the time that these extensions would be necessary, and it was on the recommendation of Mr.

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Hawtayne that the Council resolved, for the sake of the economical working of the undertaking, to replace some of the antiquated machinery by newer appliances and to remove the generating station to a site at Roselands, already the property of the Corporation. The borough accountant had prepared a report as to the first year's working, which allowing for interest and other charges, showed a balance of £834 11s. 2d. As to the Decoy and Low Level-road, etc., the Council asked to be allowed to borrow £3,000 for the purchase of the land, about 32 acres, and the remainder of the sum applied for was to enable them to fulfil their covenants as to making-up roads on property belonging to the Duke of Devonshire and Mr. C. Davies Gilbert, who were liable, however, to the repayment of a considerable amount of this as the building estate was developed. This statement was supported by the testimony of the various officials in attendance. At the termination of the enquiry the inspector visited the electric light works and the Decoy.

Hackney.—At the last meeting of the Council the Electric Lighting Committee reported on the question of the use of the river frontage of the electricity and refuse destructor works at Millfields for wharfage, etc., by the construction of a dock. The cost of carrying out this work is estimated at £1 250. The Lee Conservancy Board will accept a rental of £25 per annum for the occupation of the land, the Board at the same time undertaking to offer no objection to the construction of the dock as proposed. Subject to the satisfactory completion of the negotiations, the proposed works of the construction of the dock, for which tenders have been invited, are to be carried out. The committee further reported that as the time is not far distant when the works will be in a position to supply electricity, it is necessary that all proper steps should be taken to ensure a good demand. The price to be charged for lighting—viz., 4d. per unit—is a very moderate one, and there should be no obstacle in the way of the supply becoming popular and electricity being placed within the reach of the small consumer. It is obvious, however, that many of the small consumers could not be expected to bear the initial cost of wiring and fitting their premises at an approximate cost of from 20s. to 30s. per lamp, and this initial cost has hitherto severely operated against the expansion of electricity supply amongst this class of consumer. The free wiring system in vogue in various places has disposed satisfactorily of these difficulties, as by this method consumers may get their premises fitted up free of cost, the only monetary consideration being that a small rental per lamp has to be paid to the company undertaking the wiring, etc. There is no doubt that a system of free wiring in Hackney would have a material effect in promoting the development of the electric lighting undertaking, but the Borough Council under the Electric Lighting Acts and the provisional order has no power to borrow money for the purpose. The engineer has estimated that the wiring for the number of lights estimated for in his original report would involve the following capital outlay: first year, £7,000; second year, £5,000; third year, £8 000; fourth year, £10,000. It is proposed that the Borough Council enter into an agreement for the free wiring of consumers' premises at a rate not exceeding 2s. per lamp (for any lamp up to 50 c p.) installed per annum, and the Electric Lighting Committee will consider schemes on this basis, submitting the name of the firm they recommend to the Council for effecting this purpose.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Hackney Borough Council £30,000 for electric light installation, and the Hammersmith Borough Council £13,530 for a similar purpose. There were 112 applications for the appointment of resident foreman of the generating station in connection with the electric light installation for the Victoria-embankment and Westminster Bridge. Mr. Robert Simpson is to be appointed in the engineer's department to act as foreman, and to reside at and to take charge of the machinery and staff of the generating station. Permission was granted to the National Telephone Company to run a telephone cable into the Victoria-embankment subway through the base of the pedestal in course of erection for the Boadicea statuary group. Sanction was also given to notices under Electric Lighting Acts and Orders as follows: Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1899, to lay high-tension mains along a portion of Clareville-grove; County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, to lay low-tension mains along Odell-street and Dartnell-road, and across Longcroft-road, under the Wandsworth Order, 1892, to lay low-tension mains along both sides of Hopton-road, Streatham, and under the St. Saviour's Order, 1896, to lay mains of low and extra high tension along Newcomen-street to Great Maze-pond; London Electric Supply Corporation, to lay high and low tension distributing mains along a portion of and across Borough High-street, and to construct underground converter boxes; Notting Hill Electric Lighting Company, to lay mains along a portion of and across Dawson-place; County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, of intention to lay high and low tension mains along Heathfield-road, Alma-terrace, Trinity-road and Nicosia-road, and low-tension mains along Routh-road, Lyford-road, and Magdalen road, and to construct a transformer box in Nicosia-road, and under the Battersea Order, 1900 to lay high and low tension mains along Trinity-road and Hendham-road, and low-tension mains along Burntwood lane, and to construct a transformer box in Hendham-road; the Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains (*a*) along and across Brompton-road, and (*b*) along a portion of Victoria-road; the London Electric Supply Corporation of intention to lay high-tension distributing mains along Charing-cross, Whitehall, Downing-street, Parliament-street, and Charles-street; Metropolitan Electric Supply Company, under the West London Order, 1889 of intention to lay low-tension mains along York gate, Marylebone road and Brunswick-place, and under the Mid-London Order, 1889, to lay high-tension mains along Tower-street and Upper St. Martin's lane.

Aberdeen.—In connection with the resolution of the Aberdeen Town Council to sanction experimentally the erection of lamps in the centre of the tramway track in Union-street, the Watching and Lighting Committee of the Council had a meeting last week for the purpose of considering the matter. In order to have a practical test of the safety of the proposed experiment, says the *Aberdeen Journal*, a model of a lamp in wood was manufactured, the diameter at the base being 16in., and tapering gradually upwards to the lamp, which was erected at a height of about 16½ft. from the ground, and several feet higher than the top of the tramway cars. The model was erected opposite the Municipal Buildings and was lightly fixed at the base, but was also further supported by a couple of ropes attached to the top of the lamp and held by two men. While the committee were sitting in the town house, Councillor Wilkie, convener of the Tramways Committee; Mr. D. Moonie, the manager; and Mr. Lewis Anderson, lighting inspector, watched the traffic in the street. The cars passed quite clear of the lamp-post, but if a passenger were to project his head over the car it would come in contact with the lamp-post. Councillor Ross tried this experiment, and the lamp-post touched the crown of his hat. A projecting umbrella would also probably touch the standard. About 20 minutes to four o'clock a Bayview car, in which were a pair of light greys, approached the lamp-post. One of the pair was evidently frightened either at the post or the ropes being held by the two men and shied, springing partly upon the other horse farthest from the pole, and it lost its footing and fell. The first horse struggled a little, and came within an inch or two of kicking the standard. Mr. Moonie came to the rescue, and both horses were detached from the car to allow the harness to be adjusted, which was done, and the fallen horse having been raised, the car proceeded. The incident, however, created a considerable amount of interest, and it was considered to be somewhat an unfavourable omen for the success of the central pillar arrangement. When cars cross a given point there is a distance between them of 48in. When a lamp of the diameter of the base of the model is erected there is only 16in. clear on each side of the base of the lamp. The remit from the Council in regard to the erection of Kitson lamps in Union-street was remitted with full powers to the Lighting Sub-Committee. The committee then considered the effect of the dummy lamp erected in front of the town house, and the committee had a couple of cars drawn up in order to see what space would be available between the car and the pillar. The opinion of the committee was that when the lamps were erected first a guard should be put upon all the cars at the top to obviate the possibility of any danger to passengers. This proposal the convener and the committee agreed to see carried out, and negotiations will at once be proceeded with. It is expected that 12 standard lamps will be erected in Union-street between Union-terrace and Holborn-street. They will be of 1,000 c.p. each.

NEW COMPANIES.

The following new companies have been registered since our last issue:

C. G. Reed and Sons, Limited.—Capital, £22,500. Object: to adopt an agreement with C. G. Reed for the acquisition of the business carried on by him at 26, North street, 58 King-street, and in North-road, Brighton, to develop the same, and to carry on business as ironmongers, engineers, millwrights, electricians, etc.

East Coast Automobile Company, Limited.—Capital, £2 000. Object: to carry on the business of motorcar and automobile owners, manufacturers, hirers, and letters on hire of automobiles, carriages, and vehicles of all kinds, etc.

Pritchetts and Gold, Limited.—Capital, £40,000. Object: to adopt an agreement for the acquisition of the business now and hitherto carried out under the style or firm of Pritchetts and Gold, to develop and extend the same, and generally to carry on business as manufacturers of and dealers in storage batteries and accessories; as electrical engineers, makers of electrical appliances and machinery, etc.

Hedges, McKrell, and Co., Limited.—Capital, £1,000. Object: to acquire the business of electricians, etc., as carried on by Hedges, McKrell, and Co. at 31 and 34, Barbican, E.C., to develop the same, and generally to carry on business as electrical engineers, makers of electric tramcars, motorcars, etc.

Public Undertakings Syndicate, Limited.—Capital, £10,000. Object: to carry on business as constructors and controllers of public works and conveniences of all kinds, to include rail and tram roads, docks, piers, canals, wharves, drainage, water, gas, electric light, telephones, telegraphs, electric energy, and supply works, etc.

New Electric Lamp Regenerating Company, Limited.—Capital, £80,000. Object: to adopt an agreement made by this Company with C. W. Milne, and to carry on in all or any of their respective branches the businesses of lamp manufacturers, electric and mechanical engineers, etc.

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PROVISIONAL PATENTS, 1901.

MARCH 18.

5688. Self-fastening rail bond for electrical connection of rail. John William Shepherdson, 89, Albion-street, Leeds.

5662. Improvements in electric heaters. Alexander Ritchie Leask and Percy Morgan Bellis, 11, Southampton-buildings, Chancery lane, London.

5700. Improvements in or relating to electric clocks. Johann Pöschl and Johann M. Gautsch, 111, Hatton-garden, London. (Complete specification.)

MARCH 19.

5712. Improvements in electrical switches. Henry Lomax, Ralph Lomax, and John Tomlinson, 57 Barton-arcade, Manchester.

5714. Improvements in hand-fed arc lamps. George Smith and Herbert Hampton Hall, 57, Barton-arcade, Manchester.

5719. Self-lubrication (without oil) of the swivelling spindles or forks connected with "trolley heads" used on the overhead trolley system of electric tramway cars. Thomas Beaumont Birkby and Frederick Ernest Birkby, Woodfield Mills, Liversedge, Yorks.

5723. Improvements in apparatus for changing illuminated advertisements and for other purposes, the switch connected therewith being also applicable for electric lighting generally. Peter Mushet and Charles Plow Eggar, 154, St. Vincent-street, Glasgow.

5754. Improvements in mounting incandescence electric lamps. Ernest de Pass, 78, Fleet-street, London. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

5764. Improvements in obtaining zinc by electrolysis and apparatus for that purpose. Ludwig Mond, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5766. Improvements in the working and controlling of electrically-driven cars. Siemens Bros. and Co., Limited, Alexander Siemens, and A. Mervyn Duke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5786. Improvements relating to telephonic apparatus comprising conversation counters or meters. Henrich Eichwede, 18, Buckingham-street, Strand, London. (Complete specification.)

5808. An improved single or duplex electric clockwork switch for turning on and off electric light every half minute, or for longer or shorter period, for illumination or advertising purposes. Thomas Joseph Phippe, 199, St. Alban's-road, Watford.

MARCH 20.

5868. Improvements in ships' telegraphs for gunnery purposes. Sydney Evershed and Evershed and Vignoles, Limited, 1, Queen Victoria-street, London.

5868. Improvements in electrical heating apparatus. Richard Wade Boyd, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 21.

5921. Improvements in life guards for electric tramcars or the like. Dionysius Newton, Lombard-chambers, Bixteth-street, Liverpool.

5952. An improved watertight cover for electric cut-outs, switches, joint-boxes, and the like. Hugo Hirst and Thomas Henry Bacon, 71, Queen Victoria-street, London.

5954. Improvement in armatures for dynamo-electric machines and the like, and in the manufacture of the same. Joseph Matthews and William Davies, 77, Colmore-row, Birmingham.

5964. Improvements in or relating to electric railway signals. Alfred Julius Boult, 111, Hatton-garden, London. (Jonathan David Price and William Henry Council, United States.) Complete specification.)

5975. Improvements in carriers for glow lamps. Carl Colsman and Alfred Colsman, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5985. Improvements in and relating to current collectors for electric railways on the overhead system. August Reinecke and Adolf Jost, 322, High Holborn, London. (Complete specification.)

5987. Improvements in carrying telephone and telegraph wires across streets and protecting the trolley wires or overhead wires of electrical tramways therefrom in case of breakage. Alfred William Bennis, 6, Bakn-street, Manchester.

6004. Improvements in means or apparatus for driving dynamos on railway and other vehicles from the axles thereof, and for connecting such dynamos and batteries to lighting, heating, or other circuits on such vehicles. Frederick John Beaumont and William Mudd Still, 46, Lincoln's-inn-fields, London.

6006. Improved armature core for electric generators. Gerhard Koppelmann, 322, High Holborn, London. (Complete specification.)

MARCH 22.

6016. An automatic electric cut off. Edward Phipps Appleyard, 28, Bradford-avenue, Manchester.

6018. An improved insulated glove. Francis Pegler and James Joseph Warry, 15, Water-street, Liverpool.

6041. Improved contrivance for concealing slack wires on lifts, arc lamps, wall plugs, ceiling pendants, and the like. William Brown, 229, Munster-road, Fulham, London.

6042. Improvements in printing telegraphs. Leo Camm, 27, Powell-street, Goswell-road, London.

6043. Trolley conductor insulated fitting for electric tramways and railways. Frank Gustav Kleinsteuber, 52, Chancery-lane, London.

6076. Improvements in apparatus for the generation and electrolytic application of electric currents. Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Partly by John Oliver Surtees Elmore, India.)

6085. Improved terminal for electric wires. Eardley Delauney Billing and Alfred Dunhill, 1 and 4, Mitre-court-chambers, Fleet-street, London.

MARCH 23.

6095. Improvements in transformers and the like. William Ernest Burnand, 119, St. Mary's-road, Sheffield.

6096. Improvements in and relating to electric arc lamps. Llewellyn Burbank Codd, 211, Woodborough-road, Nottingham.

6097. Improvements in storing up waste power by balance weight for enabling electric and other tramcars or vehicles to travel up and down very steep inclines with perfect safety. Thomas Greenwood, 249, Burlington-terrace, Queen's-road, Halifax.

6104. Improvements in or connected with the trolley wheels used in overhead electrical traction. Robert Lighton Ross and Robert Bridge, 5, John Dalton-street, Manchester.

6107. Improvements in electrical measuring instruments. Arthur Cecil Heap and William Oliver Smith, Century Works, Lewisham, London.

6118. An electric fog and danger railway signal. Harry James Everatt and Arthur Tewson, 30, Holborn, London.

6125. Improvements in incandescent electric lampholders. George Herbert Parr, 111, Hatton-garden, London.

6137. Improvements in or relating to starting and controlling electromotors. Wilfrid Swanwick Boult, 111, Hatton-garden, London.

6161. Method of and apparatus for controlling single-phase alternate-current motors. Siemens Bros. and Co., Limited, and Francis Lydall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6164. Improvements in and relating to accumulator plates. Eduard Francke, 27, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on April 13.

1900.

4934. Current-feeding devices for electric meter tramcars or the like. Johannes Wilhelm Ehlers and Lambert Wheitz.

5650. Asynchronous rotary converters and other dynamo-electric machines. Thompson. (Helios Electricitäts Actien-Gesellschaft.)

5567. Electric contacts or couplings. Andreas.

5598. Electricity meters. Wright and Reason Manufacturing Company, Limited.

5649. Telegraphic apparatus. Sidney George Brown and Joseph Arthur Lovel Dearlove.

6237. Electrical gas-igniting apparatus. Schwarzenbach.

6936. Switches for electrical circuits. Moy and Ernest F. Moy, Limited.

6947. Dynamo-electric machines. Lamme. (Date applied for under International Convention, Feb. 26, 1900.)

7237. Electric railways with underground conductors. Henne and Schönfelder.

7795. Electric light fittings. Calderbank.

8289. Insulated electric cables or conductors and the manufacture thereof. Heyl-Dia.

8290. Insulated electric cables or conductors and the manufacture thereof. Heyl-Dia.

9059. Electromagnetic brakes for railway and tramway vehicles. Newell.

9060. Electromagnetic brake shoes for railway and tramway vehicles. Newell.

9212. Trolley or like current collectors for electric railways and tramways. Killip.

9279, Supports for electric conductors. Lorain and Dennery.

9563. Electrolysing process for zinc and other salts with soluble anodes. Abel. (Soc. des Piles Electriques.)

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9697. Process of depolarizing by liquid circulation in galvanic batteries. Abel. (Soc. des Piles Electriques.)

10219. Electric energy meters. Wise. (Lux'sche Industriewerke Actiengesellschaft.)

10511. Manufacture of negative or spongy lead plates or elements for secondary batteries or electrical accumulators. Electrical Power Storage Company, Limited. (Butler and May.)

15006. Method of suspending the moving parts of an electric integrating meter or other instruments. Fell. (Stanley.)

17726. Dynamo-electric generators. Batchelor. (Batchelor.)

18089. Electric railways and tramways on the closed-conduit system. Marzi.

22572. Electrostatic machines. Schall. (Messrs. Reiniger, Gebbert, and Schall.)

22842. Regulating device for electric current generators. De Hoor, Reinitz, and Stark.

1901.

466. Electric switches. Lake. (Globe Manufacturing Company.)

1010. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Thomson.)

1167. Electric meters. Mathiesen.

2346. Trolley repeholders for electric cars. Clayton.

2370. Battery electrodes. Liddle. (Globe Electric Company.)

2493. Method for obtaining electric currents from the earth. Jahr.

2570. Telautographs and methods of telautographic transmission. Newton. (Gray National Telautograph Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Mar. 23	550	518	+ 32	28 116	24.565
Birmingham Trams.	,, 23	4 019	3 960	+ 59	47 518	—
Blackburn Corp'rat'n	,, 22	407	370	+ 37	4 662	4 2235
Blackpool Corporatn.	,, 21	213	162	+ 51	30 376	22,378
Blackpool-Fleetwood	,, 23	162	188	- 26	1 736	1 872
Bolton Corporation..	,, 24	1.238	848	+ 390	16 538	9 209
Bradford City Trams	,, 24	800	350	+ 459	9,167	4,189
Bristol Tramways Co.	,, 23	3,575	2,400	+1,175	—	—
Carlisle Tr'mw'ys Co	,, 22	117	—	—	1,330	—
Central London Ry.	,, 23	6,189	—	—	73 007	—
City & South London	,, 24	2 092	1,353	+ 739	—	—
Cork E. T. and L. Co.	,, 21	344	310	+ 34	3,991	3 491
Dover Tramways ...	,, 24	154	137	+ 17	1 844	1,723
Dublin & Lucan E.R.	,, 16	72	89	- 17	774	630
Dublin U.T., elec. cars	,, 22	3 076	2,778	+ 298	—	—
Dublin S.D. Electric	,, 22	645	565	+ 80	—	—
Dundee Tram Co. ...	,, 13	569	350	+ 219	—	—
Glasgow Corporation	,, 23	8,338	8,070	+ 268	—	—
Halifax Corporation	,, 11	776	598	+ 178	37 247	29.269
Huddersfield Corp'n.	,, 23	680	575	+ 105	35 328	32 351
Hull Corporat'n E.S.	,, 23	1 483	694	+ 789	70 266	—
Liverpool Corporat'n	,, 16	8.048	7,014	+1,034	85 905	73 516
Liverpool Overhead	,, 24	1.475	1,219	+ 256	17,744	16,860
Portsmouth Corpn...	,, 23	472	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	,, 24	2 912	—	—	—	—
Southampton Trams	,, 21	594	234	+ 270	—	—
Southport Corporat'n	,, 16	a443	—	—	7 011d	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. b Since April 1, 1900. d From July 18, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Electric Railways.—			
Central London, Ordinary	10	–	39-39½
—— Pref. Half-Shares	5	–	4½-5
—— ,, ,, deferred	5	–	2-2½
City and South London, Consolidated Ordinary	100	–	46-50
—— Ordinary	10	–	4-5
—— 4 per cent. Debenture Stock	100	–	112-117
—— 5 per cent. Pref. Stock '91	100	–	122-127
—— ,, ,, ,, '96	100	–	122-127
Liverpool Overhead, 5 per cent. Pref.	—	–	12-12½
Waterloo and City, Ordinary	100	–	94-97
Telephones.—			
National Telephone, Ordinary	5	–	2½ 2¾
—— 6 per cent. Cum. First Pref	10	..	11-12
—— 6 per cent. Cum. Second Pref	10	..	10-11
—— 5 per cent. Non-Cum. Third Pref.	5	..	4¾-4¾
—— 4 per cent. Deb. Stock, Red.	100	–	97-100
—— 3½ per cent. Deb. Stock, Red.	100	–	90-92
Colonial Telephone and Electric Company	1	–	½-¾

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-1
Arca Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-120,000	1	–	11/16-12/16
British Electric Works, Ordinary, 80,001-90,000	1	–	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	–	2/-6-5/16
—— 4½ per cent. First Mortgage Debentures	100	–	88-90
British Insulated Wire, Ord., 1-70,000	5	–	10 11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	–	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4½-5
Brush Electrical Engineering, Ordinary	5	–	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	–	2½ 2¾
—— 4½ per cent. Debenture Stock	100	..	102-106
—— 4½ per cent. 2nd Debenture Stock	100	–	102-102
Callender's Cable, Debentures	100	–	109-112
—— Ordinary	5	–	15-16
—— 5 per cent. Pref.	5	–	5-5½
Crompton and Co.	5	–	5½ 5¾
—— 5 per cent. Debentures	—	–	100-105
Edison and Swan United, Ordinary	5	–	1½-2
—— 5 per cent. Debentures	5	–	3-4
—— 6 per cent. Deb. Stock, Red.	100	–	87-90
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	–	98-100
Electric Construction, Limited, Nos. 1 to 112,100	1	–	1½ 1¾
—— 7 per cent. Cumulative Pref.	1	–	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-120,000	1	–	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	–	15-16
—— 4½ per cent. Preference	5	–	5-6
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	21-22
—— 6 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	10	–	37-41
—— 5 per cent. Bonds	100	–	101 104
Telegraph Manufacturing, Ordinary	5	–	11-12
—— 5 per cent. Cum. Pref.	5	–	5-6
Williams and Robinson, Ordinary, 1-80,000	5	–	11½-12½
—— 6 per cent. Cum. Pref., 80,001-90,000	5	–	6½-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	–	103-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-181,200	1	–	¾-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	–	70-75
Bournemouth and Poole, Ordinary	10	–	12½-13½
—— 4½ per cent. Cum. Pref.	10	–	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	–	7½-8
—— 7 per cent. Preference	5	–	8½ 8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	–	6½-7½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	–	4½-5
Chelsea Electricity Supply	5	–	5½ 6½
—— 4½ per cent. Debentures	100	–	109-113
City of London, Ordinary	10	..	7-8
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	–	101-103
County of London and Brush Provincial, Ordinary	10	–	8 9
—— 6 per cent. Cum. Pref.	10	–	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	103 106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4½-5½
—— 4½ per cent. First Mort. Deb.	100	–	103-106
Electric Lt. & Traction Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	–	4½-5½
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	–	5½-6½
Hove Electric Lighting, Limited, Ord., 1-11,000	5	–	7½-8
Kensington and Knightsbridge and Notting Hill	100	–	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9½-10½
London Electric, Ordinary	8	–	1½ 1¾
—— 6 per cent. Pref.	5	–	3-4
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	12-13
—— ,, 80,001-86,760	5	–	2-2½
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
—— 5½ per cent. Mortgage Debenture, Red	100	–	97-100
Notting Hill Electric Lighting	10	–	13½-14½
Oriental, 1879	1	–	1½-1¾
—— 55 Shares	5	–	7-7½
—— 44½ Shares, New	4½	–	3½-4½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	–	5½-6½
River Plate Electric Light and Traction, Deb.	100	–	65 75
Royal Electrical Company of Montreal	$100	–	200 220
—— 4½ per cent. First Shares Mortgage Debentures	$100	–	19-25
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 6 per cent. Debenture Stock	100	–	89-90
South London, Ordinary	5	–	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	13½-14½
—— 7 per cent. Pref.	5	–	5½-6½
—— 5½ per cent. Deb.	100	–	98-101
Westminster, Ordinary	5	–	11½-12½
—— 80,001-100,457	5	–	11½-12½
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-15
Brisbane Tramway Invest., Ltm., Ord., 1-75,000	5	–	3-4
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	..	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	97-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	–	6½-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-35,000	10	..	10-10½
—— 4½ per cent 1st Mt. Debs., Nos 1-5,750 of £40 each	40	..	100-102
British Electric Traction, Ord., 1-300,000 & 60 001-90,000	10	–	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10	–	11½-12½
—— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,800	5	–	4½-5
—— 5 per cent. Deb. Stock, Red.	100	–	104-107
—— Prov. Cert., all paid	100	–	96 99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	–	1½-1¾
Dublin United Tramways (1896), Ord., Nos 1-60,000	10	–	13-14
—— 6 per cent. Pf., Nos. within 1-60,000	10	–	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100	–	98-102
Kidderminster and District Lighting and Traction, Pref.	5	–	3½ 4
London Street Tramways, Nos. 1-81,000	4	–	12-13
London United Trys., 4 per cent. 1 Mt. Deb. Stk., Prov. Crts.	100	..	103-104
New General Traction, Ordinary	5	–	3-3½
—— 6 per cent. Cum. Pref	10	–	6½-7½
Oldham, Ashton, and Hyde Tramway, Ordinary	20	..	104-106
—— 5 per cent. Cum. Pref.	10	–	11½-12½
Potteries Electric Traction, Ordinary, 26,867-40,000	10	–	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
—— 4½ per cent. Debenture Stock	100	–	107-109

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INSTITUTION OF ELECTRICAL ENGINEERS.

Some Notes on Polyphase Sub-Station Machinery

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Polyphase systems of generation and transmission, combined with direct-current distribution from sub-stations, are very much in evidence at the present time in connection with many large lighting and traction schemes, and there is little doubt but that the use of such combined systems will greatly extend in the future for those cases where power has to be supplied in very large amounts over large areas. The author thought, therefore, that a paper embodying some notes on the subject might be of interest to many members of the Institution; and, complying with a request of the President, the scope of the paper has been confined as far as possible to practical questions of everyday working that have come within his own experience. Consequently many of the points discussed must be quite familiar to those members who have worked in the same direction, who must kindly bear in mind in this connection that the author does not profess to put forward anything new, but merely to bring up for discussion some working notes on the subject.

In the following pages, then, the general ideas underlying the equipment and operation of polyphase sub-stations are first dealt with, and this is followed by some features of working, and a comparison of the different types of machinery that can be employed for the work under consideration, together with some details and examples taken from actual practice. It is always to be understood that the author has in mind the case in which very large amounts of power (transmitted at high pressures) have to be handled—the modern case, in fact. Moreover, on account of their greater commercial importance, three-phase systems are more particularly considered.

I.—Sub-Station Equipments for Lighting or Traction.

Considering the general case, applicable to large towns, the polyphase current will be sent over the transmission lines from the distant power station, usually arriving at the various sub-stations in the supply area at a pressure between 5,000 to 10,000 volts between lines, according to the length of the feeders and amount of power to be transmitted; the work to be done comprises the conversion of the whole of the current in question into direct current at 2 × 220 volts for lighting, or 500 to 550 volts for traction, together with the provision of means for regulating the current and feeding it into the low-pressure networks comprised in the area. It can be done by three different types of sub-station, each type embodying a distinct class of equipment, as set out more particularly below; the size of the units in the sub-stations will vary in general between 300 kw. and 1,000 kw. individual output.

(*a*) *Asynchronous Motor-Generator Equipment.*—This type of sub-station equipment consists in the employment of a number of polyphase induction motors driving an equivalent number of direct-current generators; the motor-generator units will be of such a size that the high-pressure current can be led directly into the motors, and consequently the equipment and operation of the sub-station will be of the simplest possible character. No starting gear has to be provided beyond a simple rotor resistance for each motor, there is no synchronising to be done, and the regulation on the direct-current side is made on the fields of the generators, either by hand or by compound windings in the usual way. The author does not know of a single case in which polyphase motors of large size (either synchronous or asynchronous) are operated with transformed current. The construction of such motors lends itself so well to high insulation of the stator that motors as small as 150 h.p. can be perfectly satisfactorily (and cheaply) built for pressures of 5,000-6,000 volts. With the large units required for sub-station work, it does not pay from either the technical or commercial point of view to employ step-down transformers—at any rate up to 10,000 volts. If the motors are less than about 500 h.p. individual output, and the pressure greater than this figure, it may pay to employ transformers, because the amount of slot insulation required will probably be found to be excessive, necessitating the employment of motors of large dimensions compared with their output. The trouble with high-pressure working without transformers in the sub-stations is, as a rule, in the switch gear for the motors; but great improvements have been made in this during recent years, and at the present time there is very little to fear in this respect.

With the high-pressure current led directly into the motors, the best arrangement for the sub-station will usually consist in employing starting switch pillars for the motors, these standing close against them, the direct-current board being away against a wall. The rotor resistance and stator starting switch would be interlocked, and thus, as each switch pillar is self-contained, the starting up of each set is performed by one movement of a handwheel, this taking the place of the engine stop-valve in a steam plant. The employment of a starting switch pillar adjacent to the motor possesses the great advantage of reducing the length of the heavy rotor cables to a minimum (an important point), while security of working is assisted by interlocking the starting gear. Of course, if the motors are provided with permanently short-circuited rotors, an auto-transformer device in the stator takes the place of the rotor resistance; this feature of construction and method of working is not advisable however, being for work of the character in question far inferior to that referred to above. It should be borne in mind, in this connection, that it is standard practice nowadays to build all induction motors of large size (having wound rotors and slip-rings), with an arrangement for short-circuiting the rings and lifting up the brushes after once the motor has attained full speed, thus limiting wear (and loss) on the rings to the period of starting up—30 seconds as a usual maximum figure. If direct current is available at the sub-station, being derived from a motor-generator already running or from another sub-station, it is perfectly possible to start up the sets as they are wanted from the direct-current side. Under certain circumstances this method of operation will give good results, but in general it is not so convenient as that first described, and consequently rarely used. In any case it is necessary for one or more units in the sub-station to be provided with rotor resistances or equivalent devices, so that they may be started from the alternating-current side whenever this may be necessary. For feeding three-wire systems, each motor would drive two direct-current machines each of half its output, one at each end of the shaft, the two machines being in series; or the motor would drive a single generator of the same capacity, feeding the outers, auxiliary devices being used in the usual way for balancing the lead.

(*b*) *Synchronous Motor-Generator Equipment.*—With this equipment, synchronous polyphase motors operated at the line pressure take the place of the induction motors referred to above; conforming with standard practice the synchronous motors would be of the revolving-field type, the exciting current being led into the field system by means of slip-rings and brushes. A sub-station with such an equipment will also be of a very simple character, but not quite so simple as the foregoing; this is on account of the necessity for synchronising the motors before switching them in, because the starting arrangements are more elaborate, and also because the synchronous motors are not self-exciting. The excitation of the motors would usually be effected from direct-coupled exciters, or from separate (induction) motor-driven exciting sets fed by step-down transformers, or from the 'bus bars; frequently the latter method, in conjunction with either of the former methods, will prove to be the most convenient. The performance of synchronous motors depends so much upon the field adjustment (see later remarks), that a well-designed field regulator for each motor is a necessity. The starting of the motor-generator sets may be effected in several ways. By far the best way from every point of view is to start them from the direct-current side, the direct current being derived from the 'bus bars, if other machines (or sub-stations) are running, or from a small auxiliary direct-current generator driven by a low-pressure induction motor, if no direct current is available at the switchboard. Of course, as soon as the first machine is running, all the others can be started from it, but it must be remembered that it is always necessary to provide means for starting up any motor-generator in the sub-station from the alternating-current side, either directly or indirectly. One of the best possible adaptations of the above arrangement is to provide an auxiliary (asynchronous) motor-generator which can be used for exciting and starting the main units when required. This auxiliary set would be shut down as soon as one or more of the main units is in operation, direct current thus being available at the 'bus bars. If the low-pressure network is arranged to be partly fed or balanced by accumulators, the starting and exciting would naturally be effected initially from these, and the whole arrangement becomes one of great simplicity. This is, however, not the general case.

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The operation of switching in a synchronous motor-generator started in this way is, of course, very simple. The set being brought up to approximately synchronous speed and excited to the right value, the correct speed (as indicated by the synchronising lamps) is attained by regulating the fields of the direct-current machine now running as a shunt motor with all main resistance out. At the right moment the main high-pressure switch is closed, and after this the direct-current main resistance perhaps short-circuited. Finally, the fields of both motor and generator are adjusted, the latter in order to take up the load, and the former in order to regulate the idle current of the synchronous motor. Assuming that no direct current is available, the next best method of starting up the motor-generator sets, together with their direct-coupled exciters, is by means of starting motors. On a bracket at that side of the motor-generator remote from the exciter an induction motor is placed, the rotor being mounted directly upon the extended shaft; this motor would be fed from a step-down transformer, and would have a capacity of about 10 per cent. of the full-load output of the main unit. The number of poles on the starting motor would be fewer than the number of field poles on the synchronous motor, being such that it can bring up the set to a speed somewhat higher than that corresponding to synchronism, in spite of the load on it due to the iron losses and excitation of the main unit, and the friction and ventilation losses of the combination. Moreover, the starting torque of this auxiliary motor must be high, it being preferably attained by the employment of a non-inductive rotor resistance. This latter is also of value when synchronising, although not absolutely necessary. To start up, then, all that has to be done is, firstly, to speed up the combination by switching in the starting motor, and cutting out the rotor resistance until the combination is at maximum speed; secondly, close the field circuit of the synchronous motor, and regulate the exciting current to get the correct pressure; thirdly, reduce the speed by slowly adjusting the rotor resistance, until the synchronising lamps indicate exact synchronism. Then switch the synchronous motor on the line, and afterwards cut out the starting motor and adjust both field systems as before. If the starting motor is constructed with a permanently short-circuited rotor (conforming to American practice), the rotor windings being of comparatively high resistance and the stator fields very strong (in order to get the necessary starting torque), then the third operation above will consist in switching out the starting motor altogether as soon as the correct value of field current has been attained. The speed of the combination will, of course, immediately drop, and the main switches must be closed as the speed passes synchronism, as shown by the pulsations on the lamps. Naturally, the operation of putting the motor on the line cannot be so well done under these circumstances, and hence, as stated above, if a starting motor has to be used at all, it is better to use a rotor resistance in conjunction with it. It may be mentioned, however, in this connection, that if the generating sets in the power station and the synchronous motors in the sub-station are well designed, and particularly if the latter machines are fitted with damping coils, the synchronous motors will pull themselves into step without doing any harm if they are switched in at approximately synchronous speed, and consequently careful adjustment may be omitted in cases of necessity. But careful adjustment is always advisable, particularly if the motor is thrown in parallel with a number of machines already running, or if the power station is lightly loaded, for the efforts made by the incoming machine to pull itself into exact synchronism may start the other motors hunting.

The third method of starting up a synchronous combination is referred to more particularly below, in connection with rotary converters; it consists in starting up from the alternating-current side by opening the field circuit of the synchronous motor, and then connecting the armature directly or indirectly to the line. The necessary torque is produced by the hysteresis drag, helped by eddy currents circulating in the pole-pieces or damping coils, and is consequently small. The method has nothing to recommend it, although frequently used, and, moreover, a little consideration will show that its employment implies a motor of low efficiency at full load, as otherwise the above-mentioned losses in conjunction with the armature currents would not be great enough to get the necessary torque. Apart from the question of power factor, the running performance of synchronous motor-generators is very similar to that of asynchronous machines, and, moreover, under proper conditions of supply, they are equally reliable.

(c) *Rotary Converter Equipment.*—Sub-stations equipped with rotary converters are of a far more complicated character than either of the types previously discussed, due to the special character of the machines and regulating devices. Although the rotary converter possesses similar characteristics to those of the synchronous motor, and also to those of the direct-current machine, yet it possesses in addition a number of special features having a large influence on its performance, the result being that even when such machines are working under the very best conditions they cannot compare with regard to simplicity of operation with either asynchronous or synchronous motor-generators. The first point to be noted in connection with the equipment of a rotary converter sub-station is that the rotaries require to be operated at low pressure. The pressure between any two slip-rings, whatever the nature of the armature winding, is always a definite percentage of that on the direct-current side with a given pole width, being about 61 per cent. for three-phase and about 71 per cent. for two-phase rotaries,* consequently step-down transformers have always to be inserted between the slip-rings of the converters and the high-pressure feeders. For the large capacity units under consideration, separate transformers are always used for each phase of the transmission line; but it may be noted here that, for small three-phase or six-phase rotaries (up to about 100 kw. capacity) it is always preferable to use three-phase transformers for the purpose, for, owing to their common magnetic circuit, possible pressure variation between the phases of the three-phase transmission becomes reduced in amount, as such transformers form excellent balancers.

In two-phase work, there will be two transformers per rotary; in three-phase or six-phase work of the character under consideration, there will be three. The manner in which these transformers are connected up in the two latter cases is of importance, and therefore a brief reference may be made to it here. Considering first the three-phase case, it may be stated at once that as a rule the best arrangement of the three transformers will be to connect them up in a "mesh" on both high and low pressure sides. This is principally because in the event

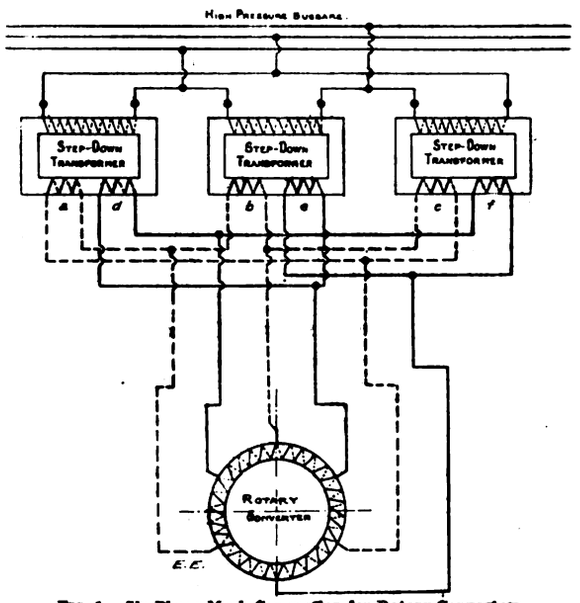

Fig. 1.—Six-Phase Mesh Connection for Rotary Converters.

of one transformer developing a fault and blowing its fuse, the supply need not be interrupted for a moment, for the remaining two will continue to supply a three-phase current to all three phases of the rotary; the reactions in the latter tend to keep the arrangement symmetrical, and the phases equally balanced. Under these circumstances the rotary can be kept fully loaded over the period of emergency, if not too long—naturally, the increase of heating in the two transformers doing all the work must be carefully watched. If the transformers had been "star" connected, single-phase current would be delivered under the same circumstances, and the rotary would have to be immediately cut out on account of the heavy sparking that would occur at the commutator; even supposing sparking to be absent, the machine would not be able to carry anything like its full load over the period of emergency, and, moreover, the system would be thrown greatly out of balance. Another advantage (of secondary importance) with mesh-connected transformers is that the secondaries are cheaper to wind, because the area of the copper in the winding is 58 per cent. of the copper area for the corresponding "star" connected transformer.

One advantage of the star connection lies in the fact that the space taken up by the primary winding of each transformer is somewhat less in comparison, because the pressure across each transformer is only 58 per cent. of the full line pressure, and hence winding space is saved, on account of the reduction in the insulation. This is, of course, an advantage, especially when dealing with pressures of the order of 10 000 volts, but, in the author's opinion, it is one not to be

* These are the no-load values—when the machine is loaded they are naturally departed from to a small extent on account of the armature drop. Moreover, if the impressed pressure wave is not sinusoidal, the values given will be departed from.

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compared with the safeguard against total breakdown afforded by the mesh connection.

Exactly the same arguments apply to the six-phase case, in which the secondaries of the transformers are arranged with either a double mesh or a double star connection, but preferably the former, as indicated diagrammatically in Fig. 1. It will be seen that this connection makes use of two distinct mesh connections, one superposed upon the other, the two meshes being in electrical connection through the armature windings of the converter. It is obtained from three single-phase transformers, similar in all respects, each being wound with two equal secondary windings. The three secondary windings, *a b c*, are mesh connected, and led to three slip-rings in connection with the armature winding of the rotary at points 120 (electrical) degrees apart, while the three secondaries, *d e* and *f*, are also mesh connected, but in the opposite direction; the three conductors from the points of this mesh are taken to the remaining three slip-rings on the shaft of the rotary, which are in connection with points on the armature winding 120 (electrical) degrees apart, and lying midway between the tappings to the three slip-rings first mentioned. A little consideration will show that under these circumstances, and because one-half of the secondary of each transformer is cross-connected relatively to the other half (the two halves differing therefore 180deg. in phase), the two meshes differ half a cycle (180deg.) from one another, and consequently satisfy the six-phase condition.

While the six-phase connection for rotary converters is more complicated and somewhat more expensive than the three-phase, yet it will undoubtedly pay to use it; as a

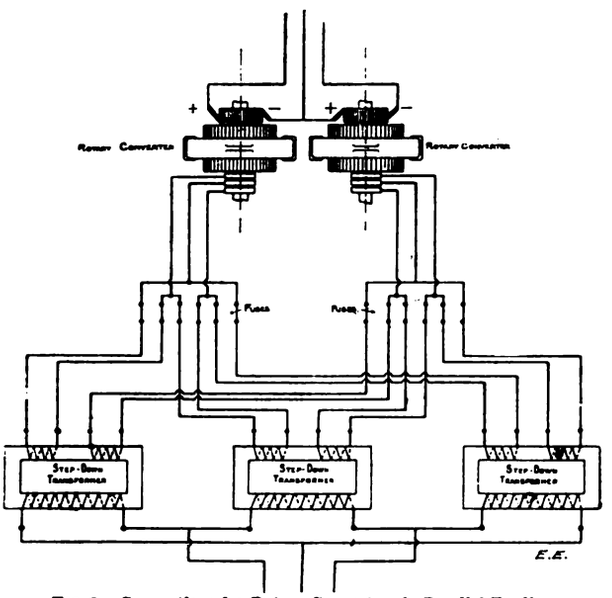

Fig. 2.—Connections for Rotary Converters in Parallel Feeding Three-Wire System.

matter of fact, it is somewhat surprising that the merits of this form of connection do not appear to be generally recognised, for Steinmetz and Kapp long ago pointed out that the output of any given rotary can be increased 40 to 50 per cent. by its use—that is to say, for the same mean heating of the armature coils a six-phase rotary has an output 40 to 50 per cent. greater than the three-phase rotary, according to the value of the power factor of the alternating-current side. As the output of any well-designed rotary converter is determined solely by the permissible temperature rise (there being no distortion of the field flux under usual working conditions—power factor approximately unity), this increased output is a great practical advantage. Another advantage of the six-phase connection with rotary converters is that the heating of the armature is much more uniform—as is well known, in two and three phase rotaries those portions of the armature winding on each side of the tappings to the slip-rings heat up considerably more than the remaining portions of the winding. With a six-phase winding the maximum temperature rise on the winding will rarely exceed the minimum by more than 20 per cent. It is not probable that the 12-phase connection will take a place in practice, for the gain in still further increase of output and uniformity of heating would be more than counterbalanced by the increased cost and complication. On account of the fact that all rotary converters have to be fed from step-down transformers, the switch gear becomes more extensive, for although, as a rule, not necessary, it is good practice to provide switches in the secondary circuits of the transformers. There is, however, one case where such switches are absolutely necessary, and that is for two-phase rotaries arranged for starting from the direct-current side. In this case, unless the transformer secondaries are open, they become short-circuited (at the moment of starting) upon the armature winding, causing a great increase in starting current, and violent sparking at the commutator, until the machine is well towards full speed. The heavy-current switches in the secondary circuits are best mounted upon or close to the transformers, which latter should be close up to the rotaries, in order to reduce to a minimum the pressure drop, losses, and cost of the heavy conductors.

Before leaving the subject of the transformer connections for three-phase rotary converters, it may be mentioned that a case sometimes arises in practice in which a special transformer arrangement is necessary. When two or more rotaries are not arranged to be fed (for any special reason) from separate groups of transformers on the alternating-current side, and they are connected to a three-wire network on the direct-current side, then it is necessary to wind each unit forming the group of (two or three) transformers feeding the rotaries with a multiple secondary winding, as described above, the arrangement being as shown in Fig. 2, illustrating the connections for two machines. That is to say, it is impossible to operate a number of rotaries feeding a three-wire network from common 'bus bars on the alternating-current side. The reason is readily apparent from the figure—the slip-ring sides of the machines cannot be *directly* paralleled, owing to the connection already existing on the direct-current side—if they were directly joined a disastrous short-circuit would naturally result. It may be noted in passing that the arrangement of the fuses in the secondary circuits of the transformers shown in this figure* (each conductor coming from a slip-ring is fused twice) is a good one, for if one transformer gives out, the service will not be interrupted, for the reason already given above. There is, however, a certain advantage in using *star-connected* transformers for converters feeding three-wire systems, for by the adoption of this form of connection better balancing can be attained; the secondary neutral points of each group of transformers may be profitably connected to the middle wire, which latter may or may not be earthed. Under these circumstances each rotary would be fed from a separate group of transformers.

The next question arising in connection with the equipment of a rotary converter sub-station is that of pressure regulation. It is clear that with motor-generator sub-stations (whether asynchronous or synchronous) this question hardly comes in, for, as already indicated, the regulation is performed wholly on direct-current machines of standard design, either automatically or by hand, in the simplest possible manner. The conditions are, however, quite different with rotary converters, because the pressure on either side is practically totally independent of the field strength (although not of the field configuration), and consequently the direct-current pressure cannot be varied by regulation on the fields alone. There are two commercial ways of regulating rotary converters, each depending upon the same principle—namely, that of altering the pressure on the slip-rings in order to get a corresponding alteration on the direct-current side. As already pointed out, the ratio of the two pressures is practically a constant. The first method consists in varying by hand the impressed pressure on the slip-rings, and can be employed in two ways—either the impressed pressure can be altered by altering the ratio of transformation of the step-down transformers, or it can be altered by means of an "induction regulator." In the first case, the step-down transformers are so arranged in conjunction with a multiple-contact switch that either the number of secondary turns, or the number of primary turns, can be altered by hand, thus altering the ratio of transformation; the transformers supplying each rotary have their regulating switches interlocked, so that the turns are cut in or out simultaneously. It is obvious that this method has several disadvantages, the most serious being those of first cost and difficulty of operation. If the regulation is performed on the primaries, the switches become somewhat difficult and expensive to construct properly, on account of the high pressure of the circuits into which they are connected, while if the regulation is performed on the secondary sides, the expense becomes even greater, on account of the heavy currents to be handled, while the difficulties that arise with the contact surfaces of all regulating switches for heavy currents are well known. But in addition there is the difficulty of arranging such switches to regulate gradually, and to avoid short-circuiting the sections of the transformer winding connected to the contacts of the regulator, as these sections are being cut out or in. Consequently the employment of an induction regulator which does not suffer from any of the above-mentioned defects, and which has but small losses as a rule, will give the best results if hand regulation of the rotaries is asked for or desired. On account of difficulties connected with insulation, induction regulators should be connected into the secondary circuits of the step-down transformers. As usually constructed, such regulators consist of an iron core arranged in connection with a shunt and

* This arrangement of fuses for such a case originated with the General Electric Company (U.S.A.).

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series winding in each phase in such a manner that a movement of the core will decrease or increase the mutual induction between the two windings. Thus if the core is moved inwards, the pressure on the converter slip-rings is reduced, on account of the inductive action of the shunt winding on the series winding, while as the core is moved outwards the effect of the shunt coils on the series coils become less and less, until at the end of the travel of the core the pressure on the slip-rings is practically the full pressure of the transformer secondaries. Such an apparatus is easy and cheap to construct, and very effective in operation, a range of 6 per cent., up or down, being easily attained; moreover, it can be readily arranged to be operated from a distance, and having no contacts or moving conductors, is unlikely to get out of order.

A modification of the induction regulator, first devised, the author believes, by Mr. M. B. Field, is shown in Fig. 3; it possesses the advantage of being somewhat more efficient than the induction regulator described above. The secondary of each step-down transformer has an extension in the form of some extra turns capable of carrying about 25 per cent. of the full secondary current: these extra turns are connected to a small regulating switch, and to the windings of smaller section of a small auxiliary transformer (with ratio, say, 1 : 4) as shown. The secondary of the auxiliary transformer is in series with the low-pressure circuit, and adds or subtracts a small E.M.F. to this circuit as desired. It will be seen that both the voltage and current can be very readily handled without undue expense, and, moreover, the supply is not interrupted should the regulating switch get out of order. The second method of varying the impressed pressure on the slip-rings of the rotary, in order to get the desired direct-current pressure, is of considerable technical interest. Briefly, it consists in compounding the rotaries, and providing a certain amount of self-induction

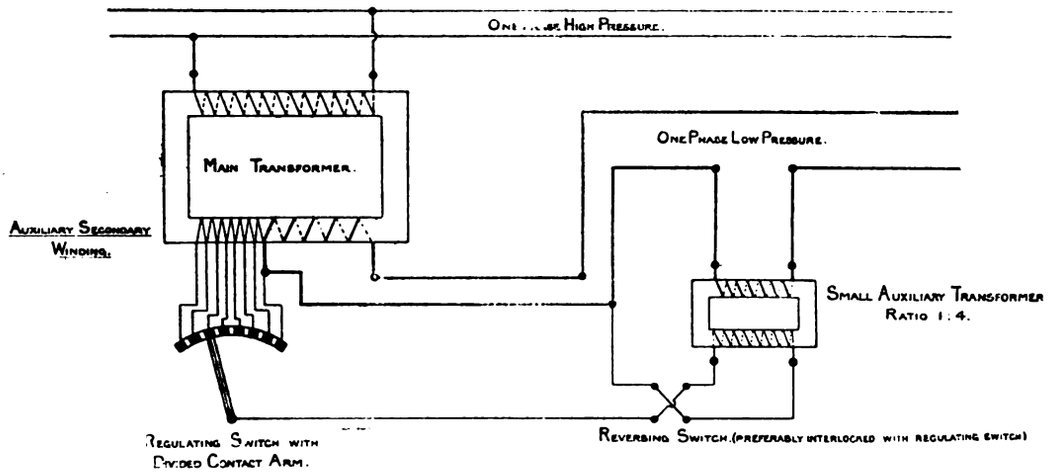
One ... ase High Pressure.
Main Transformer.
Auxiliary Secondary Winding.
One Phase Low Pressure.
Small Auxiliary Transformer Ratio 1 : 4.
Regulating Switch with Divided Contact Arm.
Reversing Switch (preferably interlocked with regulating switch)

FIG. 3.—Diagram of Connections for one form of Induction Regulator.

between the terminals of the transformer secondaries and the slip-rings of the machines, if not already existing, by inserting choking coils in the various leads. The rotary converters, being synchronous machines, operate at a power factor determined wholly by the field excitation, for an alteration of the latter with a given load on the machines increases or decreases the power factor of the alternating-current circuits; for each load on the rotary there is, of course, a certain excitation that will make the power factor a maximum, in accordance with the well-known "V" curve. Let, now, the shunt winding on the fields of a rotary converter, arranged with compound winding, and, if necessary, with small choking coils, be so adjusted that when operating at no load, the machine takes a certain amount of lagging current, say, 30 to 40 per cent. of the full-load current, partly due to the under-excitation, partly due to the reactance in each phase. As the load comes on the field flux increases, on account of the current in the series winding—that is, the lagging current diminishes, and, therefore, the impressed pressure increases, producing a corresponding rise in the direct-current pressure. This strengthens the fields still more (on account of the shunt winding), until a balance between the two pressures is attained. At full load the field flux is at its working maximum. The input current will be by this time leading, due to the over-excitation having wiped out the lag produced by the reactance, and the direct-current pressure will be raised to the correct value, on account of the increased pressure on the slip-rings. By suitable proportions of the reactance and field windings, excellent pressure regulation can be attained in this way in a perfectly automatic manner. It is perfectly easy to arrange for the direct-current pressure to be over-compounded 10 to 15 per cent., the actual regulation being nearly as good as with an ordinary over-compounded direct-current machine,* provided

* With a rotary converter of standard design, the change of field flux necessary in order to get the desired amount of over-compounding is much greater than is required with the equivalent direct current machine, for the direct-current pressure is not proportional to the field flux, but proportional to the impressed pressure on the slip-rings.

the pressure at the ends of the feeders in the sub-stations is maintained as nearly as possible constant. The only objection to this method of regulation is the influence it has upon the regulation at the feeding points—that is, at the high-pressure 'bus bars in the sub-stations—for with a number of the latter in parallel, the variation of the power factor naturally means that the attainment of constant pressure at the ends of the feeders becomes a difficult matter.

The extent to which over-compounding of rotaries can be carried—by means of the above-described method—depends mostly upon the rating of the machine with regard to the work it has to do. The limit is of course reached when the current running into the rotary is made to lead (by increasing the exciting current) the impressed pressure by 90deg., for then the inductive E.M.F. of the choking coil (which is 90deg. behind the current) is in phase with the impressed pressure, and consequently boosts it by that amount; if the current lags behind the impressed pressure by 90deg., the inductive E.M.F. of the coil is half a cycle behind the impressed pressure, and diminishes the latter to a value given by subtracting the inductive E.M.F. of the choking coil from the impressed pressure. Neither of these limits are found in practice, for if the angle or lag or lead exceeds certain well-defined values (depending upon the shape of the "V" curve—that is, upon the armature reaction of the machine), the rotary will naturally not carry its rated load. The more liberally rated is the converter the greater is the range of regulation attained; if the amount of over-compounding required is large (say 15 to 25 per cent.), the rotary must be chosen large for the work it has to do, although not in this proportion. Compound-wound rotary converters are connected and paralleled on the direct-current sides in precisely the same manner as similar direct-current machines, equalising 'bus bars and switches being used, and therefore the same precautions have to be taken with them should accumulators be used in parallel with the low-pressure feeders.

From what has already been said, it will readily be seen that of the two good methods put forward for regulating the pressure on the direct-current sides of the machines, that best adapted for the requirements of lighting work is given by the employment of induction regulators, allowing the pressure to be gradually varied by hand in accordance with the slowly varying load; for traction work, the employment of compound windings—that is, regulation by lagging and leading currents—is preferable on account of the large range of regulation required, and the rapid variations of the load. In some special cases, however, the combination of the two methods will give very good results. With regard to the starting of rotary converters, all the remarks already made regarding the starting of synchronous motor-generators are applicable, as the only difference in this respect between the two classes of machine is that rotary converters are invariably arranged to be self-exciting from their direct-current sides. Wherever possible then, such machines should be arranged to be started from the direct-current side, either from the 'bus bars, or from an auxiliary asynchronous motor-generator. As in the other case, this latter indirect method of starting is far preferable to any other, if no direct current is available at the switchboard. The next best method to this is that given by induction motors directly coupled to the shafts of the rotaries, while the fourth and last method available (briefly noticed already in connection with the starting of synchronous motors) simply consists in switching the machine directly on the high-pressure lines. As

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this method has been put forward in connection with several important British schemes, and is in use in more than one of them at the present time, it may not be out of place to devote a few words in its consideration, although in general the method is objectionable. Any modern synchronous polyphase motor can be started up without difficulty from the high-pressure lines, no matter how constructed—that is, whether the field poles be solid or laminated, whether provided with damping coils or not, etc.—it is only a matter of sufficient starting current and good mechanical design. This method of starting, as used in connection with rotary converter plants, is as follows: The direct-current main and field switches are opened, only a voltmeter being left across the direct-current side, and then the line current is switched on the slip-rings, either at full or reduced pressure, this latter being arranged for by an alteration in the number of secondary turns on the step-down transformers. Owing partly to the eddy currents in the pole-pieces, metal cheeks of field bobbins, damping coils (where these are used), but principally to the hysteresis lag in the pole-pieces, the rotary immediately starts, and is very soon up to synchronous speed. The voltmeter (already referred to) on the direct-current side indicates nothing at the moment of starting beyond very feeble oscillations of the pointer, for the current traversing its coils is, of course, alternating; but as the rotary increases its speed the pointer begins to move backwards and forwards over the scale, its movements corresponding to the rapidly diminishing frequency of the pressure at the direct-current terminals; when synchronous speed has been reached the voltmeter pointer will again be steady, for the current through it is now a direct current. The proper time for putting on the field current is just before synchronism is reached, and is indicated by the voltmeter; when the beats of the pointer are slowest—that is, just below synchronous speed, when the pointer is moving slowly from side to side over the scale—the field current can be put in. But it may be noted here that it makes all the difference at which side of the scale the pointer is when the field circuit is closed; one side is right and the other wrong, depending upon individual circumstances. If the fields have been put on when the pointer is at the wrong side of the scale, then the polarity of the direct-current side of the converter will be reversed; with most machines this means that the rotary must be switched out and synchronised again in order to get synchronism at the right pole. In order to make quite sure that the machine has synchronised at the right pole, it is good practice to provide a pole indicator on each direct-current panel, so that after the excitation has been put on the polarity of the direct-current side can be checked before the rotary is connected to the direct-current 'bus bars. Needless to say, a lamp can be substituted for the voltmeter mentioned above across the direct-current terminals—it will be bright at the first moments of starting, and also when the neighbourhood of synchronous speed is reached, while between these limits the light will pulsate, and the excitation should be put on when the light is pulsating slowly, the lamp being either bright or dark, according to circumstances.

It will be readily understood that the above remarks regarding the right time to put on the excitation in order to get the right polarity are only applicable to the case of self-exciting machines; if the machine are 'bus excited, which is very seldom, the converter will pull itself round under protest to the correct polarity with a great rush of current, no matter at which pole the machine has synchronised. A point worthy of note is that even without the exciting current the rotary will come up to absolute synchronous speed, for there is no induction motor action with the rotary converter or synchronous motor. A rotary converter can operate without field excitation, by reason of the heavy lagging currents that would run through its armature windings under these circumstances; these wattless currents magnetise the fields to the extent necessary to produce the balancing back E.M.F. of the armature. However, such a method of operation cannot be commercial, for the machines would not carry their rated load; the heavy lagging currents would overload the mains and destroy the pressure regulation of both sides of the system, and the rotaries would spark and hunt. Up to the present, the author has not made any tests on the operation of large rotaries without field excitation, for there is generally little time for such experiments when putting down plant, and, moreover, they may turn out to be somewhat costly. It is an interesting question, however, and it would be of value to know from those who have actually made tests on large units under commercial conditions whether the objections given above are as real as they appear to be. Perhaps with machines having high armature reaction (small air-gaps, etc.) the full load could be carried without the machine stopping, but its performance under these circumstances could hardly be otherwise than poor, quite apart from the bad effect produced on the system; moreover, rotaries with considerable armature reaction have a greater tendency to hunt than those with very stiff fields. When starting a converter in the manner above described, it is necessary to take certain precautions until synchronism is attained. The series field windings must be open as well as the shunt, and these latter windings must be opened in five or six places, otherwise they would break down, due to the large E.M.F. (many thousand volts) induced in them by the alternating flux of the armature. Also, as the starting current will never be less than twice the full-load current, even if damping coils are used, and will frequently be of the order of three or four times the full-load current, it is necessary to make arrangements for short-circuiting the ampere-meters and fuses, otherwise they would be damaged by the overload. The great objections to the above-described method of starting are, of course, the large starting current required and the risk of getting the wrong polarity. The former will wholly upset the pressure regulation of the system, partly on account of its magnitude, but principally because of its low power factor, while the latter might cause an accident, and in any case would cause time to be lost when adding a machine to the circuit. For lighting work the employment of this method is absolutely out of the question.

II.—Some Features of Working.

With regard to the asynchronous motor-generator sub-stations, there is practically nothing to be said, on account of the simple character of the equipment and its operation. Two points must be kept in mind, however—the sets must be run as fully loaded as possibly, and the motor air-gaps must be watched. As the power factor of the motors will be less than 90 per cent. below three-quarter load, running the machines well loaded becomes even of greater importance than with other classes of electrical machinery, in order to avoid heavy lagging currents in the feeders. As a matter of fact, it is a good thing to overload such motor-generators (in moderation) before adding a machine to the 'bus bars, for then a high power factor over a wide range of load is assured. The risk is very small, on account of the

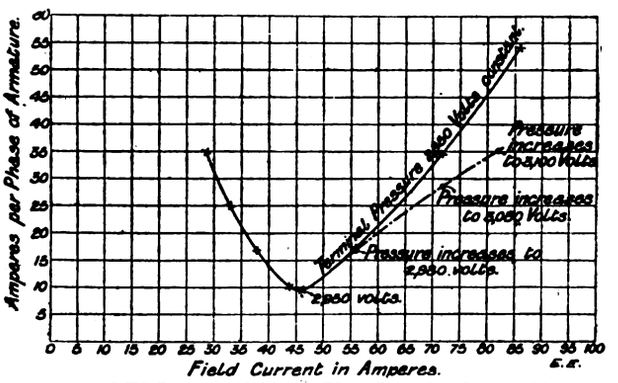

Fig. 4.—"V" Curves for 650-b.h.p. Three-Phase Synchronous Motor. Constant Speed. Constant Load.

rapidity with which another set can be started up and put on the circuit. The other point just mentioned—relative to the air-gaps—is of some importance on account of the small clearance in the motors. As with all induction motors, the air-gap length is determined wholly by mechanical considerations, being made as small as possible in order to get high power factors, it becomes necessary to check it from time to time in order to make sure that the gap at the bottom has not decreased to a dangerous extent. With large induction motors the gap (iron to iron) will be originally about 1/450th of the rotor diameter. A 200-b.h.p. motor would thus have a clearance of 0·1in. with a rotor diameter of 3¾ft., so it will be seen that no considerable diminution of this length can be allowed on account of the magnetic pull, even assuming exceptionally stiff shafts. The stator case of such motors should never be cast with the bed-plate, for if it is separate a thickness or two of metal foil can be inserted between the feet of the case and the bed-plate seatings, by removing which the gap at the bottom can be increased when the brasses have worn to such an extent that something must be done, and yet not enough to justify their replacement altogether. With sub-stations employing synchronous machinery, such as synchronous motor-generators or rotary converters, several highly interesting and important features of working present themselves. The first is the regulation of the power factor, and has already been mentioned in connection with rotory converters, the power factor at any load on the machine can be regulated to the extent necessary in practice by adjusting the field excitation. The curves shown in Fig. 4 give a good idea of the practical case; they are curves taken for the purpose of this paper from the 650-h.p. Kolben three-phase motor forming part of the motor-generator illustrated in Plate I., and whose test curves are given in Fig. 6. The shape of the no-load "V" curve of a synchronous machine is an indication of its performance—a very broad curve indicates, for instance, a motor of but moderate over-load capacity, and one that will require but small alterations in the excitation for varying loads; while a

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very steep curve indicates a machine that must work always with its excitation properly adjusted, otherwise its overload capacity will be small and its parallel running properties inferior. At the same time this latter type of curve is a characteristic of machines with close pressure regulation. When the machine is loaded, the "V" curve alters somewhat with regard to position and shape on account of the increased armature leakage, as indicated in Fig. 5. The amount of this alteration is an indication of the quality of the armature design in this respect—the smaller the alteration in shape, and the less the inclination of the axis, *a b*, from the vertical, the smaller the pressure drop, and the smaller the increase of excitation necessary for the motor from no load to full load in order that it may work under the best conditions. Synchronous machines, whether motors or generators, should be so designed that the shape of their "V" curves lies between the two limits mentioned above, for then excellent parallel running, high over-load capacity, and good pressure and excitation regulation will all be attained; otherwise one or other of these necessary good qualities will be attained at the expense of the remainder. Running as generator, then, the full-load drop of the machine at constant speed and excitation should be in the neighbourhood of 5 to 6 per cent. with 100 per cent. power factor, and 18 to 20 per cent. with 80 per cent. power factor. Better regulation than this is not asked for in modern practice with units of medium and large output; nor is it desirable, especially when sub-stations employing synchronous machinery are fed from them; with better regulation abnormal synchronising currents may pass between the main units, inviting hunting on the part of the rotary converters or synchronous motors. Of course the generators would become at the same time much too heavy and expensive.

Returning to the actual no-load "V" curve shown in Fig. 4, it will be seen that when running practically without load, at the constant impressed pressure of 2,950 volts per phase, attained by regulating the bus-bar pressure in the power station, the excitation for the minimum armature current of 9·5 amperes is 46 amperes. A reference to the no-load characteristic of the machine (Fig. 5) shows that with this minimum value of armature current an induced pressure of 2,250 volts per phase is attained. With minimum armature current at a given load, the difference between the impressed pressure and the back pressure—that is, the difference between 2,950 and 2,250 volts in this case—is a measure, among other things, of the quality of the motor from the point of view of pressure regulation; the difference between the two pressures under these circumstances is due to the impedance of the armature and to the pressure and current beats which occur with all synchronous machinery. With a constant load and excitation on a synchronous motor or rotary converter, the back E.M.F. is continually changing its phase relative to the impressed pressure, a result directly due to variations in the angular velocity of the generators, assisted by the momentum of the machine itself. At constant impressed pressure a decrease or increase of excitation, corresponding to a decrease or increase in the back E.M.F., causes a fairly rapid increase of the armature current (and apparent watts) taken by the motor. At a given load for any value of the motor excitation, a definite value of back E.M.F. takes such a (mean) position in the vector diagram that the resultant of it and the impressed pressure has a value equal to the impedance pressure of the armature. If the excitation be increased above the value corresponding to maximum power factor, the impressed pressure at the terminals of the motors must of necessity lag behind the current in order that the above-mentioned relations are maintained; for the impedance pressure has a constant phase angle relative to the current in a given machine. On the other hand, if the excitation is less than the critical value, then the impressed pressure must lead the current for the same reason. From the "V" curve, and knowing the various losses and constants of the machine, it is possible to make an approximate calculation of the amount of lead or lag that can be given to the current. For this 650-h.p. motor running light the maximum lead works out to be about 75deg., while the maximum lag is about 70deg. In general, it is not possible to obtain more of the "V" curve than shown in Fig. 4, for, if pushed much farther, the running of the motor becomes unstable, hunting is set up, and the machine drops out of step. The two legs of an experimentally obtained no-load "V" curve always differ—one is invariably straight, the other convex (cp. Fig 3). In this respect the curves thus obtained from well-designed commercial machines differ somewhat from the theoretical curves, in which, as Steinmetz has proved, one leg is convex, the other concave. This difference between theory and practice in this respect is due to armature reaction and to the influence of the highly saturated armature teeth when the current is greatly leading or lagging. The dotted curve to the right of the "V" curve (Fig. 4) illustrates clearly what happens in a

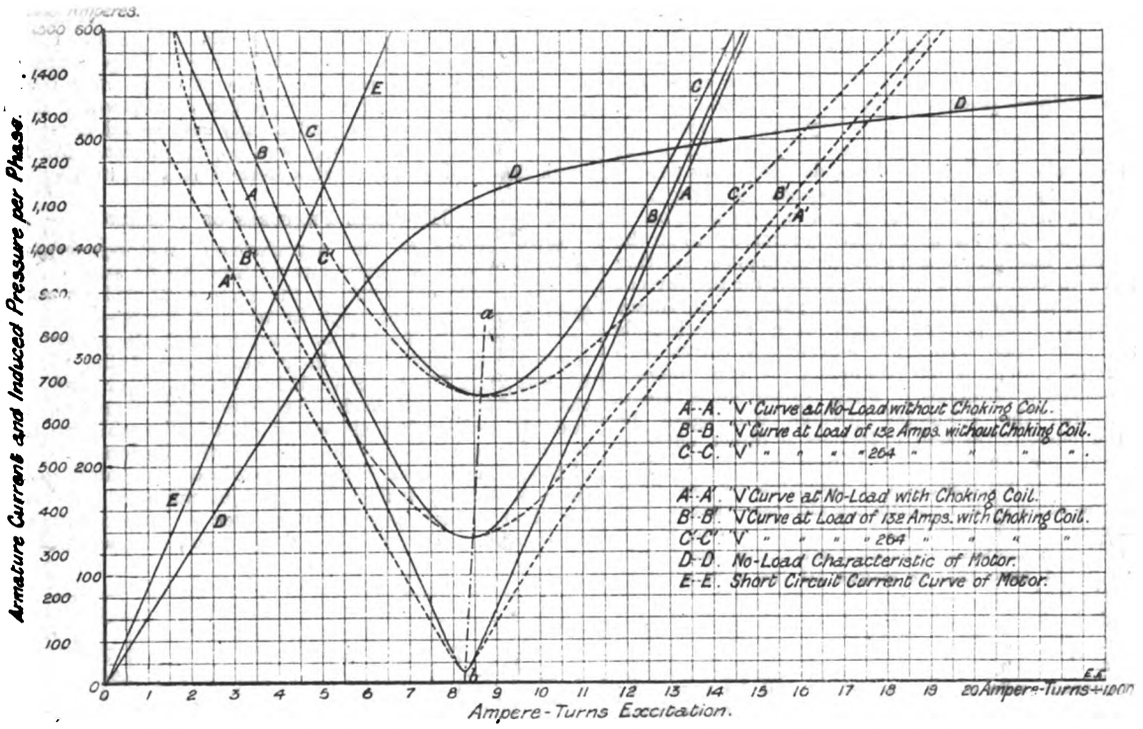
Armature Current and Induced Pressure per Phase.
Ampere-Turns Excitation.
A-A. V Curve at No-Load without Choking Coil.
B-B. V Curve at Load of 132 Amps. without Choking Coil.
C-C. V " " " " 264 " " " " .
A'-A'. V Curve at No-Load with Choking Coil.
B'-B'. V Curve at Load of 132 Amps. with Choking Coil.
C'-C'. V " " " " 264 " " " " .
D-D. No-Load Characteristic of Motor.
E-E. Short Circuit Current Curve of Motor.

Fig 5.—"V" Curves for 725-b h.p Two-Phase Synchronous Motor at Constant Pressure. Constant Speed. Three Different Loads.

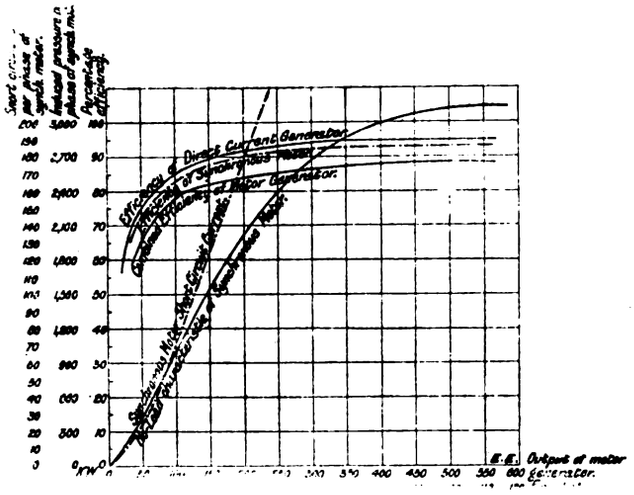

Fig. 6.—Results of Tests on 450-kw. Synchronous Motor Generator.—Prague Tramways. Speed, 240 revolution per minute. Frequency, 50 cycles. Volts, 3,000/600 650 per phase.

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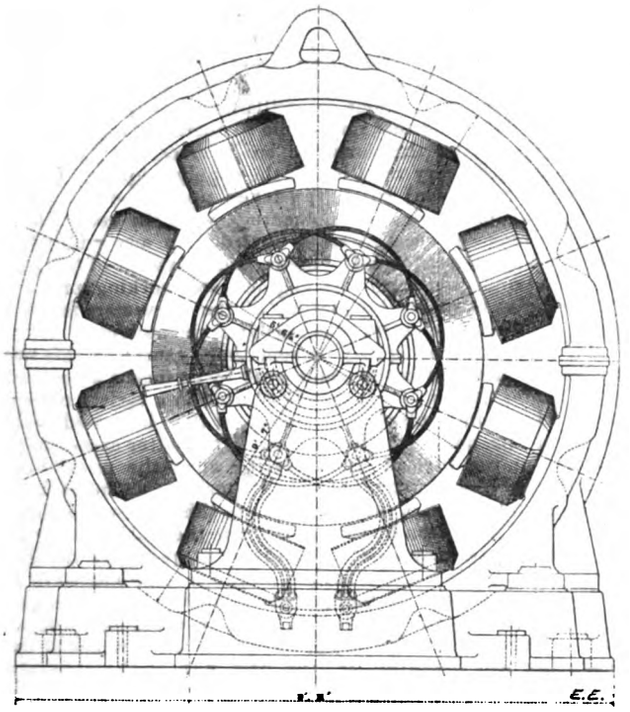
transmission plant when the impressed pressure on the synchronous machinery is not maintained constant, but is left to take care of itself; the pressure at the ends of the feeders rises steadily with increased excitation of the synchronous machines. In this case the 1,000-kw. generator supplying current to the motor (through a long three-core cable) had its excitation adjusted once for all at the beginning of the second test, to such a value that the impressed E.M.F. on the motor was the same as before—namely, 2,950 volts—*when the armature current had its minimum value.* The excitation of the synchronous motor was then increased, the dotted curve



showing the increase of (leading) armature current; the effect of this was to raise the impressed pressure on the motor—that is, the pressure at the ends of the long feeder—from 2,950 volts to 3,100 volts. That is to say, the drop in the feeder (which possessed a considerable inductive drop, owing to the presence of a choking coil in series at the station end) was first wiped out, and then the pressure at the sub-station end was gradually increased to the extent of over 5 per cent. simply by increasing the excitation of the motor. The frequency, of course, was constant throughout the tests, and consequently the motor speed also.

A little consideration of the above-described characteristic of synchronous motors will show at once how valuable machines of this class become in connection with any transmission plant on account of their condenser action. It will also show the great superiority of synchronous motor-generators and rotary converters over an asynchronous machine for sub-station purposes, from the point of view of the regulation of the system and the line losses, etc. Instead of having a lagging idle current throughout the system, wasting energy and impairing the regulation at all points, the power factor of the system can be kept practically at or above unity throughout, the effect of pressure drop in the feeders can be nearly annulled if desired, and there will be no other losses except those corresponding to the load, unless it is desired to work with a considerable leading current in order to raise the pressure at the sub-station ends of the feeders, as described. It is not possible to get a power factor of *exactly* unity in the circuit by adjusting the excitation of a motor running light so as to obtain minimum armature current—that is to say, the bottom of the "V" curve does not mean that the current running into the armature of the motor is in phase with the impressed pressure; it is very nearly in phase, but not quite, owing mostly to the difference in the E.M.F. waves of line pressure and motor pressure. Large synchronous motors, when well loaded, and if of good design, generally have full-load power factors of 96 to 98 per cent. when working at the excitation corresponding to minimum armature current.

In practice the utilisation of the phase-rectifying properties of synchronous (motor) machinery works out as follows. With rotary converter sub-stations, if the machines are compounded, the power factor of the system will be nearly unity at about half load, the current lagging somewhat before this, and leading afterwards, in accordance with what has already been said in this connection; at full load the drop in the feeders supplying the sub-station will be considerably reduced. If the rotaries are shunt-wound, or if synchronous motors are employed, the field current is so adjusted that the power factor is highest at about three-quarter load; at both lighter and heavier loads the current is somewhat out of phase, the minimum power factor being, say, 0·95. Or, if heavy overloads are expected, the machines had best be somewhat over-excited at full load in order to increase the impressed pressure, especially in synchronous motors, for the overload capacity is thereby increased, the torque being proportional to the square of the impressed pressure. Thus with a synchronous motor-generator sub-station, if the motors are well designed, it is not necessary to alter the excitation continually with the load; but two adjustments between no load and full load will be generally advisable, in accordance with what has been said above. The small amount of field regulation required in practice with well-designed synchronous motors is well illustrated by Fig. 5. If a sub-station equipped with synchronous machinery has to work in parallel with large inductive loads, such as large induction motors, or another station arranged with asynchronous motor-generators, it is well to arrange for the lagging current to be balanced by the synchronous machines. That is to say, the synchronous motors or rotary converters will be liberally

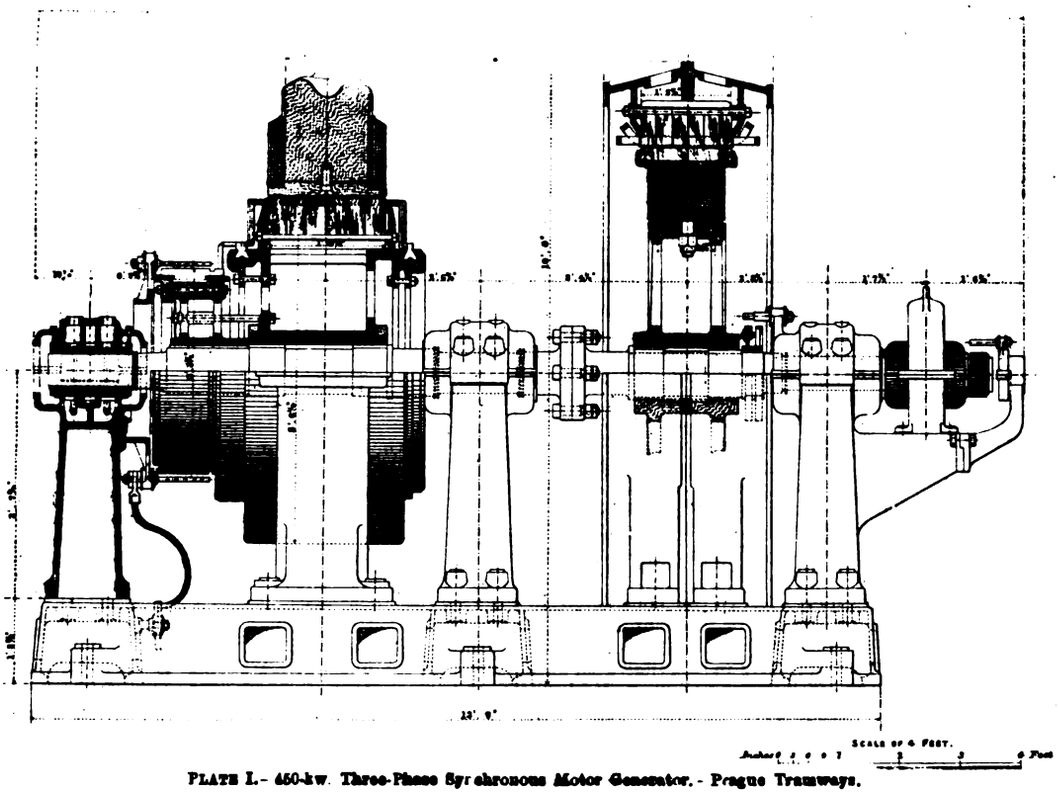


PLATE I.—450-kw. Three-Phase Synchronous Motor Generator.—Prague Tramways.

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designed, in order that they may carry the balancing leading currents (and increased excitation) in addition to the load.

A word or two may be said here regarding the overload capacity of the three classes of sub-station equipment. With motor-generator sub-stations, what may be termed the permanent overload capacity depends only on the direct-current machines—that is to say, it will be in general about 20 per cent. for two hours—the position of the brushes on the direct-current machines remaining unaltered. With rotary converters the corresponding overload capacity is, of course, greater, and in practice is determined as a rule by the commutator heating. The commutators of rotary converters invariably have peripheral speeds bordering upon the upper limit of good practice—say, 3,000ft. per minute—consequently an overload of about 30 to 40 per cent. for two hours is about as much as can be furnished without overheating the commutators. If it were not for this, and provided the field system was well over-excited, the overload capacity could be safely taken to be 50 to 60 per cent. for the time stated. It would be determined by the permissible safe temperature rise of the armature coils and step-down transformers. It is hereby assumed that these latter are artificially cooled by means of cooling pipes in the oil, or by forced draught, the normal temperature rise being 35deg. C., conforming in these respects to good modern practice.

What has been called the "permanent overload capacity" above is, however, really of minor importance in practice, for the plant would not be subjected to such treatment except when being taken over, or when a breakdown occurs. The important point, particularly with sub-stations feeding tramway or railway systems is the momentary overload capacity—that is to say, the effect of short-circuits of brief duration has to be considered. Regarding this point, it may be at once stated that the three classes of equipment are perfectly satisfactory, and, moreover, from this point of view, there is but little to choose between them. Well-designed asynchronous and synchronous motors and rotary converters fed from a well-designed power station will all stand overloads of 100 per cent. for a few seconds without falling out of step, the two classes of synchronous machines behaving in a very similar manner to the asynchronous machines. This is about the safe limit of overload capacity for standard machinery—the short-circuit, or whatever it may be, causing the momentary overload is naturally unexpected, and consequently the plant as a rule cannot be stiffened up by field regulation, to stand more, or to stand this amount for a longer period, with safety. It does not follow that the machine will drop out of step, although asynchronous motor-generators designed for high efficiency would probably pull up. The synchronous motors or rotaries would generally become unstable in their running, and start hunting.

With regard to the falling out of step of synchronous machinery, it may be observed here that once this happens the inherent tendency of a machine to pull itself in again is determined by the torque it can exert in a very short time—namely, half a cycle. Consequently, if there is any load on the machine, it must necessarily pull up. Should a momentary short-circuit pull out the circuit breakers in the power station, or otherwise break the circuit on the alterating-current side of the converting machinery, it is always necessary to give the sub-stations time to shut themselves down, rather than immediately replace the circuit breakers, while the converting machines are still turning. Under these latter circumstances even induction motors will not run up to speed, while the synchronous machinery forms simply a pulsating short-circuit across the mains, a synchronous motor or rotary acting alternately as motor and generator relative to the transmission lines, and gradually pulling up. Before this happens, the circuit breakers will be out again. Apart from this, it would in general be impossible to keep in the circuit breakers on the direct-current sides of the converters.

One of the most important questions to be considered in connection with the design and operation of a synchronous sub-station equipment is that of parallel running. The converting machines have not only to run perfectly in parallel with one another, but the various sub-stations have to run perfectly in parallel with one another, and with the power station also. In most modern installations this requirement has been easily attained, but in others great difficulties have arisen, and have had to be got over at great cost before satisfactory working over the whole system was attained. It is, therefore, of interest to discuss as briefly as possible the leading features of the question. With a rotary converter sub-station, for instance, unless every detail of the system is thoroughly well designed, from the engines in the power station to the rotaries themselves, there will be trouble with regard to the parallel running of the machines—that is to say, they will hunt. The term hunting, as applied to synchronous machinery of this character, means that while running at synchronous speed (as measured by a tachometer) the machines oscillate between themselves—that is, during a revolution they increase and decrease their angular velocity above the mean velocity, corresponding to exact synchronism, causing the armatures to swing backwards and forwards from a fixed point (in a precisely similar manner to the swing of a pendulum) while still keeping in step. The effect of this is to cause the pressure on each side of the rotary to fluctuate more or less badly, so that working at constant pressure on the direct-current sides becomes impossible. Once a rotary has started hunting, unless the small oscillations are immediately checked, they will invariably continue to increase in amplitude until the armature swings over and loses synchronism. The running performance of synchronous (motor) machinery depends so much upon the variations in the velocity of the power-house engines during a revolution, and upon the oscillations set up by the engine governors, etc., that if these variations or oscillations exceed certain well-defined limits, it becomes impossible to operate the sub-stations successfully. That this must be so becomes clear when it is considered that every variation in the supply frequency (during an engine revolution) has to be taken up by the sub-station machines against their own momentum, with the result that if the armatures get accelerated or retarded to any extent from this cause hunting is bound to occur, and operation of the plant becomes impossible until the engines are working properly. This is a case in which the hunting of the converters is due to a well-defined cause outside the machines themselves.

But although hunting may be sometimes caused in this way, the speed variations in the engines are by no means a necessary accompaniment to it, for it may be started in a variety of ways (of which engine pulsation is one), and then increased by the action of the machines themselves. This latter case—that of hunting on the part of the rotaries when the power-house engines are entirely suitable—is of considerable interest. A working explanation of what happens in this case is as follows: Let a slight oscillation be set up between the machines, by any little thing that may occur with the most perfectly designed plant it is possible to have, such as a sudden large change in the load, a short-circuit, or faulty setting of the brushes on one machine, or an engine hunting in the power station (due to a small mishap, etc.). This slight oscillation is accompanied by a weakening and distortion of the field flux of the converter. The mere fact of there being an oscillation implies field distortion for a fixed point on the armature during the swing is either a little ahead of or a little behind the true position (corresponding to exact synchronism) it should have at this instant. This means that the machine is acting either as a generator or motor, taking either a leading or a lagging current from the lines, and shifting the diminished field flux to one or other of the pole-horns. The armature will now try to follow this change of field configuration, taking a large current in the reverse direction in order to do so. But this change of current immediately distorts the field flux in the opposite direction to a much larger extent, and the armature again tries to swing to the new position. Thus each oscillation of the armature gets larger and larger, and the field distortion is greater and greater, until finally the flux from the poles gets swept nearly entirely away from the pole-faces to the pole-horns and gaps between them, the machine eventually swinging out of synchronism. During these oscillations the converter is acting alternately as generator or motor, giving up to, or receiving power from, the other converters in parallel with it, giving them in this way alternately a push and a pull at the wrong times, causing them to start hunting also. The combined effect of the various machines in parallel is to increase the hunting originally set up, and if other sub-stations are in parallel the oscillations may also be taken up by the machines in these, the combined effect perhaps even reacting on the generators in the power station, causing them to start oscillating also. It is thus obviously necessary to provide means of checking the oscillations while they are still small, otherwise they will get out of control and spread over the whole system. The sparking and flashing over which frequently takes place at the commutators of rotary converters when hunting is directly due to the pulsation of energy, and to the field distortion and fluctuation, for good commutation under these conditions naturally becomes impossible. The distortion of the field is really the root of the whole matter, and if this is prevented, or reduced to a minimum, hunting cannot occur. That the whole magnetic system of a rotary converter that is hunting is in a very disturbed state is made readily apparent during working. For instance, a spanner held in the hand between two field poles is strongly attracted and repelled. As a matter of fact, even when the machines are working properly there is a certain amount of field pulsation, it being sometimes easily possible to estimate the speed of the power-house engines from the small quick movement of the pointer of the field ampere-meter.

(To be continued.)

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NOTES.

Bombay.—*Indian Engineering* in its issue for March 9 has a note to the effect that the Corporation of Bombay have empowered the Commissioner and a committee, subject to compliance with certain specified conditions, to make arrangement with the Pioneer Electric Light and Power Company of London to work the two concessions of the tramways and the electric lighting.

Engineers' and Shipbuilders' Institution.—The *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, Part 4, for the session 1900-1901, includes Mr. E. L. Orde's reply to the discussion on his paper on "Liquid Fuel," the resumed discussion on Mr. F. W. Jennings's paper on "The Ventilating and Heating of Ships by a Forced Circulation of Warm Air," and a paper on "Some Attempts to Increase the Efficiency of Marine Boilers," by Mr. G. M. Brown, B.A.

Institution of Mechanical Engineers.—Special interest attaches to the meeting of the members of this institution on the 19th inst., in that on this occasion Mr. Wm. H. Maw will deliver his presidential address. It has been decided, having regard to the national mourning, to abandon the annual dinner of the institution, which was to have been held on the 18th inst. A conversazione will, however, take place on May 17, for which invitations will be issued in due course. The provisional programme of the summer meeting, to be held this year in Barrow-in-Furness, has now been issued.

Royal Institution.—The lecture arrangements at the Royal Institution after Easter include a course of six on "Cellular Physiology, with special reference to the Enzymes and Ferments," by Dr. Allan Macfadyen, and a course of three lectures by Prof. Dewar on the "Chemistry of Carbon." The Friday evening meetings will be resumed on April 19, when a discourse will be delivered by Prof. J. J. Thomson on "The Existence of Bodies Smaller than Atoms." Succeeding discourses will probably be given by Dr. Hans Gadow, Mr. Charles Mercier, Prof. Jagadis Chunder Bose, Mr. Richard T. Glazebrook, Mr. A. Henry Savage Landor, Earl Percy, M.P., and other gentlemen.

Clock Illumination.—The illumination of a clock face is undoubtedly an important business, and it is a matter for surprise, now that the electric light is obtainable in so many quarters, that progress in this direction has not been more rapid. As pointed out by Mr. A. A. Johnston in a paper on this subject before the Society of Arts last week, gas is the worst form of illuminant for the illumination of clocks. It corrodes the works, smokes and discolours the glass, dries up the oil, and is altogether most unsuitable. Lamps are preferable to gaslight, but the advantages of the electric light over all others for this purpose must be generally admitted. One advantage not specifically mentioned by Mr. Johnston is the ease with which the illumination of the dial can be made automatic when electricity is the lighting agent.

Chicago Street Fire.—We gather from the *Electrical Review* of New York that a unique street fire recently occurred in Chicago, which was due to an electric tramcar violently colliding with a tank wagon carrying gasolene, 500 gallons of which were spilled into the street. In attempting to run the car on through the pool of gasolene the arcing between the rails and wheels set the inflammable liquid on fire, and in an instant flames shot up 20ft. into the air, burning the car where it stood, and severely scorching the buildings on either side of the street. The fire-engines were called out, but their streams had no visible effect on the blazing mass, which continued to burn for half an hour. We are afraid that the fire would have occurred whatever system of electric traction were employed, unless, of course, two overhead conductors were used, so that the rails did not act in any way as a return.

Municipal Electrical Association.—The annual convention of this association will this year be held at Glasgow, the dates fixed for the meeting being June 19, 20, and 21. Unfortunately, these dates are exceedingly close to those arranged by the Institution of Electrical Engineers for their trip to Germany, which in the ordinary way will start on June 22. In order, however, to give those going to Berlin rather more time, a goodly number will leave on the Friday night, the 21st, in which case they will be able to spend some hours in Hanover. Reverting to the Glasgow convention of the Municipal Electrical Association, we understand that the date could not be altered, owing to the part which the Corporation of Glasgow are taking in welcoming the electrical engineers. The full programme of the arrangements is shortly to be issued, and from what we hear the interest in the meeting is likely to be well sustained.

Electric Automobile Failure.—It is announced that the operation of "ply-for-hire" electric automobiles in Chicago is to be given up by the local company, owing to the small use made of the vehicles by the public and the heavy cost of maintenance due to the bad condition of the streets. This decision will be another disappointment to those who have contemplated the useful application of accumulators in automobiles. While, however, streets are what they are—and, we believe, the conditions prevailing in the United States are even worse than here—it would be useless to hope for any other result with the types of accumulators now in vogue. Be their suspension as perfect as it may, the injurious effect produced by bad roads can be only very partially overcome. Moreover, bad roads involve a much heavier type of car than would otherwise be necessary, thereby entailing a battery of correspondingly greater capacity. This, again, means an increase of the aggregate weight to be carried, and so further adds to the difficulties of designing a commercially successful car. Except within very restricted limits—that is, where the work of the automobiles is confined to the better roads generally to be found in the centre of a town—the commercial success of electric automobiles is evidently not yet.

Electricity at the Pan-American Exhibition.—As far as possible it is intended to make the electrical exhibit in the electricity building at the Pan-American Exposition a collective one rather than one consisting exclusively of individual commercial exhibits. From an illustration accompanying a short article in the *Western Electrician* on the subject, one may see that the structure itself will present an exceedingly handsome appearance with its towers of elaborate design rising to considerable heights. Inside the building the design and architecture will be no less beautiful, and here the progress in the development and application of the various branches of the science and industry will be well demonstrated, including a collection of historical matter relating to the subject which will show the gradual development of the apparatus used. A special feature will be the exhibit illustrating the application of electricity to the propulsion of cars and vehicles. The utilisation of electricity in various forms of manufacturing industries will also be shown. The department is proposed to be divided into two groups—viz.: (1) the collective exhibit, consisting of retrospective exhibits of historical interest, illustrating models, or practical

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contrasts showing the advances in art; and (2) the commercial exhibit composed of those exhibits possessing distinctive merit, whether this consist of workmanship, novelties, or useful applications.

Solar Motor.—Mr. Chas. F. Holder is responsible for an article in the *Scientific American* which describes a solar motor now at work in Southern California. It consists of a large glass reflector, which is built up of a number of comparatively small segments of silvered glass mirrors. These segments are so arranged that the rays from the sun are reflected on to a boiler in the focus of the mirror, and it is stated by the author that the heat is quite sufficient to keep going a 10-h.p. engine. Naturally, under the circumstances, it is claimed that 15 h.p. is the maximum output. The outer diameter of the reflector is 33ft. 6in., while the inside diameter is 15ft. It is built up of 1,700 odd mirrors, and is so arranged on its stand that it can be rotated so as to have its plane always at right angles to the sun's rays. The boiler contains about 100 gallons of water, but the illustrations do not make clear quite how the water and steam spaces are arranged. Owing to the exceedingly dry locality in which this apparatus is erected, the steam is condensed in passing through the engine, and is returned to the boiler. There are no figures given as to the cost, but the author considers that in the very dry localities, where water can be obtained from artesian wells and where fuel is exceedingly dear, there is an opening for such motors. It would seem to us that, apart from the first cost, there might be a considerable amount required to keep the apparatus in order in view of the severe climatic conditions under which it works.

Electric Tramway in Georgetown.—An instance of the enormous growth of electric traction in every quarter of the globe comes from Georgetown, in British Guiana, where an electric tramway of some 10 miles in length has just been opened for the public service. From some particulars of this new line which we have before us we gather that the system has been constructed on the most modern methods. The overhead trolley wire, however, has been adopted, and some little controversy appears to have arisen as to the new wires deranging the telegraph and telephone service of the city, but a satisfactory arrangement would seem to have been arrived at. Hitherto the only tramway in the town consisted of about a mile of line, the cars being drawn by mules. Some years ago, however, on a visit of Mr. W. B. Chapman, an enterprising Canadian financier, the idea was mooted of introducing an electric tramway service. The success of a similar venture in Jamaica, introduced by this gentleman, encouraged the proposal to try the experiment in Georgetown, and ultimately a Canadian company was formed for the purpose. The property of the Georgetown Tramway Company was purchased by the new company, known as the Demerara Electric Company, which later also purchased the electric lighting and power company, and obtained a license defining its powers and authorising it to provide electricity for public and private purposes. Some difficulty was experienced in getting the requisite material for the electric tramway, but the actual work of construction was rapidly got through in the summer of last year. The cost of the service is put down at about £5,000 per mile, or about £50,000 for the whole service.

Tuition in Modern Languages.—In every walk of life a sound knowledge of the modern languages, and especially the French language, will always be found of high value. This year the Teachers' Guild have again arranged for a course of instruction at Tours, Lisieux, and Elbeuf during the summer holidays. The aim is to promote among English people not only a knowledge of the language, but also of the customs and ways of thought of the French nation. The courses in all three centres will commence on or about Aug. 1, and will continue for three or four weeks according to the wish of the students. They are, however, advised to stay in the country a short while longer if possible. The courses include lectures, classes for phonetics, reading, dictation, conversation, and composition, the small fee of £2. 2s. being charged, which gives the right to attend all classes of any one of the professors engaged. Towards the end of the courses at each of the three towns examinations will be conducted by a Board of French professors. The guild have also in view the organisation of a Spanish course of lectures and classes at the ancient town of Avila, about 70 miles from Madrid. The details of the arrangements in connection with this course will depend upon the number of students who express their desire to attend. The hours of work at each place will be from 8.45 a.m. to noon, thus leaving the afternoons free for excursions in the neighbourhood, and the evenings for meetings of a social character. In due course a handbook will be issued by the guild giving full syllabuses of the lectures, time-tables, etc., and in the meantime further particulars may be obtained from the secretary to the special committee having the arrangements in hand—Mr. H. B. Garrod, 74, Gower-street, W.C.

A Portable Plant.—Some interesting details of a portable electric lighting plant which has recently been adopted on the Eastern Bengal State Railway, appear in the February number of the *Indian and Eastern Engineer*. The generating plant consists of a Castle dynamo, giving an output of 134 amperes, coupled direct to a Mirrlees-Watson compound. This high-speed engine set is mounted on an iron frame carried on three pairs of wheels, the whole being covered by a wooden wagon body with double roof and sunshades. Arrangements are made for clamping the frame to the rails, and at full speed no movement or vibration is felt. Steam at 120lb. per square inch is supplied by a locomotive boiler carried on four wheels, with a tender for fuel and water attached. Water is supplied to the boiler by a duplex pump delivering through an exhaust-steam feed-water heater, while as a stand-by the boiler is also fitted with Gresham's combination injectors. In the generator truck is fitted the switchboard, which is of marble, with the necessary instruments. It is arranged for four circuits, each capable of carrying 75 amperes. Adjustable resistances for each circuit fitted are behind the board. Attached to the generator truck is a carriage fitted as a store and workshop and office for the attendant. In this wagon are fitted oil-tanks, reels for the cable, and hooks for lamps, etc., as well as a vice, bench, and necessary instruments for testing and repairing lamps. The necessary tools and stores for running and maintaining the plant, as well as all that is required for erection of posts and lines, are arranged in racks and shelves round the sides of the carriage. With this plant it is possible to work one night at one terminus and the next at another terminus 10 miles away. In fact, the whole was arranged with an eye to rapid movement as well as to durability and economy in working. A native staff, under the supervision of an European inspector, run the plant, which up to the present would seem to have given every satisfaction.

Rapid Transit in Boston.—The chief matter of controversy which is engaging the attention of both the general public and the local authorities in Boston (U.S.A.) just now, is the proposal to build a subway under Washington-street and relieve the congestion in the down-town district by

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removing the surface cars altogether. The question has arisen in connection with the near completion of the elevated railway construction in Boston, on which experimental trains have already been run. The project to do away with the present means of transit in Washington-street, which is one of the busiest thoroughfares in the city, is naturally viewed with disfavour by the Elevated Railway Company, who own the system, in view of the large reduction in the daily revenue which would result. At the present time the surface cars in this particular street are a very important source of revenue to the company, but it is not to be reasonably expected that the same use would be made of the new elevated railway on short distances. Some time ago the company yielded to the mandate requiring the removal of Tremont-street's tracks after the subway had been constructed beneath that thoroughfare, but they were not seriously affected in consequence, as Tremont-street was not by any means the source of revenue that the tracks in Washington-street are now. The Legislature have granted hearings to petitioners for the subway under Washington-street, and the general opinion seems to be that the subway will be forced upon the people of Boston by the outside citizens of Greater Boston, who largely outnumber the residents of Boston proper. But the Elevated Railway Company are determined to fight the proposition to remove the surface tracks from Washington-street, subway or no subway.

Cooper's Hill.—As a result of the investigation by the Visiting Committee of the Royal Indian Engineering College into the grievances of the seven professors of the college who were requested to retire from their appointments, the Government have decided that Mr. W. N. Stocker shall, for the present, remain as professor of physics. This is the only modification of the original programme of changes at Cooper's Hill. All the papers dealing with the matter have been issued in the form of a Blue-book, and the most important of these, as conveying the final decision of the Government, is the communication to the president of the college from the Secretary of State for India. From this document it appears that the report of the Board of Visitors has been considered by the Secretary of State in Council and has received his approval. This report confirms their previous expression of opinion as to the necessity for changes in the course of instruction which in recent years has been carried on at the college. These changes require the retirement of Messrs. McLeod, Hearson, Heath, Shields, Reilly, and Hurst, and the pensions and gratuities already sanctioned will be issued to them with effect from April 4. In view of the further recommendation submitted by the Board of Visitors that the instruction in physics, which has hitherto been restricted to the first and second year students, should be extended to the students of the third year, it has been decided that Mr. W. N. Stocker shall, for the present and until further experience has been gained, be retained as professor of physics. The contemplated developments in the teaching of electric engineering render it possible that the new lecturer in electro-technology may not be able to devote a sufficient portion of his time to the teaching of physics. It must, however, be understood that Prof. Stocker can no longer be responsible for or connected with that department of the college which includes electro-technology. He will take up such a position in relation to the lecturer in this branch as the president of the college may assign to him.

Central-Station Design.—In the United States one would suppose that the electrical equipment of central stations would be highly advanced, in view of the competition between English and American manufacturers which takes place for the supply of electrical machinery in this country. The fact remains, however, that while in the States they have advanced the equipment of street railways and the transmission of power plants to a very high degree, they are not at all up to date in the equipment of their lighting installations. We do not wish to call attention to one particular place, but we have before us one of our American contemporaries for March 16. In this an illustrated description is given of a new electric lighting plant in a small town which is spoken of as being up to date. We are surprised to find, therefore, that in this so-called up-to-date installation the engine and dynamos are still coupled together by means of belts. A still greater cause for surprise is that the new steam-engine which has just been installed is designed to run with 80lb. steam pressure. A feature in the installation, which shows how standardisation can be carried too far, is the combination of the arc and incandescent lighting plants. Thus the large machines, which are alternators, are wound to give 1,100 volts, which are transformed down to 110 volts for incandescent lighting to private consumers. The street-lighting is done by means of constant-current transformers. In order to supply these, step-up transformers are installed which raise the pressure of the primary from 1,100 up to 2,000 volts, so that standard arc-lighting transformers can be employed. In the same installation there is also a certain number of incandescent circuits for street-lighting in which 50-c.p. incandescent lamps are arranged in series. We may add that this station is nothing like so complicated or even so backward, as compared with English stations, as other electric lighting installations we have heard of in large towns in America. In these larger stations there is often supply being given by no less than five or six different systems, all requiring independent machinery or mains.

The Electric Lighting of Chicago.—We have just seen a report of the city electrician of Chicago on the electricity department for last year. We gather indirectly from the report that street-lighting is the only work which is actually carried out by the department, and that at the beginning of last year there were some 3,502 arc lamps actually being supplied. This number had increased at the end of the year to 4,239. The average cost per lamp throughout the year for materials, such as coal, carbons, stores, etc., was £7. 7s. The labour charges per lamp, including the labour in central stations, as well as labour in trimming, came out at just over £4 per lamp, making a total of £11. 7s. per arc lamp per annum. These figures do not include any interest on capital, and they are said by Mr. Ellicott to be higher than in the previous year. One point of interest in the report is that the use of series arc lamps in private houses, which lamps were supplied by various electric light companies, is on the decrease, but that even now some 26 per cent. of the private arc lamps are still supplied on the constant-current system, which involves the introduction of high-voltage circuits into consumers' premises. Throughout the year a considerable amount of work has been done in constructing underground conduits for the various overhead wires which previously disfigured the streets of Chicago. It is now proposed to take even more stringent means in this direction, and if the proposals of the engineers to the city are accepted, conduits will be constructed into which all electrical conductors will be placed. In view of the number of electric lighting and telegraph companies having running rights along the streets, combination conduits would have to be constructed with independent manholes, so that each company would have access to its system without being able to interfere with the wires of

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its rivals. The proposal respecting the construction of these conduits, the cost of which would have to be borne by the companies in the ratio of the space they required, is to come before the City Council shortly.

Electrolytic Deposition of Lead from Solutions. In a valuable paper on this subject, Mr. L. Glaser states that homogeneous metallic lead is deposited from slightly acid concentrated solutions of lead nitrate or acetate, containing, for preference, considerable quantities of the corresponding alkali salts, by a current of about 0·004 ampere per square centimetre at the cathode. From an abstract of this paper given in the *Journal* of the Chemical Society, it appears that when an anode of lead is used, the E.M.F. is about 0·1 volt. When the conditions are such that lead hydroxide can be formed at the cathode, spongy lead is deposited. Concentrated solutions of lead or alkali salts dissolve considerable quantities of lead hydroxide; when such a solution is electrolysed, the removal of lead from the layer of solution in contact with the cathode dilutes it. This more dilute solution deposits the lead hydroxide or basic lead salt which it contains on the cathode, and so prevents the regular deposition of the metal giving rise to the spongy deposit. Lead chloride and sulphate give unsatisfactory results, owing largely to the formation of insoluble lead chloride or peroxide at the lead anode. By using very small current densities and E.M.F.'s, it is, however, possible to obtain coherent deposits. The deposition of lead may be utilised for plating objects with lead or for separating lead and silver, the alloy being used as anode in a solution of nitrate saturated with chloride; the silver remains behind undissolved. Coherent deposits of lead are also obtained, although with more difficulty, from alkaline solutions. The concentration of the lead ions is so small in these solutions that the liquid surrounding the cathode soon becomes so impoverished that the E.M.F. rises, and the next available cathion (an alkali metal) is discharged. This results in the secondary reduction of lead sponge. By keeping the E.M.F. low and replacing the liquid in contact with the cathode by vigorous stirring, however, good deposits may be obtained. The analogy between the deposition of lead and of zinc is pointed out in conclusion.

Decomposition Potentials of Fused Salts.—The *Journal* of the Chemical Society gives an abstract of a paper by Mr. Richard Lorenz on "The Theory of the Decomposition Potentials of Fused Salts." The author points out that it is not safe to apply the methods used for the determination of the decomposition potentials of substances in aqueous solution to fused salts, because assumptions which are correct in the case of solutions are not necessarily so in the case of fused salts. He supposes that when a gradually increasing E.M.F. is applied to a fused salt (for example, lead chloride) through indifferent electrodes, metal is liberated at the cathode which is at first almost completely dissolved by the electrolyte, the polarisation at the cathode remaining very small. As the E.M.F. increases, and with it the quantity of metal liberated in unit time, the solution becomes more concentrated and the rate of solution of metal smaller, until finally the rate of deposition of metal exceeds the rate of solution and the maximum cathodic polarisation is attained. The same process occurs at the anode, the halogen rapidly diffusing into the whole of the anodic electrolyte until this is saturated. If the liquids surrounding the electrodes are not separated, the dissolved metal and halogen rapidly reunite, hindering or preventing the attainment of the maximum polarisation. According to the arrangement of the apparatus, the maximum polarisation may be reached first at one or other of the electrodes or simultaneously at both of them, and therefore the curves representing the connection between reverse E.M.F. and the applied E.M.F. may have a variety of forms. The author gives several of the characteristic shapes of curve which, according to his views, are to be expected, and states that they agreed with curves obtained experimentally. They exhibit changes of direction which correspond to the changes of direction in the current E.M.F. curves obtained by Garrard, and which he takes to indicate decomposition potentials. When the anode and cathode liquids are separated from each other, the curve shows no *per saltum* change of direction, but the current increases in proportion to the applied E.M.F., so that it would appear as though fused salts may be decomposed by any E.M.F.

The Inspection of Works.—The question of the competition between firms manufacturing the same class of articles in one country, is one which should be made subservient to the competition between those manufacturers as a whole and their rivals in foreign countries. In England we are afraid that there is much too much conservatism in such things, and that one firm is apt to strongly object to allowing its rivals to inspect its works. In the same way the friendly discussion of details amongst the staffs of rival works is often deprecated by those in command. While the one firm may for the time being gain some slight advantage from this course, the whole industry suffers, and even the firm which is taking the lead is apt to fall back in the international contest for the same reason. We had recently brought to our notice the extreme freedom in which American manufacturers derive mutual advantage from the frequent inspection of their rivals' works. The case in point was that of a town in which the factories were practically all devoted to the manufacture of machine tools, and in which the whole of the manufactories were open, so that one firm had free access to the manufacturing methods employed in other works in the same place. In fact, the friendliness went so far that when one firm had devised a new machine for the manufacture in quantity of a certain class of nut, and had proved by experience that the new machine was a great success, it was then quite ready on request to lend the patterns of the tool to other manufacturers in the same town so that they could for themselves make machines of exactly the same type. Naturally, the rivalry between two makers is not quite so keen in America as in this country, as there the manufacturing firms are very apt to restrict themselves to one or two types of machine tools only, and then, perhaps, make only one or two sizes. The fact remains, however, that by free intercourse manufacturers as a whole are able to be a great mutual assistance to each other, and this assistance is of the utmost value in enabling them to secure export trade. If a moral were needed, we have in view one old-established manufacturing electrical works in England which for years has been exceedingly jealous of allowing anyone but an actual customer to go over their works. The heads of the technical staff were very sure of their own self-sufficiency. In our opinion it would now be correct to say that no engineer with manufacturing experience would gain any information whatever by seeing through the works in question.

Snoqualmie Power Plant.—We have already described in these columns the power plant at Snoqualmie Falls for supplying power to Seattle, Tacoma, and the neighbourhood, which takes a front place among the many water-power developments in the United States. A station is now being built by the Seattle Electric Company which will contain rotaries and transformers for supplying their

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consumers with this Snoqualmie power. Already the alternating lighting circuits, both arc and incandescent, are carried by Snoqualmie, and to this it is proposed to add the direct-current three-wire network in the down-town district, and 500-volt: direct-current power service. A new and interesting feature of the Snoqualmie plant is the plug-board for connecting transformers on different circuits. This plug-board, which has been devised by Mr. Doble, is somewhat on the principle of a Thomson-Houston arc-circuit switchboard. From details which are given in the *Electrical World*, it appears that the plug switches are above the transformers in the transformer-house. Running lengthwise of the transformer-house over the transformers are 12 angle-iron conductors mounted on porcelain insulators, such as are used on the high-tension line. To these the 12 high-tension line wires are connected through long-break switches. Below these line terminals is a set of angle-iron conductors running at right angles to the line terminals, and to which the various transformer terminals are connected through high-tension long-break switches. It is evident that by a plug the line terminals and transformer terminals can be connected together at the crossing points of these angle-iron conductors so as to get any transformer connected to any line. Of course, disconnections cannot be made with the plugs, but that is not necessary, because in such cases the circuit breakers are used, as there is one on each line and each transformer. The angle irons are drilled and bushed for plugs at only such points as will allow the transformers to be connected in the right combination. Some peculiar effects have been investigated by Mr. Doble in connection with the opening of high-tension circuits. There are two circuits running to Tacoma and two circuits to Seattle. It was found that upon opening the Tacoma circuits, the circuit breakers on the primaries of the transformers supplying Seattle would always go out as if on a short-circuit. *Vice versâ*, if the Seattle circuits were suddenly opened, out would go the circuit breakers on the primaries of the Tacoma transformers. Much theorising as to induction, resonance, etc., was indulged in by those who saw the phenomena. The trouble, however, was conclusively proved to be caused by a short-circuit on the line due to the discharge of the line through the lightning arresters. The instant the Tacoma circuit was broken the Seattle line current would jump across the lightning arresters to ground. Upon disconnecting the ground wires of the arresters the phenomena disappeared, showing conclusively that the current jumping across the arresters was responsible for the effects produced. The Westinghouse-Wurts arresters are used, and the line voltage per gap is only about 300, which is extremely low, and makes the effect all the more remarkable. At Tacoma also preparations are being completed by the Tacoma Railway and Power Company for carrying the greater part of its load with Snoqualmie power.

Commercial Application of Electricity.—Mr. C. E. C. Shawfield, the Wolverhampton borough electrical engineer, has just published a very comprehensive circular book on the "Commercial Application of Electricity," a copy of which is now before us. In itself the book is exceptionally a handsome production, but apart from this it contains some most important and reliable information with regard to electric lighting, heating, and cooking, and electricity as applied for power purposes. It must be clearly understood, however, that it is not intended to be a technical and scientific treatise on electricity, the chief aim of the author being to place before the residents of Wolverhampton such information as will clearly demonstrate the advantages to be gained by the commercial application of electricity. The first section of the book is devoted to the subject of electric lighting, and here Mr. Shawfield gives a comparison with the cost of gas lighting. From the point of view of first cost, electricity is supplied by the Corporation of Wolverhampton at the practically same cost as gas when used for an average of three hours per day, but when used for a longer period it becomes decidedly cheaper than gas. For instance, taking the average of three hours per day, the cost of electric light with one 16-c.p. lamp in use at 4½d. per unit comes out at 26s. 6s. per annum, whereas 27s. would be charged for gas through a burner giving an equal light for the same period. If the light be used on an average for eight hours per day, however—the charge for electric light being reduced to 3·469d. per unit—the annual cost works out at 58s. 5d. as against 72s. for gas, the latter being calculated on the figure of 2s. 9d. per 1,000 cubic feet. Moreover, the estimate for the former illuminant includes the expenditure on lamp renewals, it being assumed that the average life of an electric incandescent lamp is 1,000 hours, and the cost of the lamp to be 1s. 6d. Some beautiful and artistic designs of electric light fittings accompany the descriptive matter on this subject. The author next turns his attention to arc lamps, and gives a selection of the types of ordinary arc lamps in use in this country at the present time. In many respects the "open" type of arc lamp is the most efficient light-giving medium at present upon the market, and he points out that for lighting large areas and for effective advertising it is impossible to obtain the same pleasing results at the same cost by any other illuminant. The initial cost of these lamps, including wiring and fixing, varies from £5 to £9 each; the consumption of energy is usually 5, 10, or 15 amperes. This "open" type of lamp is particularly recommended for drapers' shops and such like premises on account of the brilliancy of the light obtained. Dealing with the "enclosed" type of arc, the author states that it successfully fulfils the requirements of economical use with a pressure of 200 and 230 volts. A large number of these lamps are connected to the Corporation's mains at the present time, and we gather are giving every satisfaction. Section 2 of this interesting publication embraces the application of electricity for heating and cooking purposes. By simply attaching a flexible wire to an electric light plug and connecting on the heating appliance, the required effect for this purpose is produced, and, as the author states, it is quite possible by this means to obtain any requisite amount of heat. A few of the advantages of cooking by electricity are its ease of manipulation and control, its cleanliness and freedom from danger, and the uniformity of results obtained. The terms offered by the Corporation for electricity used for heating and cooking purposes are 2d. per unit for the use of the maximum demand for an average of two hours per day, and 1d. per unit for all consumed in excess. The application of electric motors for commercial purposes forms the subject of the third section, and in this division the author gives many valuable facts and figures, together with a large number of illustrations of the various types of motors in use. An interesting feature is the comparative recent adoption of the electric motor to electric fans and ventilators. Mr. Shawfield states that his object in preparing this section of the book was to impress manufacturers and users of power generally with the fact that the cost of applying electricity practically for power purposes can, and does, compare very favourably with the cost of gas and steam plants; and bearing this in mind, he has given some nine or ten tables which should go a long way in the matter of convincing manufacturers both as regards the practical application and the economy of electricity.

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MANCHESTER ELECTRICITY WORKS.

Three-Phase Extensions.

During the past week we have been privileged to inspect some three-phase plant which has been put down by Mr. C. H. Wordingham at Manchester as a temporary aid to the low-pressure system of distribution. The present time seems to us to be a suitable occasion to briefly review the present system of supply in use at Manchester, and also the extensions which have been arranged by the late city electrical engineer. We have to use the term "late" city electrical engineer, as Mr. Wordingham severed his connection with the Corporation of Manchester on Saturday last.

The area of supply now controlled by the Corporation extends much beyond the city boundaries. The area inside these boundaries is some 20 square miles, and electric light and power are to be distributed over an area of 25 additional square miles outside. The tramway system also extends over practically the same area, so that the power for the tramways must be provided for from the same generating station as the lighting. The map (Fig. 1) shows the general configuration of the districts, with the proposed situations of the sub-stations and generating works. Mr. Wordingham's scheme for supplying this large area is briefly as follows: Continuous current will in all cases be delivered at the consumers' terminal, and to the tramways. The distribution will be by a five-wire network in the central part of the city, and from a three-wire in the remainder of the area, with a pressure of 400 volts across the outers in each case. The network will

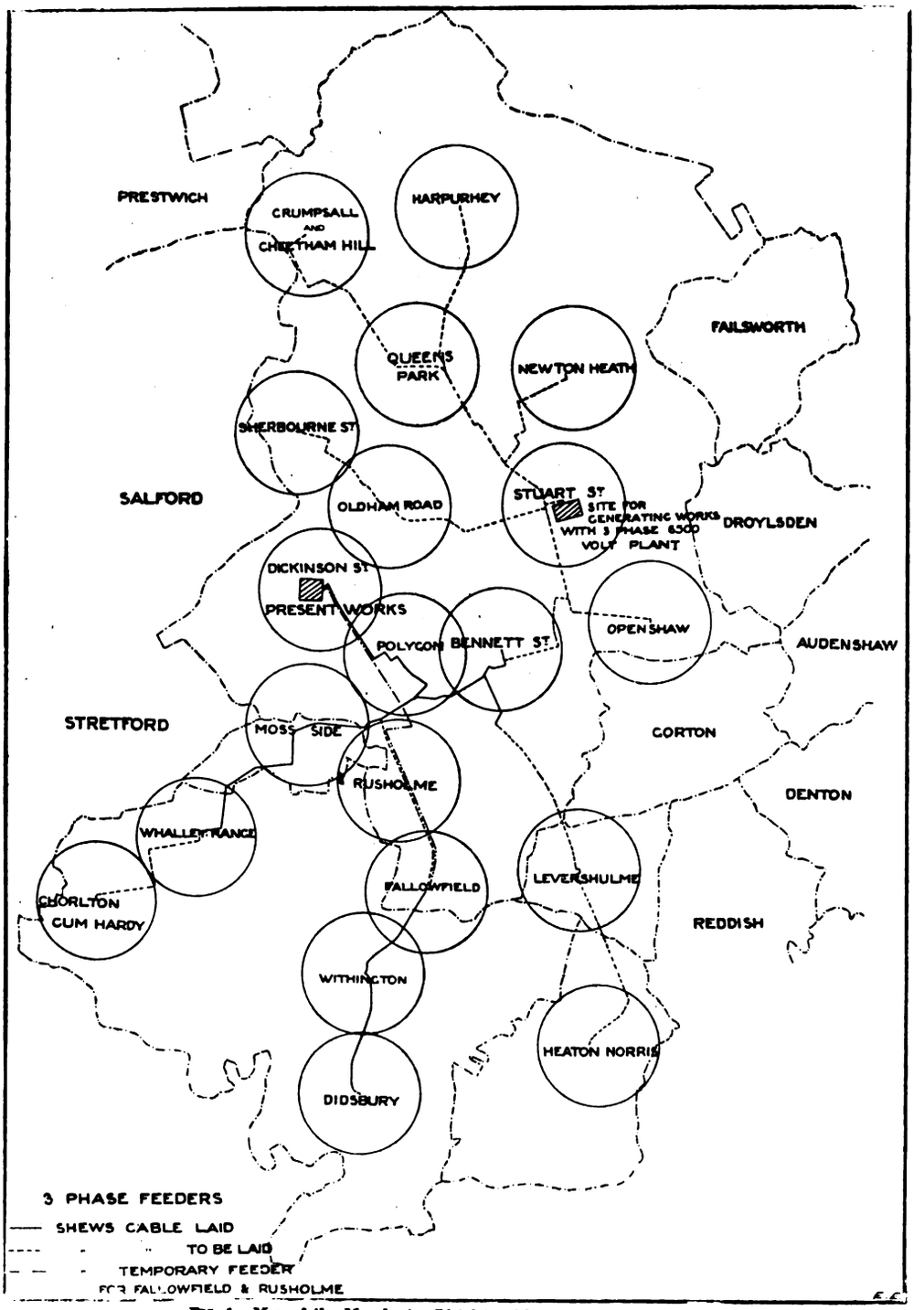

Fig. 1.—Map of the Manchester District, with position of Sub-Station.

The map (Fig. 1) shows the general configuration of the districts, with the proposed situations of the sub-stations and generating works. Mr. Wordingham's scheme for supplying this large area is briefly as follows: Continuous current will in all cases be delivered at the consumers' terminal, and to the tramways. The distribution will be by a five-wire network in the central part of the city, and from a three-wire in the remainder of the area, with a pressure of 400 volts across the outers in each case. The network will be so arranged that it may be either connected up as one continuous system, and that it may, if desired, be split up into a number of small portions, each quite independent of the others. The tramway network will be supplied at a pressure of 500 volts, and will be similarly arranged either to work as a continuous whole or to be split up into distinct sections.

Both networks are to be fed partly by current generated at low pressure and partly by current generated at extra high pressure, the arrangements being as follows: The present generating station at Dickinson-street, in which current is generated at 440 volts or thereabouts, is to be retained,

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and to be supplemented by an additional generating station now in course of construction in Bloom-street, adjoining Dickinson-street. The capacity of the Dickinson-street works is 12,000 i.h.p., and the capacity of the Bloom-street station is to be 14,000 i.h.p. These two stations

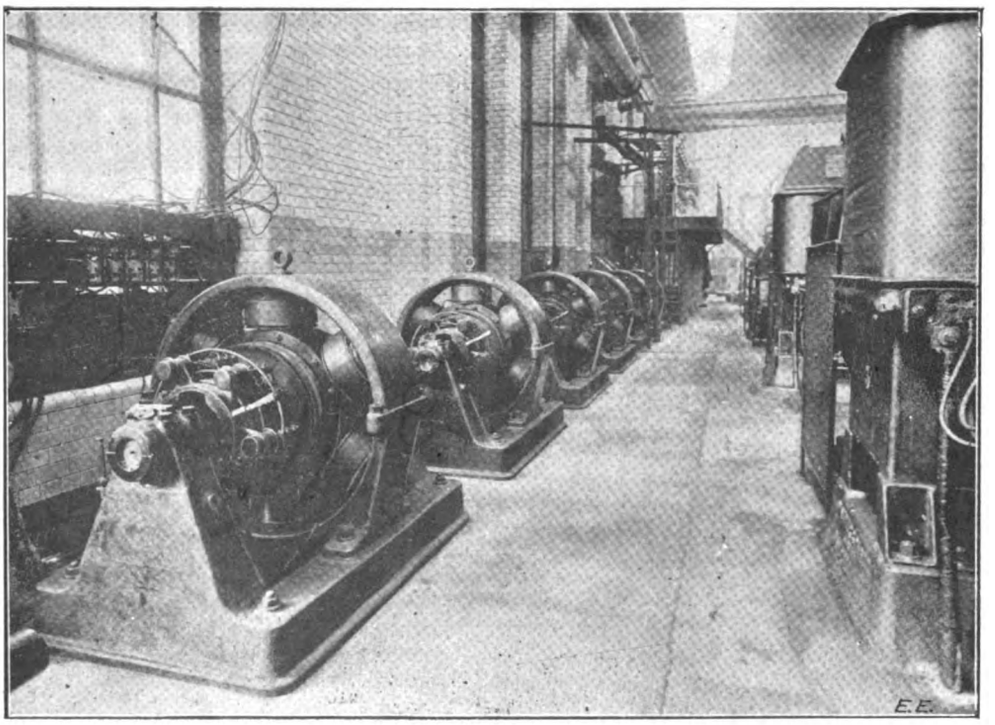

FIG. 2.—View of the Three-Phase Plant and Switchboard at Dickinson-street, Manchester.

together will eventually supply all the demand within a half-mile radius from them, this comprising the densest portion of the lighting, and by far the densest portion of the tramways load. The remainder of the network will be supplied from a single generating station at Stuart-street (Fig. 1) on the eastern border of the city.

current for delivery into the distributing networks. The static transformers will have their windings so arranged as to give on the continuous-current side of the rotaries two distinct pressures, the lower pressure being such as to give 420 volts or thereabouts for the lighting network, the higher giving 500 volts or thereabouts for the tramways. Each sub-station is designed to supply a radius of about half a mile, as is indicated by the circles on the map. The Stuart-street generating station would, in Mr. Wordingham's scheme, have an eventual capacity of 50,000 h.p.

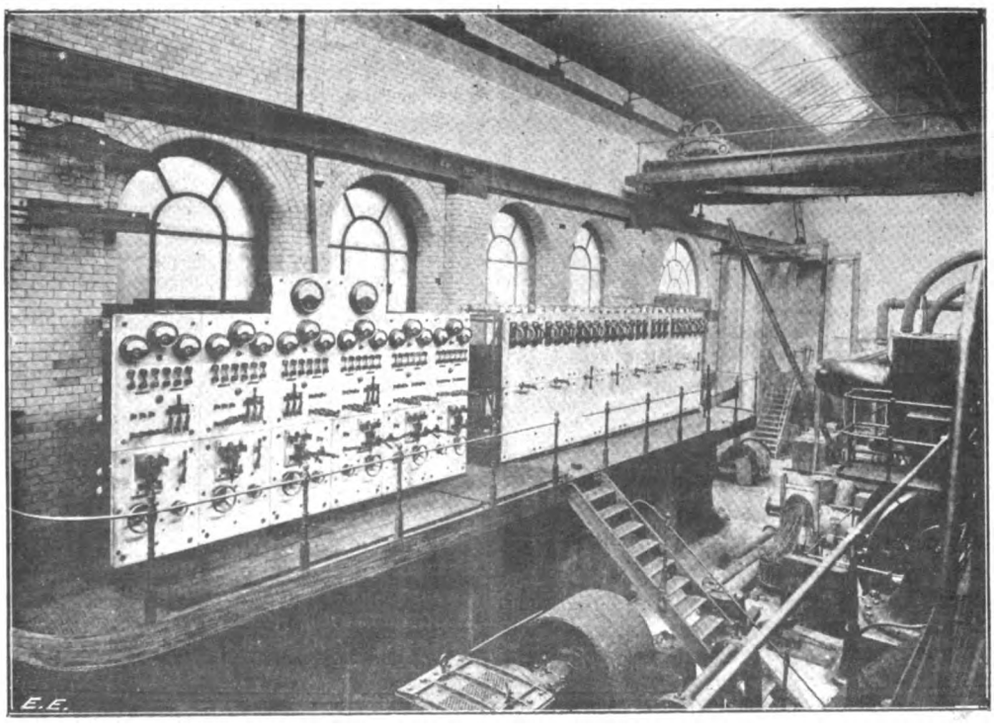

FIG. 3.—The Three-Phase Switchboards at Dickinson-street.

Here three-phase current will be generated at a pressure of 6,500 volts, and be transmitted to sub-stations placed about a mile apart. In each of these sub-stations the current will be transformed down by means of static transformers to a suitable pressure, and then passed through rotary converters which will transform it into continuous

With reference to the above scheme it may be pointed out that the use of different pressures for lighting and traction was practically unavoidable, unless uniformity throughout the whole area for lighting consumers had been sacrificed. An increase in pressure from 400 to 500 volts would involve changes in a large amount of plant installed for

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the lower pressure, as some 3,700 consumers, having lamps and apparatus aggregating the equivalent of 382,000 8-c.p. lamps, are now installed. On the other hand, it was

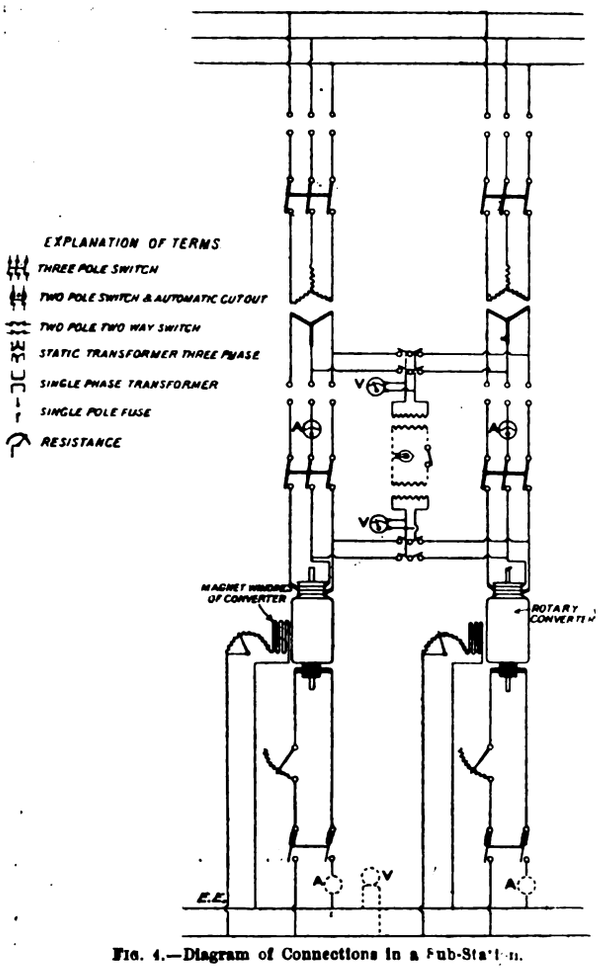

FIG. 4.—Diagram of Connections in a Sub-Station.

imperative that the traction network should be supplied at the pressure which has become standard in this country—not only because the standard pressure rendered stock

up this scheme, Mr. Wordingham has been very largely influenced by considerations relating to possible difficulties in connection with electrolysis on the tramway system, and his principal object in spacing the sub-stations at so short a distance apart has been to keep down the loss of pressure in the rails to a very low figure. It is hoped that in most cases the maximum drop will not exceed 1 or 1½ volts.

As regards the present state of the scheme, Dickinson-street is fully equipped, the Bloom-street station is now

FIG. 6.—Full-size Section of Three-Phase Feeder Cable.

under construction (the plant being actually in store), while, though the general scheme for Stuart-street has been worked out, the specifications have not yet been drawn up, nor consequently are any of the contracts let. Much work, however, has been done in connection with acquiring sites for sub-stations and laying the extra high-pressure mains and the low-pressure networks. A few words respecting the Bloom-street generating station may be of interest. The difficulties of the site are considerable, and have been greatly increased by the necessity

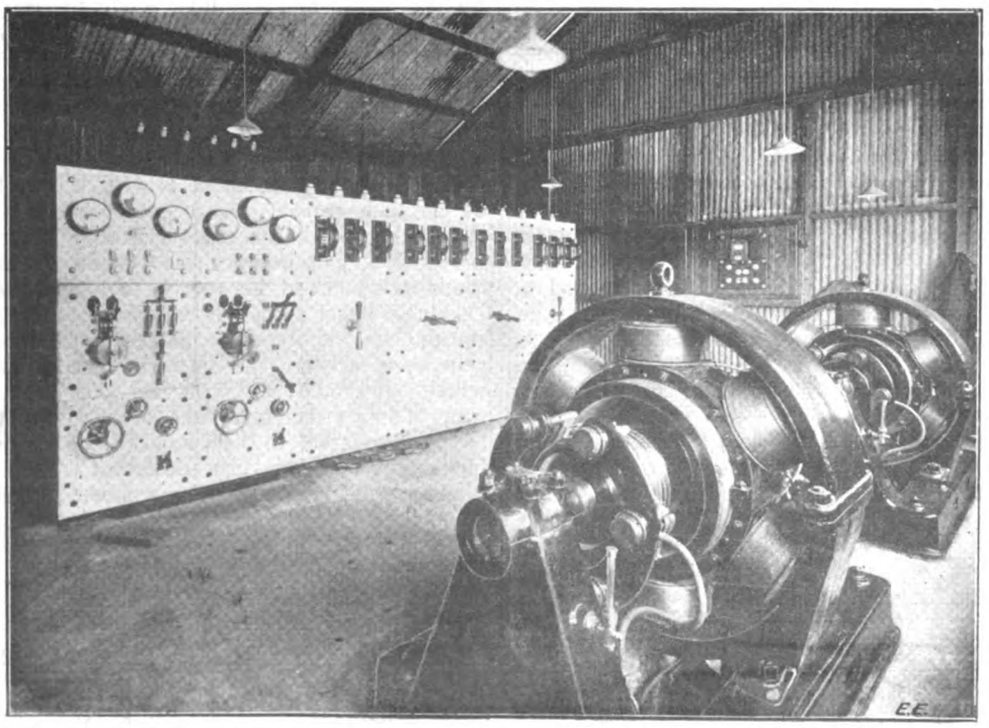

FIG. 5.—A Typical Sub-Station with Switchboard and Rotaries.

equipments available, but also because in the future it is practically certain that traffic will be interchanged between various large towns, and the inconvenience of a different pressure would have been very great. In drawing

for getting the maximum possible capacity of plant on to the space. The area of the site is only 1,950 square yards, and on this are to be accommodated all the plant, including boilers, economisers, chimney for natural draught, engines,

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dynamos, surface-condensing plant, switchboards, etc., for developing 14,000 i.h.p. Briefly, the arrangement is as follows: The site is roughly oblong, but wider at one end than the other, no one corner being square. The engine-room is parallel with one long side, the boiler-house is parallel with the other; the two touch at one end. At the base of the triangle formed by their sides is placed the chimney. The engine-room will contain four generating sets, each comprising a compound condensing engine, the high-pressure cylinder being 38½in. diameter, the low-pressure 76in., the length of stroke 4ft. 6in., directly coupled to a continuous-current dynamo running at 75 revolutions per minute. The dynamos are compound wound, each giving 4,400 amperes at 410 to 440 volts when running as a shunt-wound machine, and a proportionately reduced current at 500 volts when running as a compound machine. The plant is thus interchangeable for lighting or traction. It will give an output 33 per cent. in excess of this for one hour, and 50 per cent. momentarily. The boiler-house will contain 11 Babcock boilers, each having a heating surface of 5,140 square feet, the whole guaranteed to produce 200,000lb. of steam per hour at a pressure of 160lb. per square inch. All boilers are fitted with superheaters. Above the boilers will be fitted the economisers, each boiler having its own economiser, and a reserve flue being provided for each pair of boilers. The main flues discharge into the chimney at a level of 30ft. from the ground. The chimney is octagonal, 230ft. high, and 12ft. across the octagon inside. The steam-pipes are in complete duplicate, and are also arranged so that they can be cut up into sections, and certain boilers allocated to particular engines if desired. The feed-water arrangements are somewhat novel, inasmuch as a separate pump is provided for each boiler, the object being to secure that each economiser shall do its full amount of work, a difficult matter when several economisers are fed in parallel from a single range. The pumps of every pair of boilers are interconnected with one another, but not with any other pumps, and each pump can easily furnish sufficient water for two boilers at full steaming rate. The boilers will be fitted with chain grate stokers. It was expected that the Bloom-street station would be running in time for the winter now passed, and the first instalment of generating plant has actually been warehoused since May, 1900, but the buildings are very greatly behindhand.

In order to test the main scheme, and at the same time to enable certain distant portions of the district to be supplied to be lighted before the final arrangements were completed temporary three-phase plant was ordered some time ago, and has just been put to work. The temporary plant is arranged as follows: Continuous current, generated at Dickinson-street at a pressure of about 420 to 440 volts, is passed through six rotary converters (Fig. 2), each having a capacity of 100 kw., and is by them transformed into three-phase current having a pressure of about 260 volts. The continuous sides of all these rotaries are supplied in parallel, and the three-phase sides also deliver in parallel into three omnibus bars on the switchboard shown in Fig. 3. From these omnibus bars the primary windings of static transformers are supplied, there being six sets of such transformers, each set consisting of three single-phase transformers, having their windings connected star fashion. The static transformers raise the pressure up to 5,000 volts, and at this pressure the three-phase current is at present transmitted to two sub-stations, separate mains being used from Dickinson-street to each of these, and a cross connecting main being run between the two sub-stations, so as to give an alternative supply to either sub-station through the other. At each sub-station the three-phase current is taken to high-pressure omnibus bars, and then through the primary windings to two sets of static converters, as is shown by the diagram of connections (Fig. 4). As at Dickinson-street, each set comprises three single-phase transformers, but the low-pressure winding has attachments made at 10 different points, thus giving 10 different pressures at will. The regulation of the number of turns on the low-pressure winding is effected by a multiple-contact switch, not unlike those used for accumulators. Thus a resistance is connected across each coil during the changing-over period, so that no short-circuiting of the coils occurs, as this would damage the winding by excessive current. From the low-pressure side of these static converters the current is passed into the slip-rings of two 100-kw. rotary converters, the continuous sides of each supplying into the distributing network. The high-pressure windings of all static transformers are connected star fashion. The switchboard arrangements are such that every rotary converter is controlled by an automatic cut-out, fuses are arranged throughout the system on both continuous and alternating current sides, and stock apparatus is employed as far as possible. The high-pressure switches are insulated wholly with porcelain, and give two breaks on each phase. Each of the switch contacts for this purpose is placed between two square slabs of slate, which prevent any cross arcing from one phase to the next. The whole of the switchboards and the connections are devoid of any inflammable material. Thus the whole of the high-pressure connections are made with bare copper on porcelain insulators without oil, and at Dickinson-street are completely enclosed by wire guards, the switchboard being fixed above the converters. Especial care has been taken to thoroughly earth every individual part of the framework and guards, as well as the handles of the high-pressure switches. As will be seen from the illustrations (Figs. 3 and 5), there is no accessible metal in the front of the board in connection with the 5,000-volt circuit. The rotary converters in the sub-stations (Fig. 5) are started up from the continuous-current side in all cases, and means are provided for varying the field excitation if desired.

The arrangement has been at work for about a fortnight with results satisfactory in every way, no hitch or difficulty of any kind having occurred. It is noteworthy that one of the sub-stations is supplying a load in which motive power largely preponderates, there being large engineering works taking some 350 h.p. close by. Before the sub-station was got to work this portion of the network was supplied rather indifferently at low pressure from Dickinson-street, with the result that the pressure, in place of being about 406 volts, was only from 320 to 330 volts.

The method of balancing the continuous-current three-wire network is one that may not be known to some of our readers, and as it is extremely successful and satisfactory it is worth describing. As already stated, the static transformers have their windings connected star fashion. To the middle point of the low-pressure winding of the step-down converters a connection is taken from the middle wire to the ordinary three-wire network, and the rotary supplies current directly across the outer conductors of the network. The whole of the balancing is done on the alternating side of the combination. Experiments show that the results obtained are quite as good as with the ordinary methods by means of balancing-motor-generators, if not better, and the elimination of the entire apparatus otherwise required is a material gain in every way. It may be mentioned that the middle point of the star on the high-pressure side at Dickinson-street station is connected to earth. The sub-stations are supplying in parallel with the low-pressure generating station, the network forming one continuous whole. It should be emphasised that the above arrangement is only a temporary one, as, of course, it would never be contemplated to permanently use a fourfold transformation such as that described. It is intended to generate the current in the permanent scheme directly at 6,500 volts.

The efficiency of the system is most satisfactory. Mr. Wordingham specified that the plant should be run at the maker's works, connected in such a manner that continuous current was taken in by a rotary converter, converted to low-pressure three-phase current, stepped up by a static transformer, stepped down again, passed through a second rotary, and the continuous current from this absorbed by an artificial resistance. In this manner measurements of continuous current only had to be made. When run under these conditions, after six hours the mean of the efficiencies at full load, threequarter, and half load was to be not less than 78 per cent. The actual tests of a combination run in this way gave an efficiency of 79·7 per cent. Other combinations were tested by a modification of the Hopkinson

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method, the continuous current being returned to the first rotary, and the efficiencies of the combinations measured in this manner varied from 78 to 80 per cent. Full particulars are given in the annexed table :

	First set. Per cent.	Second set. Per cent.	Third set. Per cent.	Fourth set. Per cent.	Fifth set. Per cent.	Sixth set. Per cent.	Required by specification
Full load	81·1	79·2	80·9	80·7	80·3	80·6	—
Threequarter load	80·3	80·6	80·8	80·0	78·9	80·6	78
Half load	77·6	80·0	78·3	78·0	75·3	79·0	74
Mean efficiency	79·7	79·9	80·0	79·2	78·0	80·0	78

The accompanying map shows the general scheme of the district supplied. The sub-stations are situated at the centres of the circles, which are half a mile in radius, those arranged for supplying Manchester and the adjoining districts of Moss Side, Withington, Heaton Norris, and Levenshulme being shown. Additional sub-stations will, of course, be required for other districts, the orders of which have been taken over—viz., Denton, Audenshaw, Droylsden, Prestwich, Failsworth, Whitfield, etc. The

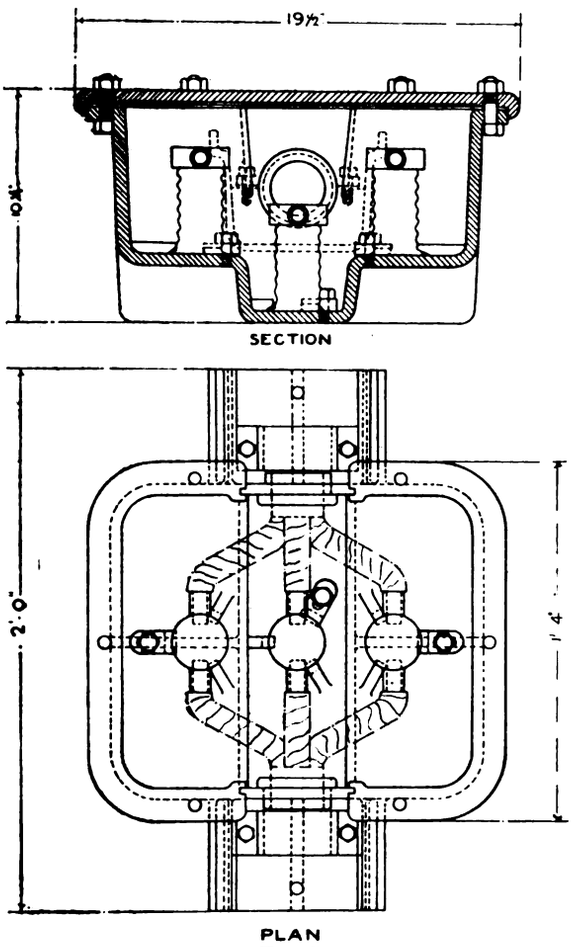

FIG. 7.

lines show the routes of the high-pressure three-phase mains serving to connect the sub-stations to the generating station at Stuart-street. The number of mains along each portion of the route varies with the number of stations beyond that portion. The number of mains leaving the Stuart-street generating station is 30. This is owing to the requirements of the Board of Trade, who could not be persuaded to allow mains having a larger capacity than 1,000 kw. each. The route towards Bennett-street and Openshaw will thus have 19 mains.

The general scheme of the arrangement of the mains is that there shall be a direct main from the generating station to each sub-station, and that there shall be an alternative means of reaching each sub-station. All the feeders under the scheme are to be of uniform size, each comprising three conductors of 0·15 square inch section, the conductors being stranded and made into the shape of a segment of a circle (Fig. 6) with rounded corners, thus enabling the conductors to lie more compactly together in the cable. The three conductors are laid up to form what is sometimes called a clover leaf cable, the insulation employed being impregnated paper, the impregnating material being practically dry. The insulation is enclosed within lead in the usual way, and over the lead is an armouring of round steel wires. The cables were supplied by the British Insulated Wire Company, of Prescot, and were laid by the Corporation's own staff. Owing to their large size they could not be made in greater lengths than 110 yards, and hence a considerable number of joints were necessitated. The method of jointing is described below : The cables are all laid on Callender's solid system in cast-iron troughs. The troughs are in 9ft. lengths, and contain either two or three cables. Ordinary wooden bridges are used, but in addition to these, one bridge in every length of troughing is of malleable iron, secured to

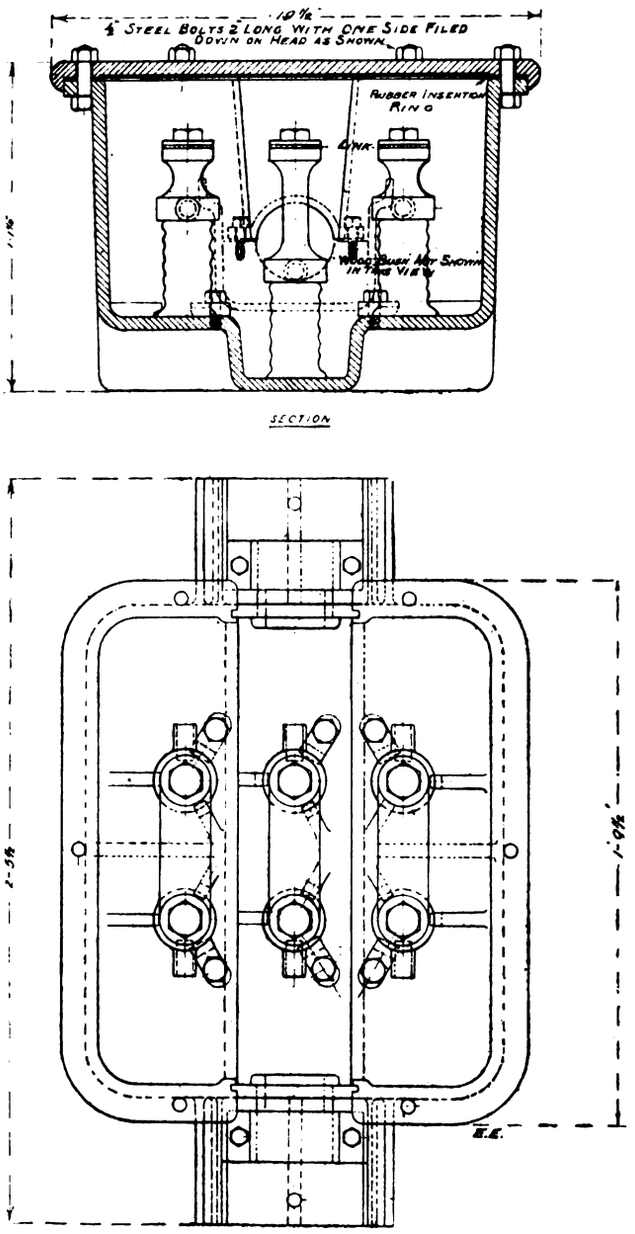

FIG. 8.

the bottom of the trough by set screws, and a malleable iron clamp is placed over the cable so as to secure efficient contact between the armouring and the length of troughing. By this means the cast-iron trough is rendered electrically continuous throughout the length of the cable. The troughs are covered by pitch-pine boards 1½in. thick, treated with Stockholm tar all over.

The joint-boxes were specially designed by Mr. Wordingham for the work, and are shown in Figs. 7 and 8. The boxes are of such a shape that the three conductors can be bent outwards from the centre of the cable, and have not to be brought into the same plane as one another. The brass connecting pieces are carried on porcelain insulators, giving very high insulation in air. These insulators are gripped of the bottom of the box by two wedge-shape lugs cast

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in the bottom, and a third, similarly shaped, fixed by a set screw, while the brass connecting pieces which they support are rigidly held by means of a kind of bayonet joint. The whole of the box is filled up with Callender's box compound, so that although the insulators are ample sufficient to insulate the conductors in dry air this is not relied upon, but is supplemented by means of the box compound, which has

ment is very convenient—indeed, the whole of the jointing is carried out without any complication. It will be noticed that the principle employed by Messrs. Callender and Co. in their joint-boxes has been utilised—namely, a sliding shutter to close the ends—thus enabling the sweating of the cables to be done outside the box.

A large proportion of the mains required for the per-

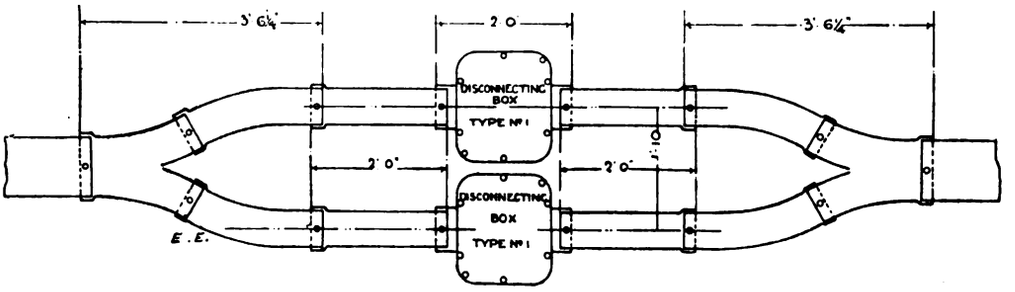

FIG. 9.

a very high dielectric strength. Another feature of these boxes suggested by Mr. F. E. Procter, mains engineer, who was responsible to Mr. Wordingham for the laying of the mains, consists in clamping together the armouring and the lead by means of clamps on the box itself, thus very neatly and simply ensuring the efficient connection between these, and avoiding any want of continuity in the earthed shield round the conductors. Owing to the high

manent scheme has now been laid, and three have been utilised for the temporary supply above described. As already stated, the mains brought into use comprise one from Dickinson-street to Moss Side station, another from Dickinson-street to Bennett-street sub-station, and a third from Moss Side to Bennett-street sub-station. These mains were all tested with a pressure of 13,000 volts between each conductor and earth, the other two conductors of the

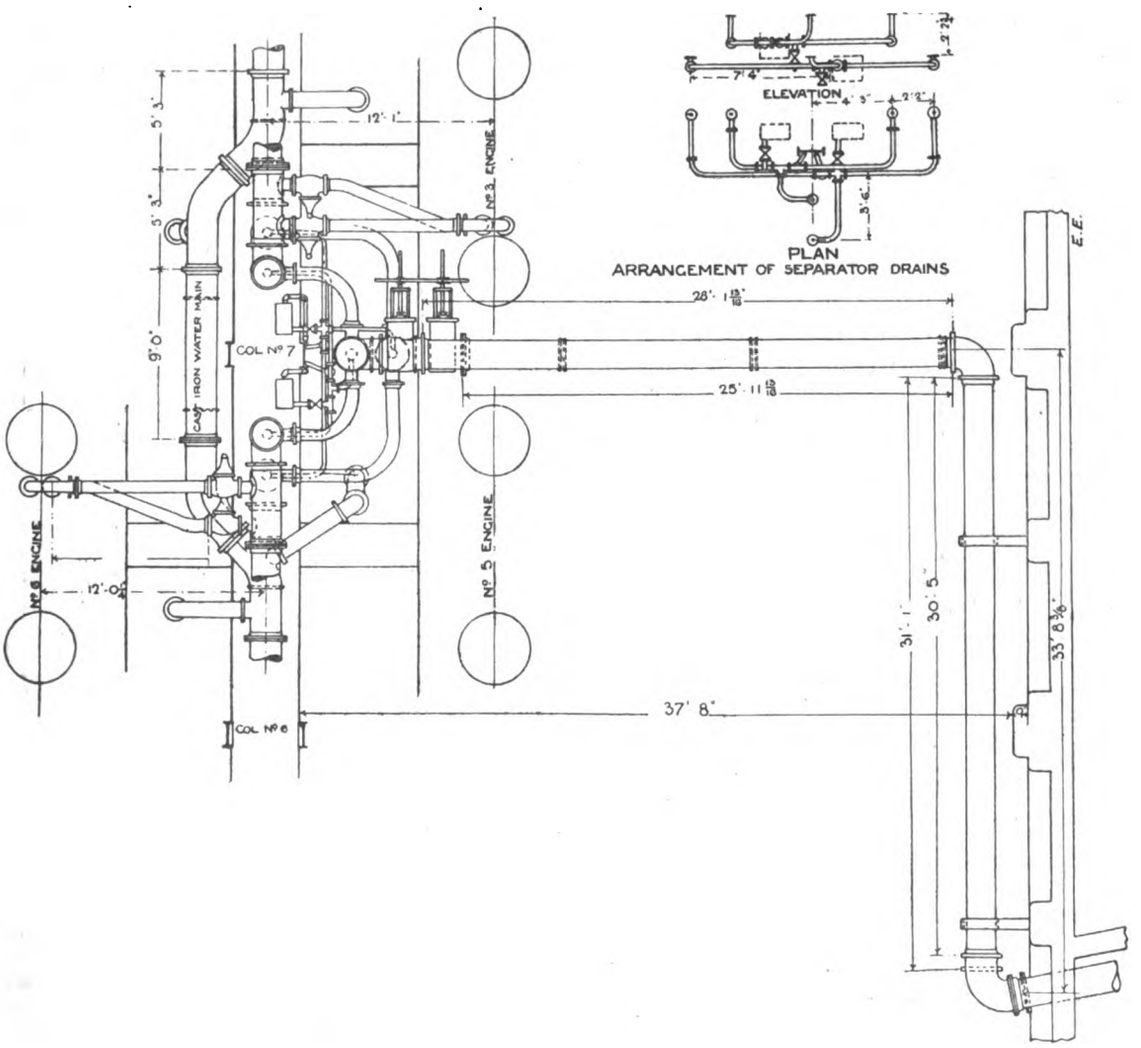

FIG. 10.—Plan of Expansion Sections, arranged by Mr. C. H. Wordingham for Large Steam-Pipes.

pressure it is unavoidable that the boxes should be somewhat bulky, and the method of leading the cables to them may be of interest. This is shown in Fig. 9, which shows joints on cables in a trough containing two feeders. It will be observed that a Y-shaped casing is fixed to the end of the trough, and two cables are taken into separate pieces of troughing, thence through the joint-box, and then again through a Y-shaped casing. The arrange-

cable under test and the armouring being connected to earth during the test, each conductor being tested in this manner in turn. The capacity of the conductors was similarly tested, and tests were made of the conductivity of the cables. These are all set forth in the accompanying table, and in all cases the joint-boxes are included in the test. The result of the equality of capacity between the conductors of the cable is most noteworthy, this being of

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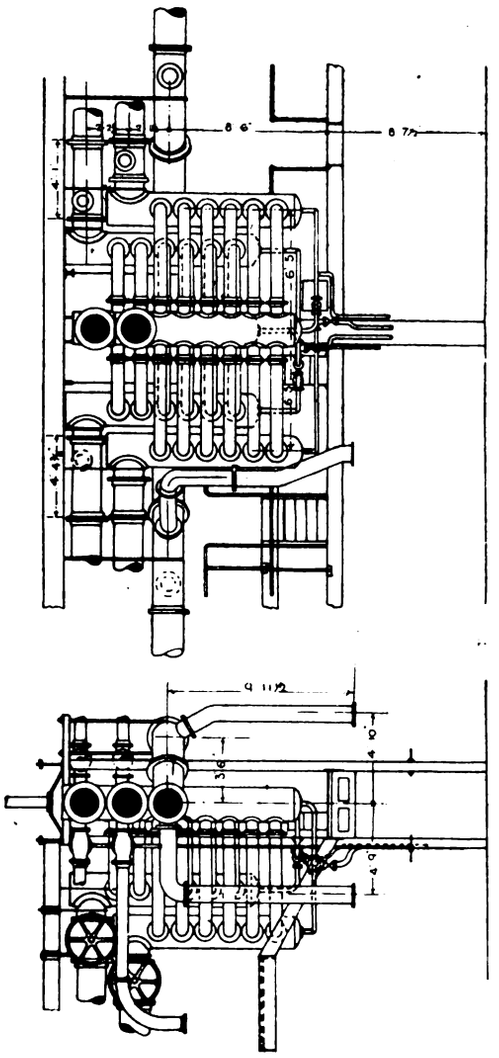
great importance on working with rotary converters. The requirements of the specification were severe, but the result actually obtained is seen to be better even than that specified. It is most satisfactory to know that the cables withstood a pressure test of 13,000 volts without the slightest hitch or mishap of any kind the first time the test was applied—a fact which speaks well both for the makers of the cables and for the staff engaged in laying them.

In Figs. 10, 11, and 12 we give details of an interesting design of Mr. Wordingham for providing against the expansion in the large steam-pipes at Dickinson-street station. The large size of the steam-pipes and the small space available prevented the employment of large bends, and matters were further complicated by the fact that tees had to be taken off from the bends. The use of a number of small-diameter pipes giving a spring bend has proved most successful.



FIGS. 11 AND 12.—Elevations of Expansion Joint.

The photographs from which Figs. 2, 3, and 5 were made were taken by Mr. R. Banks, of Manchester.

The whole of the transforming plant, together with the switchboards, was supplied and erected by Messrs. Thomas Richardson and Sons, West Hartlepool, the English representatives of Messrs. Brown, Boveri, and Co., and Mr. Oswald Dewey, distributing station assistant, was responsible to Mr. Wordingham for supervising the contractors during erection and for the carrying out of the efficiency tests.

TESTS OF THE B.I.W. CO 'S HIGH PRESSURE THREE-PHASE FEEDER MAINS LAID ON THE SOLID SYSTEM IN MANCHESTER

(1) *Dickinson street Station to Bennett street Sub Station.*

	Copper resistance per mile.	Insulation resistance per mile.	Capacity per mile.
A.	0·291 ohm	1,100 megohms	0·240 microfarad
B.	0·291 ohm	336 megohms	0·243 microfarad.
C.	0·291 ohm	205 megohms	0·245 microfarad

(2) *Dickinson street Station to Moss Side Sub Station.*

	Copper resistance per mile.	Insulation resistance per mile.	Capacity per mile.
A.	0·289 ohm	1,540 megohms	0·241 microfarad
B.	0·294 ohm	1,200 megohms	0·239 microfarad
C.	0·289 ohm	1,850 megohms	0·241 microfarad

(3) *Bennett street Sub-Station to Moss Side Sub-Station.*

	Copper resistance per mile.	Insulation resistance per mile.	Capacity per mile.
A.	0·293 ohm	265 megohms	0·243 microfarad
B.	0·287 ohm	434 megohms	0·241 microfarad
C.	0·288 ohm	535 megohms	0·243 microfarad

SLABY'S METHOD OF TUNING IN WIRELESS TELEGRAPHY.

[BY OUR SPECIAL CORRESPONDENT.]

In the course of a lecture delivered before the Kaiser in Berlin, at the end of last year, Prof. Slaby gave some remarkable demonstrations of the possibility of receiving several messages simultaneously on a single vertical conductor, each message being recorded on a separate telegraphic instrument as if no other disturbance had been present in the receiving conductor. Marconi has also in this country carried out some successful experiments in multiplex wireless telegraphy, but his method does not appear as yet to have been published. Slaby's method is explained in some detail in a full report of his lecture, with some additional notes, published in the *Elektrotechnische Zeitschrift*, vol. xxii., p. 38.

Attempts at tuning or syntonising the electric waves in the transmitting and receiving conductors have hitherto been made by making the product of their capacity and self-induction equal. Under these conditions, as is well known, the frequency of the electric waves generated in each conductor will be the same. Slaby has attacked the problem from a different standpoint—namely, by investigating the form of the electric wave in the vertical conductor, and determining its nodal points and ventral segments. He found that the alternating potentials were not uniformly distributed throughout a vertical conductor connected to earth, but increased towards the top of the wire. This was indicated by theoretical considerations, and was proved experimentally by causing them to act on a photographic plate.

The mechanical analogue suggested by this result was that of a vibrating steel wire fixed at one end in a vice. When an elastic wire so fixed is plucked to one side, the end of the wire fixed in the vice is a nodal point, and the free end of the wire being at the centre of a ventral segment has the maximum amplitude of vibration.

If the electric waves in a vertical conductor connected to earth are of the same nature as the vibrations in the steel wire arranged as described, then the earth should be a nodal point with no variation of potential, and the maximum variation of potential should be at the upper end of the wire. One important practical deduction follows from this—namely, that the coherer should not be intercalated in the conductor anywhere near the earth connection, as has hitherto been the almost universal practice, but as far away from it as possible—for instance, at the top of the wire. Now, it is evidently inconvenient to have the coherer fixed at the top of the wire, and Prof. Slaby has ingeniously got over this difficulty by a method suggested by an extension of his mechanical analogy.

If the straight steel wire is bent into L shape with two equal limbs, and the corner is fixed (not too tightly) in the vice, then vibrations produced in one limb will be transmitted through the nodal point in the vice to the other limb, in which they will be exactly reproduced owing to its length and natural time of vibration being the same. Applying this to the electric waves, we see that all that is necessary to get a point of maximum potential variation in an accessible position is to connect a horizontal wire of equal length to the vertical conductor where it makes connection with the earth. The free end of the horizontal wire is then a point of maximum potential variation, and here the coherer is connected.

The present practice of placing the coherer near the earth connection of the vertical conductor has only

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succeeded, according to Slaby, through the imperfections of the apparatus used. The length of the receiving wire is not usually exactly one-fourth of the wave-length (as, according to the mechanical analogy, it ought to be), and the earth connection is consequently not a true nodal point; and, moreover, the transmitting apparatus usually sends out parasitic auxiliary waves, which, near the earthed end of the receiving wire, produce small irregular variations of potential. To this circumstance is due the unreliability and frequent and unaccountable failures of the ordinary wireless telegraphic apparatus.

The extension wire for making connection with the coherer need not necessarily be straight; it may be wound on large reels, and in this form is much more easily handled. Slaby's arrangement so much heightens the effect of the electric waves on the coherer that vertical conductors without any special insulation, such as lightning conductors, flagstaffs, and the iron masts of ships, may be used. Slaby's method of tuning the receiving wire so that the coherer is affected by only one definite length of wave, can now be understood. One method is fairly obvious. If we make the receiving wire exactly equal to a quarter of a wave-length, or to any uneven multiple of the same, then all other waves for which the earth connection is not a nodal point pass freely into the earth, and do not affect the receiving apparatus. This apparatus is, for these waves, immune. The waves which are incompatible with the inherent rate of

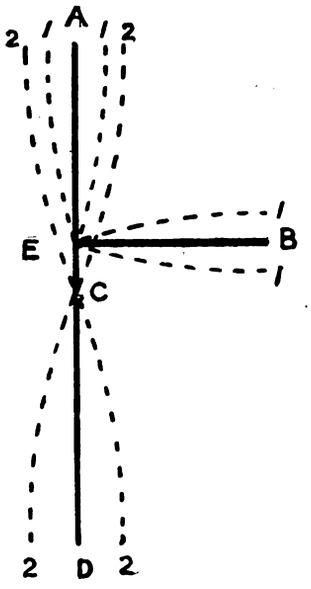

FIG. 1.

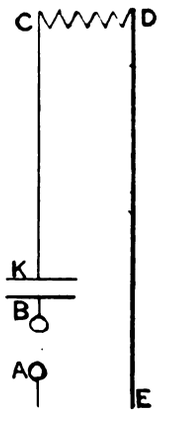

FIG. 2.

vibration of the wire are filtered or sifted out. The waves for which the earth connection is a nodal point create corresponding waves in the horizontal wire (of equal length with the vertical wire) which leads to the coherer. The coherer is therefore affected only by waves of a length which the vertical conductor is adapted to receive.

It would appear at first sight that with a given receiving wire only one kind of waves could be received, unless cumbersome apparatus for raising and lowering the vertical conductor was used; but Prof. Slaby has made a remarkable discovery by which almost any length of wave striking a vertical conductor can be caused to act upon a coherer, and, what is still more remarkable, each length of wave can be focussed on one coherer without affecting other coherers connected up to the same vertical conductor.

The *rationale* of the selective process may be explained by the help of the diagram (Fig. 1). A E represents a vertical receiving wire connected to earth at E. From this an extension wire, E B, leads to a coherer at B. When the ether waves that strike the wire A E are in length equal to four times A E, then E becomes a nodal point, and stationary potential waves represented by the dotted lines, 1, 1, are generated in A E and E B. When waves of a greater length strike A E, they will, as a rule, pass into the earth at E. But, by Slaby's ingenious device, a wave of any given length may be prevented from passing into the earth and directed upon another coherer. Slaby's device is to connect another extension wire, E D, to the vertical conductor at E, making the total length of A E+E D equal to half the wave-length to be received. Under these circumstances the wave forms a new nodal point at C, bisecting the total length of wire A D, the potential waves in this case being represented by the dotted lines, 2, 2. By connecting any convenient number of extension wires of different length to the vertical conductor at E, as many different kinds of waves can be received and caused to act on separate coherers.

The certainty of this sifting-out process, and the power of the waves to break down the resistance of the coherer, can be very much increased by the use of an exceedingly simple device discovered by Prof. Slaby, and termed by him a "multiplicator." The multiplicator is simply a small choking coil intercalated between the end of the extension wire and the coherer. It is necessary, however, that this coil should be tuned to the same frequency as the waves in the conductor to which it is connected. Slaby has proved experimentally that the multiplicator may increase the potential difference at the end of the extension wire as much as 10 times.

The inventor of this very simple and useful device does not profess to fully understand its theory, but he considers that it probably acts as a sounding-board acts to a tuning-fork. The learned professor, however, seems to have somewhat erroneous views as to theory and action of the sounding-board of a tuning-fork. He says, for instance, that the vibrating prongs of a tuning-fork are more quickly damped, or come sooner to rest, when the fork is not in contact without a sounding-board, than when the converse is the case. It can easily be shown by experiment that this is the reverse of the truth. Starting with these erroneous premises, he explains the action of the sounding-board by saying that the vibrations of the fork are transferred to another medium whose vibrations are less damped, and are increased in amplitude. The usual, and in our opinion the correct, theory of the sounding-board is that its larger surface prevents the air flowing away in currents, and thereby ensures the conversion of a larger proportion of the vibration energy into sound-waves in the air. The true analogue to the multiplicator is not the sounding-board, but the heavy pendulum which is set into violent vibration by a sufficient number of exceedingly small synchronous impulses. The self-induction of the coil corresponds to the mass of the pendulum bob, and the natural frequency of the electric vibrations in the coil is the same as that of the electric waves in the wire to which it is connected. The energy of many impulses in the wire is stored up in the ever-increasing swing of the magnetic field of the coil, till the E.M.F. acting on the coherer is multiplied, as we have seen in some cases as much as tenfold.

The sending or transmitting apparatus used by Prof. Slaby has several points of novelty about it. The object aimed at was to get the maximum possible amount of energy into the electric waves generated by the apparatus. For this purpose not only is a high tension necessary, but also a large quantity of electricity. Instead of a single insulated wire, as in the Marconi apparatus, a loop connected to earth at E (Fig. 2) is used. While the tension in the spark-gap, A B, is rising, the condenser, K, is charged through the earthed wire, E D, the coil, D C, and the vertical wire, C K. As soon as the spark passes at A B, the condenser discharges into the wire C K, but the waves generated in C K are not able to pass through the coil, C D, because it is asynchronous to these waves—*i.e.*, the natural frequency of electric oscillations in the coil, C D, is not in tune with the frequency of the waves in C K. The waves in C K have thus the advantage of carrying the large quantity of electricity stored up in K. The waves radiated into space are entirely generated by the vertical conductor, C K. The length of the waves sent out are completely determined by the length of the vertical conductor and the capacity of the condenser. The wave-length may be changed as required by intercalating tuned coils in the conductor, the electric inertia of which reduces the frequency.

Prof. Slaby gives, in an appendix to his lecture, a sketch of the mathematical theory on which his investigations

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have been founded. The theory of the transmitter leads to the following differential equation :

$$R\frac{dQ}{dt} + L\frac{d^2Q}{dt^2} = \frac{1}{C}\frac{d^2Q}{dx^2},$$

where R, L, C, and Q denote resistance, self-induction, capacity, and quantity, and x the distance from the end of the vertical conductor. The solution gives the equations :

$$Q = Ae^{-\frac{R}{2L}t} \cos\frac{2\pi}{T}t \sin\frac{\pi}{2l}x;$$

$$T = 4\sqrt{CL},$$

where A is a constant ; l the length of the wire ; R, L, and C are the quantities indicated by these symbols for the whole path of the wave, and $\frac{1}{T}$ is the frequency of the waves. The expression $\sqrt{CL}$ gives, when C is in electrostatic units, and L in electromagnetic units, in the case of

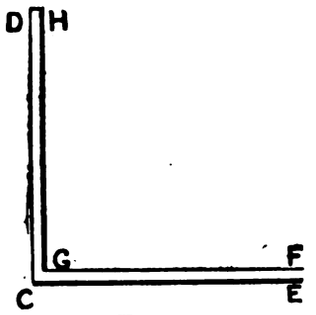

FIG. 3.

very long wires, the value of l, showing that the wave-length $\lambda = 4l$. The potential difference per unit length is

$$\frac{dV}{dx} = Be^{-\frac{R}{2L}t} \cos\frac{2\pi}{T}t \cos\frac{\pi}{2l}x.$$

These formulæ show that the length of the waves generated are four times the length of the vertical wire, and that the changes of potential in the wire follow a simple harmonic law.

The simple relation of the length of the wave to the length of the wire, only holds when the proximity of the earth to the wire causes insignificant changes in the capacity of the wire. Even small inclinations of the wire towards the earth effect considerable changes in its capacity, and, as a consequence, considerable increase in the length of the waves. The earthing of the spark-gap of the transmitter for this reason, introduces changes in its operation that are by no means to be neglected. These deductions from theory have all been verified by experiment in Prof. Slaby's laboratory.

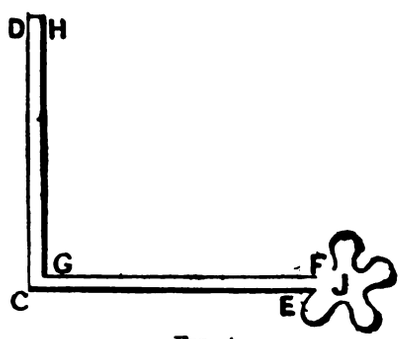

FIG. 4.

When the receiver has the form of a loop, as in Fig. 3, D being connected to H, and E and F free ends, C D and G H on the one hand, and C E and G F on the other hand, form exactly similar oscillations, having ventral segments at D and H and E and F and nodes at C and G. A spark micrometer inserted between E and F shows no difference of potential. If, however, a further extension, E J (equal to half a wave-length), is connected to E (see Fig. 4), there is a difference of phase between E and J of 180deg. The spark micrometer inserted between J and F gives nearly double the length of spark obtained between F and the earth.

The value of these experiments in the design of the transmitters and receivers in wireless telegraphy is self-evident. Another important experimental fact bearing on this question, discovered by Prof. Slaby, was that when the coherer is placed at the lower end of the vertical conductor a very large capacity exists between it and the earth, as much sometimes as a microfarad.

The arrangement sketched at Fig. 4 subjects the coherer directly to double the E.M.F. obtained in the ordinary arrangement, and enables it to be kept completely free from the influence of the earth. Another valuable property of this arrangement is that the coherer is not affected by the static charges in the atmosphere, and whoever has been engaged in experiments with wireless telegraphy knows how frequent the disturbances are which are due to atmospheric electricity.

Prof. Slaby's assistant, Count Arco, has devised an important simplification of the arrangement shown in Fig. 4. Since the potential at E and F is always the same, one-half of the loop, H, G, F, becomes unnecessary, and the coherer is inserted between E and J instead of between F and J. The possibility of such a receiver with no earth connection disposes of an assertion that has frequently been made—namely, that the transmission through the earth forms an essential factor in wireless telegraphy.

THE USE OF ELECTRICITY IN INDIA.

BY GEORGE CECIL.

Although India's best friend, or most ignorant and biassed admirer, cannot truthfully describe that uncivilised country as having embraced progress and all that appertains thereto, the fact remains that electricity, and the advantages which are to be derived from its use, are no stranger to "the unchanging East." It may be thought by the sceptical that the science in question exists in India but in its crudest form. This, however, is not so. Hindostan has advanced beyond extracting electric sparks from the back of the sombre-coloured grimalkin. Even the Leyden jar is forgotten. For if the newest developments of the science of electricity have not as yet been introduced to

The native is employed by the electrical engineer as a "handy man.'

the notice of Anglo-Indian *savants* and electrical engineers, at least the more generally known uses to which electricity has been put have, for some time past, been identified with commercial and industrial undertakings in India. Still, the fact remains that our exiled brethren, and the plum-coloured inhabitants of our Eastern Empire, are not apt to avail themselves to the fullest extent of the adjuncts and accessories of civilisation in connection with electrical appliances.

Though as far back as 600 B.C. Thales of Miletus is

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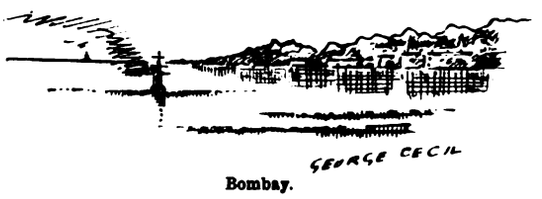
said to have experimented with amber, there is no record of any Aryan professor of electrostatics having published the result of his searchings in the papyrus edition of the Indian newspapers of the period. Nor do the archives of Hindostan's native Press contain any information to the effect that Theophrastus or Pliny were known to India's

An Indian Fruit Market furnished with the Electric Light.

electricians of that day—in connection with their amber and straw experiments. Although amidst the gleanings of electrical information coming to us from the Middle Ages we are able to extract the fact that Wolimer, the King of the Goths, was able to emit sparks from his arms and legs, and that to Anthero of Tiberius was administered electric

Ram-Dam of India.

shocks by the family doctor, there is nothing in Eastern writings to show that the experiments of Dr. Gilbert, of Colchester, in connection with alum, mica, salt, resin, sapphire, carbuncles, beryl, gum mastic, vincentina, and their power to attract light substances, were known in the East at the period during which they took place—namely, about



Bombay.

the year 1600. Robert Boyle, Otto von Guericke, Isaac Newton, Francis Hawksbee, Stephen Gray, Dufay, Boze, Winkler, William Watson, as well as the Royal Society, all experimented largely from 1627 to 1748. But it does not appear that in Hindostan the Ram Dams, Jeejeebhoys, and Chuckerbutties did likewise. Although eminently a kite-flying race, Franklin's experiment in 1750 was not copied by his dusky *confrères*, neither is there an instance of any public-spirited Oriental having suffered the fate of the intrepid Richman of St. Petersburg. Indeed, had a nigger scientist been found ready to risk a sacrifice, it is doubtful if a *fidus Achates* in the shape of a native Sokolow would have been willing to witness the experiment. Nor has India produced a contemporaneous John Canton. And as to the discoveries of Becarria and Symmer, Wilcke, Priestley, Cigna, Delaval, Kinnersley, Wilson, Cavendish, Coulomb, and Galvani, they were unnoticed in the East—the somnolent East. Neither have India's scientific historians made any mention of, or allusion to, the research of the celebrities named. Possibly had the then unconquered Orient possessed an Æpidus, interesting manuscripts bearing on how the news of their discoveries was received in Calcutta and Bombay might now be on view in the museum of India's capital. Perhaps Lord Curzon, the Viceroy, who is known to be an enlightened patron of the sciences, will cause an exhaustive enquiry to be made as to why from 1706 to 1806 no Government historian was engaged in summarising the Oriental march of electrical development and science. And since so unique an opportunity for the consumption of red-tape, eyelets, and official paper is too tempting a plum to escape the official appetite, it is moderately within the bounds of possibility to expect to find such an enquiry instituted, and at a comparately early date—say, during the coming century.

The man of mixed parentage makes but an unsatisfactory telegraph clerk.

The plum-coloured rapscallion who bilks the electric bel supplier.

The more ancient application of electricity in India, as elsewhere, is the telegraph. The wires spread their tortuous lengths throughout the length and breadth of the land. To the most remote place a loving message may be dispatched, or an insulting remark may be hurled. The wife of the "Commissioner" (a local *Pooh-Bah*) of Lucknow will angrily enquire of the Bombay bootmaker "why he has made her boots big enough to fit an elephant"; and the man of commerce will reply that he "has given her a perfect fit." By means of the nearest telegraph office, and a couple of rupees (2s. 8d.), these messages will be transmitted. With the exception of the villages, every place in Hindostan possesses an office from which telegraphic messages may be dispatched. The railway stations are equally blest. It should be added (in case the reader runs away with an unduly exalted idea of India's civilised attributes) that the telegraph system is controlled by the Anglo-Indian intelligence—a strange and weird evolution—and ministered to by the Eurasian (idiot) element.

The telephone is also greatly *en évidence*. In Calcutta each mercantile office of any importance possesses one of these useful appendages, and even in benighted Madras they are not unknown. In Bombay, Cawnpore, and elsewhere, they have for some years past been popular,

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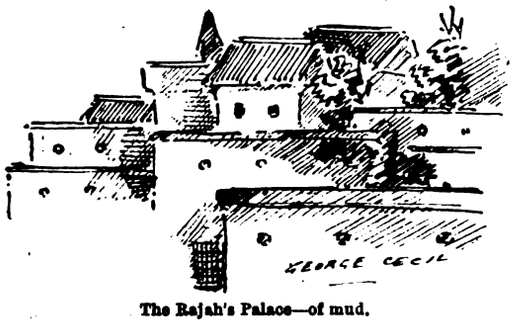
and the semi-barbaric rajahs and other Aryan ragamuffins have their palaces and the houses of their rag, tag, and bobtail prime ministers, and other rapscallion dependants, fitted up with them. Indeed, more than one maharajah and other Oriental potentates will ring up their prime ministers or grooms of the bedchamber at three o'clock in the morning, with a view to asking them if it is raining or if it is going to be a hot day.

Electric lighting is at present confined to Calcutta, Bombay, and one or two other towns. The more enlightened of the wealthy Aryan community also possesses installations, for which, in all probability, they will endeavour to avoid paying; for the heathen man and brother is, alas, a sadly dishonestly intentioned person.

The Prime Minister, a Sikh.

The Rajah; he indulges in electric light.

Though the infernal and ear-splitting noise of the telephone bell pleases him, he strongly objects to settling the electrician's "little account." The dazzling light which is born of electricity pleases him immensely; but he does not dazzle the electrical engineer with an alarming readiness to settle the bill. In fact, as often as not, that painful episode, the "summons for debt," has to be applied to the black royalty before he can be prevailed upon to grudgingly disgorge. In several jute and cotton mills the electric light is to be found, as also in one or two merchantile offices of the more important of India's towns. The steamers which ply between Calcutta and Burma, and between Bombay and the coast ports, are similarly supplied; and the passenger line which conveys Hindostan's moneymaking inhabitants to China and Singapore, as well as the Royal Indian Marine steamers (which transport troops from India to other Eastern stations), are replete with that light which affords the maximum of quality with the minimum of danger from fire.



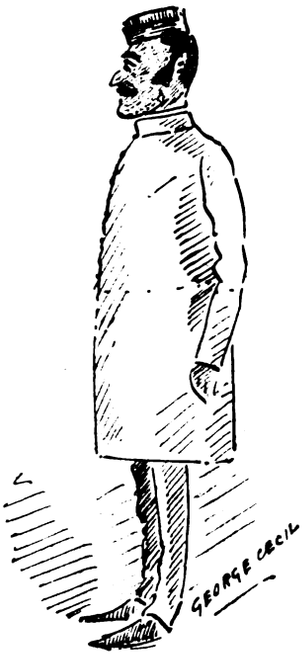
The Rajah's Palace—of mud.

Nor are the Anglo-Indian medical fraternity backward in appreciating the healing powers of the galvanic battery. Though the patient would have reason to fear the application of this instrument at the hands of many exiled and domiciled doctors, he readily subjects himself to be operated on by "civil surgeons" of reassuring qualifications.

Electric bells are to be found in a few regimental messes and in several hotels. As they are apt to get out of order somewhat easily, possibly owing to the inexperience of the Eurasian mechanic who undertakes to mend them, they are occasionally known to provoke exceeding great anger.

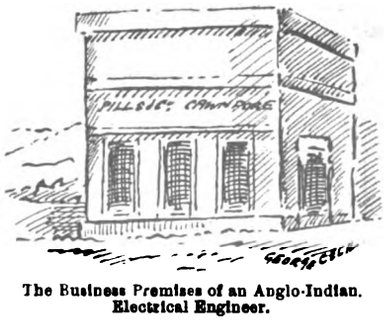
Though electricity has made strides in India of late years, the latest and most improved appliances are not, perhaps, in general request. Arc lamps are to be found in more than one Indian town, as is also the electric fan—in fact, the latter is rapidly becoming popular. In this connection it may be observed that in Calcutta and Bombay there is a possibility of this useful development of elec-

The Eurasian—two parts fool, and the other foolish.



The Parsee millionaire.

tricity enabling the exile and martyr to dispense with the "punka," and its attendant demon—the "punka-wallah.' In the Protestant cathedral of Calcutta the innovation in question rules the roost; but, with that lack of commonsense which distinguishes the Anglo-Indian from his fellow-beings, the powers-that-be have caused the fans to be hung too high. Thus are the perspiring worshippers deprived of the full benefit of this cooling apparatus. Dynamos and motors are shipped to Calcutta, Bombay, Madras, and Kurrachee in fairly large quantities, as are also telephones and their adjuncts. Incandescent lamps, and turbines (for tea-garden use), are occasionally cleared by the landing agents; but brass floor standards and lamps for the drawing-room are not as yet in demand. Batteries for the use of the Government telegraph department, and



The Business Premises of an Anglo-Indian Electrical Engineer.

to the order of mercantile firms, are exported by several manufacturers.

Electric tramways have not, up to the present time, adorned the metropolitan thoroughfares of India's leading cities, though the subject of their introduction is sometimes mooted.

Nor are electrical elevated railways in vogue. Possibly a Parsee millionaire may desire to gain undying fame by presenting to the city of Bombay a system of this nature. Should he, however, own shares in the local tramway company, he will probably refrain from this method of gaining immortality; for Oriental desires are firmly restrained and governed by economical tendencies. The machinery of the jute, flour, cotton, paper, bone, and sugar mills is not, it may be added, driven by electric power.

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THE DIESEL OIL-ENGINE.

In further reference to the Diesel oil-engine, which we described in our last week's issue, the indicator diagrams we then gave were taken while we were inspecting the engine, and we had not the diagram of the air-clearing cylinder. Through the courtesy of Messrs. Scott and Hodgson, we are now able to give three more diagrams, which represent the normal working of the engine in question. Thus Fig. 1 is of the power cylinder, which is

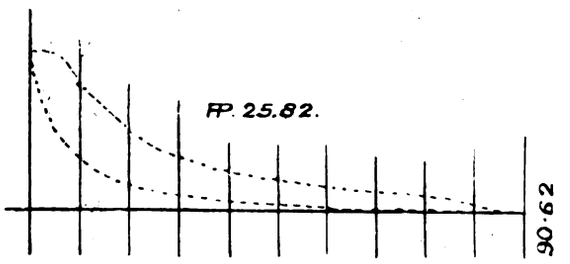

FIG. 1.

7⅞in. in diameter with a 10¾in. stroke. The diagram was made with a spring with which an inch marked on the diagram equals 500lb. At 216 revolutions, the power developed is equal to 25·82 h.p. In Fig. 2 is shown the action of the clearing cylinder, of which the diameter is 9in., and which works on the same piston rod as the working cylinder.

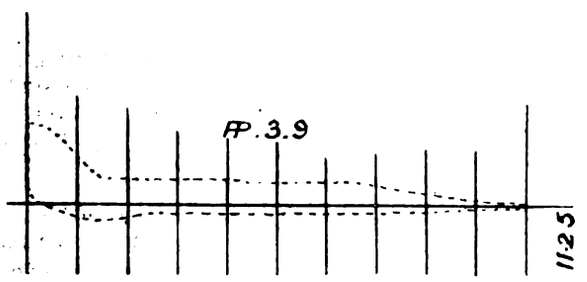

FIG. 2

This diagram, which shows that some 3·9 h.p. is consumed in the compression of the air, was made with a spring in which 1in. deflection corresponded to 60lb. On the left-hand side of this diagram will be seen the high compression at the end of the stroke, at which point air is taken into the smaller air-pump. Fig. 3 is a diagram of the small

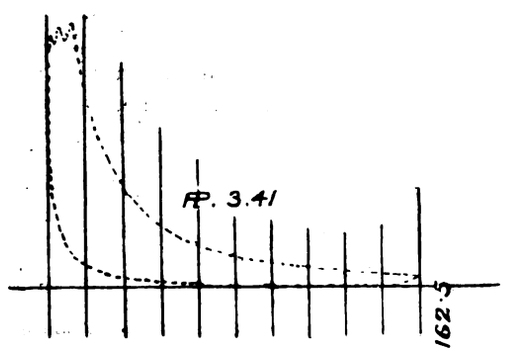

FIG. 3.

air-pump, the diameter of which is 3⅛in. with a 5½in. stroke. This diagram was also made with a spring of $\frac{1}{100}$. In reproducing the diagrams we have kept them at full size.

BOOKS RECEIVED. — We have received from the publishers, Messrs. Thomas Nelson and Sons, a work entitled "Differential and Integral Calculus for Beginners," by Edwin Edser, A.R.C.S., F.Ph.S.; price, 2s. 6d. From Messrs. Longmans, Green, and Co. we have "Twentieth Century Inventions—a Forecast," by George Sutherland, M.A.; price, 4s. 6d.

BRIGHTON ELECTRIC LIGHTING ACCOUNTS.

The Brighton electric lighting accounts for the year ended Dec. 31, 1900, have just been published. The total expenditure on capital account to this date amounts to £339,601. We give herewith an abstract of the revenue account, general balance sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£11,151	3	2			
Oil, waste, water, and stores	1,329	18	9			
Wages at generating station	5,355	6	0			
Repairs and maintenance: buildings, £885. 6s. 9d.; engines, boilers, dynamos, etc., £1,672. 10s. 11d.	2,557	17	8			
				20,394	5	7
Distribution of Electricity.						
Wages and other remuneration	665	8	7			
Repairs, maintenance, etc., of mains	709	5	4			
	1,375	14	11			
Repairs, maintenance, etc., of transformers, meters, etc.	1,013	5	4			
Outlay for works executed	708	2	1			
				3,097	2	4
Public Lamps.						
Street lighting installations	472	1	5			
Attending public lamps and repairs	3,711	17	6			
				4,183	18	11
Rates and taxes				1 236	12	4
Management Expenses.						
Salaries	2,976	11	11			
Stationery and printing	316	11	5			
Registrar of stock, and stamp duty	179	0	10			
General establishment charges	285	8	2			
				3,757	12	4
Insurances	144	18	6			
Law expenses	11	7	0			
				156	5	6
Total expenditure				32,825	17	0
Amount carried to net revenue account				19,600	0	0
Balance to be carried to next account				185	11	11
				£52,611	8	11

Cr.	£	s.	d.
Balance from last account, £144. 10s. 2d.; less bad debts written off, £130. 8s. 11d.	14	1	3
Sale of current per meter: 1,158,147 units at 7d., £33,779. 5s. 9d.; 1,898,710 units at 1d., £7,911. 5s. 10d.; additional (minimum) charges under special contracts, £65. 17s.	41,756	8	7
Public lighting: 66,591 units at 7d., £1,942. 4s. 9d.; 603,275 units at 1d., £2,513. 12s. 11d.; attending, etc., £3,711. 17s. 6d.; installation works, £472. 1s. 5d.	8 639	16	7
Rental of meters, works executed, rents receivable, interest on cost of main	2 201	2	6
	£52,611	8	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital—amount received	285,139	0	7
Premiums on stock issued, £13,118. 3s. 1d.; less discounts and costs, £3,506. 16s. 4d.	9,611	6	9
Sundry creditors	10,295	19	9
Customers' deposits	1 604	19	3
Interest accrued due	920	13	6
Proportion of appropriation in respect of sinking funds accrued due	6,887	14	9
Balance at credit of revenue account	185	11	11
Balance at credit of net revenue account	107	15	2
Treasurer	4,035	9	4
Reserve fund	1,792	4	5
Surplus account	39 021	15	1
	£359,602	10	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	335 104	18	0
Stores on hand	1 932	5	8
Sundry debtors for current supplied	15,312	10	9
Other debtors	4	15	0
Engineer's advance	50	0	0
Reserve fund investment	7 198	1	1
	£359,602	10	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		4 391,255
Quantity sold	Public lamps 669,866	
	Private consumers by meter 3,056,857	3 726,723
Quantity used on works		180,915
Total quantity accounted for		3,907,638
Quantity not accounted for		483,617

Number of public lamps, 262 arc, 1,242 incandescent.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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AMERICAN ENGINEERING COMPETITION—A NIGHTMARE.

Poor England! According to the chatterers throughout the daily Press of her own land, the fiat of her doom has gone forth, and she is ere long to sink into commercial insignificance. The land of the "Stars and Stripes" is to compass this end. Not long since the *Times* took up the work of damnification, and the articles that appeared in the "Thunderer" under the heading "American Engineering Competition" have now been published in book form by Harper and Brothers. We are glad this is so, because reference is far more easy, and we take it the work gives the best that can be said for America and the worst that can be said for us. The author had to give the American side, not ours. What he says is interesting. Much is true and worthy of the most careful consideration, though much is useless if used in argument for America. In the second article, on "Imports and Exports" (p. 9), the author gives the American policy as follows: "It is their intention when the reaction in trade comes, or when supply is in excess of demand, *to keep up values in America by stinting the supply to the home market, and to force the export trade by cutting prices for foreign countries.*" (The italics are ours.) Adam Smith, Bentham, Bastiat, or Mill should have dealt with this as an economic problem, but they are gone; yet we may well ask how it strikes the economists of to-day. Bastiat says, "When a man by his labour has made some useful thing—in other words, when he has created a *value*—it can only pass into the hands of another by one of the following modes: as a gift, by the right of inheritance, by exchange, loan, or theft." The author of the articles must put his own interpretation upon the words by which he has defined the American policy; ours may be wrong, but, such as it is, we give it. The Americans are to "create a value." This value can be measured in the ordinary way by a monetary basis. Assume the value of x pounds per ton of iron. Does the policy of the Americans mean that they will give us as a gift a part of the value they have created? If so, many thanks. Does it mean that their customers at home are to pay an excess fictitious value, say $x + y$ pounds per ton, so that the manufacturers may make us a gift of y pounds per ton, or any other non-American buyer? If so, again many thanks. If it does not mean one of these things, what does it mean? The author, indeed, states that "a reversal of the protective policy of the American Government to free-trade principles would upset these schemes, but American manufacturers have little fear of such a contingency. . ." A protective tariff means, of course, an excess over the true created value x, and, again, is a real gift to buyers outside the States if the policy is pursued; but we admit, as all must admit who trouble themselves to think, that a "gift" may have disastrous results for someone. Let us show this by a simple, homely example. A grocer establishes himself in a village and sells his sugar and tea fairly and honestly. The squire comes along, and during a fit

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of compassion opens another shop, and sells tea and sugar to the villagers at half the price of the grocer, bearing the loss out of his own pocket. He makes certainly a gift to the villagers, but what about the grocer? His custom goes, and he is ruined. Are the Americans graciously going to be generous, and present the world outside America with a free gift? If so, it will be good for the world in general, though in the concrete some suffering will be caused by the reorganisation of capital investment and of labour. On the whole, we may take this declared policy as part of the game of bluff—it is economically unsound, and Americans are not fools. The real question is, whether the American ironmasters can produce a ton of pig iron at a lower cost than British ironmasters? To this question Sir Lowthian Bell has replied "No," and there is no greater authority than he; hence why trouble about the "policy."

SECONDARY EDUCATION.

The decision given in the Court of Appeal last Monday on the case of "The King against Cockerton," will tend to clear up the muddle at present attending the organisation of secondary education in the United Kingdom. The Master of the Rolls on that day delivered judgment, in which Justice Collins and Lord Justice Romer concurred, to the effect that the London School Board had no powers to provide, out of rates, art schools and classes of the kind presided over by the Science and Art Department. It will be remembered that an auditor of the Local Government Board surcharged and disallowed certain sums which had been spent by the School Board on such classes. The auditor's action was endorsed by the Divisional Court, and it was against this decision that the School Board appealed unsuccessfully. The result is good in one way, in that it tends to keep down the number of the secondary schools to reasonable limits. Up to the present, although the State has subsidised such education by grants on examination results, far too much has been left to private enterprise. The school boards will now be prevented from competing out of rates with privately equipped institutions for secondary education, but a satisfactory state of affairs will only be reached when such education is officially organised and controlled by the State, and thus all wasteful competition between rival institutions in the same district prevented.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

INDUCTION EXPERIMENTS.

SIR,—On p. 442 of your issue for March 29 you publish an account of some "Induction Experiments" by Mr. Emile Guarini. Several experiments are described in which the author uses induction coils, and, as I understand it, obtains on a galvanometer which is connected to the secondary coil a continuous deflection *in one direction*, this deflection being produced by induction from an interrupted current in the primary.

Now, considering the secondary coil alone, what is the meaning of such an induced *continuous* current? (I am assuming such a possibility.) A fundamental law of current induction is that the quantity of electricity set moving in a circuit by induction is directly proportional to the amount of magnetic flux cut by the circuit and inversely proportional to the resistance of that circuit. Or, if M be the total flux cut by a coil of one turn and resistance R, then $Q = \frac{M}{R}$, where Q is the quantity of electricity moved.

Now, in order to effect a continuous transfer of electricity in one direction, the flux must continually be cutting the coil in one direction—*i.e.*, the flux in the coil must be *continuously increasing* in one direction. A little reflection shows this to be an impossibility unless the primary current increases continually in one direction. I understand Mr. Guarini's explanation of the continuous deflection to be that the two half-waves of induced current are not equal, which inequality causes a continuous current, on the whole, in one direction. But the foregoing argument also applies to this—viz., the flux would be required to continually increase, on the whole, in one direction.

The only way in which to account for the continuous deflection of the galvanometer must, so far as I can see, be found by examination of the action of the instrument itself. In any case surely a "continuous" current was not flowing in the secondary circuit, or even a rectified one.

Mr. Guarini also states that in a certain case the primary current at "make" rises instantly to its maximum value (p. 443, line 29). He also represents this in Figs. 6 and 8 by the line 13-14 rising vertically. This, again, is an impossibility, as it would require an infinite primary E.M.F., and would induce an infinite secondary E.M.F., whereas no secondary E.M.F. is shown (in Fig. 8) in the negative direction.

I must apologise for trespassing on your space, but it seemed to me that the experiments required comment.—Yours, etc.,

R. C. CLINKER.

HIGH-VOLTAGE LAMPS.

SIR,—We notice that at the Board of Trade enquiry into the question of the change of electrical pressure, several expert witnesses brought forward the subject of the inefficiency of the 200-volt lamp.

It may be of interest to state that we have lately been carrying out tests on both 200-volt and 100-volt lamps, and we may mention that we have found, taking an average number, that the 200-volt lamps of one maker consumed at start 4 watts per candle, increasing to 4·3 watts per candle after 500 hours, whereas the same maker's 100-volt lamps consumed 3·5 watts per candle at start, increasing to 3·7 per candle after 500 hours.

In the case of another maker, the 200-volt lamps had an efficiency of 2·8 watts per candle at starting, increasing to 3·2 watts per candle after 500 hours, whereas the 100-volt lamps by the same maker consumed 3·1 watts at first, increasing to 3·7 watts per candle after 500 hours.

Of course, it is not our place as independent testing authorities, to offer opinions on results, but we give these results for what they are worth, hoping that they will be of interest.—Yours, etc.,

THE ELECTRICAL TESTING LABORATORIES, LIMITED.
(L. W. Wild).

Westminster, S.W., March 30, 1901.

ELECTRIC MINERS' LAMPS.

SIR,—During the meeting of the Institution of Electrical Engineers on Thursday last, the impression was created and raised in the discussion (through a slip) that the gas detector on exhibition in the room was the property of the Sussmann Electric Miners' Lamp Company, of 37, Walbrook, E.C. I beg to state that the indicator has never been connected with the above company, but is known and patented as "Prested's indicator for detecting the presence of dangerous gases," and the *sole address*, 44, *Brecknock-road*, *N.W.*

I sincerely hope that the unfortunate mistake can be rectified when reporting in your valuable paper.—Yours, etc.,

FRED. J. TURQUAND (part inventor).

12, Oxford-gardens, Ladbroke-grove, W.,
March 30, 1901.

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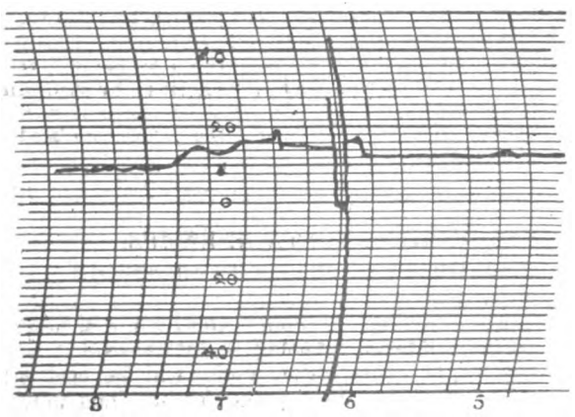
BARE COPPER MAINS.

An objection frequently urged against bare copper mains, even by those who admit their many points of superiority over any other class of main, is that in the event of a water-pipe bursting they may be short-circuited and greatly damaged. It may not be uninteresting, therefore, to give particulars of an instance in which such a mishap occurred in Manchester. About 6.25 a.m. on March 28 a 15in. cast-iron water-main laid in Miller-street, burst. Along the same street there runs a concrete culvert containing five quarter square inch conductors laid on the Crompton system. Manholes about 3ft. 6in. by 3ft. 6in. by 5ft., provided with ventilating covers, are fixed at each end of the culvert. The main was not cut off until 7.30 a.m. No effect was felt at the station and there was very little disturbance in the earth current, as will be seen from the accompanying tracing taken from the recording ammeter through which the connection to earth from the middle wire is made. The current rose from 12 amperes, the normal to 17 amperes, then fell off to the extent of two amperes, and momentarily attained a sufficient value to throw a circuit-breaker set for about 80 amperes. This circuit breaker was restored within about three minutes, when the earth current was found to be only 14 amperes, remaining at this value until the main was cut off. On opening out the culvert, it was found that the water from the main had rushed through it, and the lower end—the street having a considerable gradient—was



Record taken by recording ammeter in the earth connection at Manchester where water got into the conduit with bare copper mains.

actually filled up with soil carried in by the water. On enquiry it was found that the water had entered the culvert, and had actually put a very considerable pressure on it, a pressure sufficient to force off the covers from both manholes. It was through the open manholes that the soil was enabled to enter the culvert. The pressure of water in the water-main would be approximately 90lb. per square inch, and the amount of damage done to the roadway and footpath was very considerable, a great deal of soil being washed away into the basements of the houses. The culvert was found to be uninjured, and after being thoroughly cleaned out was covered in again, and the supply re-established by about 6 p.m. We are indebted to Mr. C. H. Wordingham for the above facts.

PRESENTATION TO MR. C. H. WORDINGHAM.

A pleasing ceremony was performed on Monday afternoon at the Dickinson-street electric works, at Manchester, when the members of the official staff and workmen in connection with the electricity department met together for the purpose of presenting to Mr. C. H. Wordingham, M.I.C.E., an illuminated address, accompanied by a valuable microscope complete with its accessories, as a token of their high appreciation and esteem, and in recognition of the eminent services which he has rendered to the department. The address, to which was appended the signatures of the whole of the staff and workmen, read as follows: "We, the staff and workmen of the electricity department, desire to avail ourselves of the opportunity afforded by your retirement from the important and responsible position as city electrical engineer to the Corporation of Manchester, by venturing to ask your kind acceptance of this address, accompanied by a microscope, as a small token of our high appreciation and esteem, and in recognition of the eminent services which you have rendered. We have not failed to recognise the straightforward and honourable principles which have actuated you in all your business relations during your period of office here, and we desire to place on record the extreme courtesy and friendly feeling which you have always manifested. We much regret that you are leaving, and in asking your acceptance of this address we beg to convey to you our heartfelt wishes for your future welfare, and sincerely trust that you will be spared to enjoy a long, happy, and prosperous life."

The illuminated address and microscope were presented in a very able manner by Mr. W. F. Long, the senior assistant engineer remaining at the works, and before acknowledging the gift various members of the staff testified to Mr. Wordingham's exceptional worth and ability, and to his eminently successful and brilliant career with the Corporation, and to the uniform kindness which had endeared him to all in the department. It was stated that Mr. Wordingham's efforts had been the means of making the undertaking not only a successful one financially, but also one the magnitude of which was not equalled by any in the United Kingdom.

Mr. Wordingham heartily thanked those present for the handsome gift presented to him. In an appropriate speech he stated that he was particularly pleased with the unanimous expression of goodwill, and, although he fully valued the magnificent instrument, he appreciated the illuminated address in a much fuller sense, as he knew that the signatures contained therein were the names of sincere friends.

Mr. Wordingham was listened to with every attention, and at the close hearty cheers were given for him. "For he's a jolly good fellow," and the singing enthusiastically of "Auld Lang Syne," brought to a close a meeting which will always be recalled with feelings intermingled with pleasure and regret in the memories of those who were present. The microscope was supplied by Messrs. Becks, of London.

FORTHCOMING EVENTS.

THURSDAY, APRIL 4.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper on "The Proportions of Cylinders for Multiple-Expansion Engines," by Mr. A. Hanssen.

SATURDAY, APRIL 6.

Glasgow and West of Scotland Scientific Society.—General meeting.

WEDNESDAY, APRIL 10.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., ordinary meeting.

FRIDAY, APRIL 12.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper on "Iron Lined Tunnelling Construction," by Mr. A. Woodroffe Manton.

SATURDAY, APRIL 13.

Institution of Junior Engineers.—At 3.30 p.m., visit the Great Northern and City Railway works to inspect the plant described in Mr. Manton's paper.

MAY 8 AND 9.

Iron and Steel Institute.—At 10.30 a.m. each day, annual meeting at the Institution of Civil Engineers. Report and treasurer's statement for 1900; presentation of the Bessemer gold medal for 1901 to Mr. J. E. Stead, F.I.C.; president's inaugural address. Among the papers expected to be read are the following: "On the Physical Properties of Steel," by Mr. J. A. Brinell; "On the Heat of Formation of Carbides and Silicides of Iron," by Mr. E. D. Campbell; "On the Use of Hydraulic Power in the Manufacture of Iron and Steel" by Mr. R. M. Daelen; "On Dust in Blast-Furnace Gas," by Mr. A. Greiner; "On the Economical Significance of High Silicon in Pig Iron for the Acid Steel Processes," by Mr. Axel Sahlin; "On the Effect of Copper in Steel Rails and Plates," by Messrs. J. E. Stead and John Evans; and "On the New Bessemer Shop and Heating Pits at the Works of the Barrow Hematite Steel Company," by Mr. J. M. While.

Institution of Mechanical Engineers.—The annual dinner arranged for the 18th inst. has been abandoned.

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LIGHT RAILWAYS.

In the House of Commons on Monday Mr. G. Balfour asked leave to bring in a Bill to amend the Light Railways Act, 1896, explaining that its object was to continue the powers of the Commissioners for five years, pay a salary not exceeding £1,000 a year to a second commissioner, who was to be a barrister of not less than seven years' standing, and that of the £1,000,000 authorised to be advanced, £750,000 should be available for special advances and £250,000 for other advances. Leave being given, the Bill was brought in and read a first time.

The Commissioners have decided to report in favour of the granting of an application by the Lyndhurst Electric Light and Traction Company, Limited, for powers to construct a light railway from Lyndhurst-road Station to Lyndhurst Town, a distance of over two miles.

The Worcestershire County Council have instructed their Highways and Bridges Committee to consider and report what light railways are required in the county, and whether it is desirable that the Council should apply for powers with reference to the construction of any or all such railways. It is proposed that the county road surveyor should make a list of the roads on which light railways might properly be made, the Council to decide whether it is desirable to obtain orders. Any company wishing to construct railways will be asked to do so on the terms settled by the Council.

A projected light railway between Ripon and Kirkby Malzeard has been approved by the Ripon Rural District Council.

At the last meeting of the Glamorgan County Council a report was adopted of the Parliamentary Committee stating that, in consideration of the Pontypridd District Council agreeing to carry out the scheme of their proposed tramways with a clause providing for satisfactory widening of the county road, and also to purchase the existing tramways in 1903, and to oppose any extension of such period, the Council should not oppose the granting of the tramway order now applied for so far as it related to their roads.

In the House of Commons recently Mr. Weir asked the President of the Board of Trade whether he was aware that only two light railways have so far been constructed in the six Highland crofting counties under the terms of the Light Railways Act, 1896, and that many of the proposed railways for which the Secretary for Scotland had long since granted certificates on the ground that they were necessary means of communication between fishery harbours and the interior of the country, and cannot be constructed without special assistance the State, have been abandoned by the promoters owing to the terms of the Act; and, in view of the difficulty experienced in obtaining local aid for the construction of such railways in the Highlands, would the Government consider the expediency of so amending the Act as to admit of effect being given to the recommendations of the Secretary for Scotland? Mr. Gerald Balfour said the first part of the hon. member's question did not correctly state the facts. No light railway had been constructed in the crofting counties under the Act of 1896. Under that Act, however, four light railways have been authorised, while two have been constructed under special Acts. He was not aware what difficulties the hon. member referred to as having been experienced by promoters in consequence of the terms of the Act, nor was he at present satisfied that there was any necessity for an amendment of the law prescribing the conditions upon which grants are paid.

The Commissioners have held an enquiry as to the expediency of granting an application of the Potteries Electric Traction Company, Limited, for an order to authorise certain proposed extensions. The North Staffordshire Railway Company opposed railways Nos. 1 and 2 (Hartshill and Trent Vale). The Commissioners said that the case put forward by the railway company, important as it was, was not sufficient to justify them in withdrawing the order from the consideration of the Board of Trade, and they therefore proposed to grant the application, including the clause for extension of time. With regard to the purchase clause, they were of opinion that Stoke should be put in the same position as all the other boroughs. With regard to the proposed extension to Sneyd Green and Townsend, they could say this: that if the promoters issued advertisements and gave notice, as had been done in previous cases to everybody interested, and if they were able to prove to them (the Commissioners) there was no opposition on the part of anyone to those extensions, they would undoubtedly be disposed to consider very favourably those proposed additions to the order.

At a recent meeting of local and East Coast fishermen at Carloway, held for the purpose of advocating the completing of the Carloway new road and of the constructing thereon a light railway, with the view of developing the fishing industry and making more adequate provision for the growing requirements of the place as an important fishing centre, several resolutions were passed, amongst which was one strongly recommending that this important fishing centre be connected by rail with Stornoway.

The Commissioners have held an enquiry into the application by the East Sussex light railway promoters for an order to construct a light railway from Northiam to Rye, a distance of eight miles. The Commissioners said they were prepared to recommend that the order be granted, but they were very strongly impressed with the desirability of a junction with the South-Eastern Railway at Rye, and hoped steps would be taken to ensure this.

At an extraordinary general meeting of the proprietors of the Goole and Marshland Light Railway a resolution was passed approving of the proposed Bill in Parliament, intituled "A Bill to confer additional powers upon the North-Eastern Railway Company for the construction of new railway and other works, and the acquisition of additional lands, and upon that company and the Midland and Lancashire and Yorkshire Railway Companies in respect of their Normanton Station, and upon the Hull Joint Dock Committee for the execution of works and acquisition of lands, and for vesting in the company the Goole and Marshland Light Railway and the Isle of Axholme Light Railway, and for other purposes." It was stated that negotiations for the sale of the company's undertaking had taken place some time with the North-Eastern Railway. The terms of purchase have been arranged, and will probably amount to £8,000 a mile.

At the Board of Trade Offices on the 28th ult., before Sir Courtenay Boyle, an order was considered authorising the construction of a light railway in the borough of Mansfield, and the urban districts of Mansfield Woodhouse, Sutton-in-Ashfield, and Hucknall-under-Huthwaite. There was no objection to the preamble of the Bill, and the clauses were considered in detail.

The Commissioners have approved, subject to the sanction of the Board of Trade, the scheme for the proposed Dean Head light railway near Halifax. It is to consist of a passenger and goods line 4 miles 7·5 chains in length, commencing at Upper Firth House Mills, Stainland, and terminating at Greetland by a junction with the Stainland branch of the Lancashire and Yorkshire Railway. There are also to be three short branch lines for the accommodation solely of goods traffic from mills and quarries. The capital of the company is to be £63,000 in £1 shares, £10,000 of which may be subscribed by the Lancashire and Yorkshire Company, who are to be entrusted with the working of the railway. Five years is the period stipulated for the completion of the scheme.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

365. Which is the best type of bucket (or piston) for the water end of a boiler feed pump suitable for the pressures used at central stations, etc., and are any such pumps fitted with ebonite packing rings?—G. H.

366. Describe the process of making commutators for small direct-current dynamos in large quantities. Are special tools required?—S. S.

ANSWERS.

Question No. 359.—Describe a combined balancer booster, and state fully the part it acts in connection with electric lighting.

Best Answer to No. 359 (*awarded* 10*s.*).—A combined balancer booster almost invariably consists of four dynamos on one long bed-plate or bed-plates bolted together end to end, with all the shafts rigidly coupled up. The two inner machines generally form the balancing set, and the outer machines the two boosters. This arrangement has been brought into general use with the advent of the three-wire continuous-current system. The purpose the balancing set serves is to keep the voltage at the feeding points on

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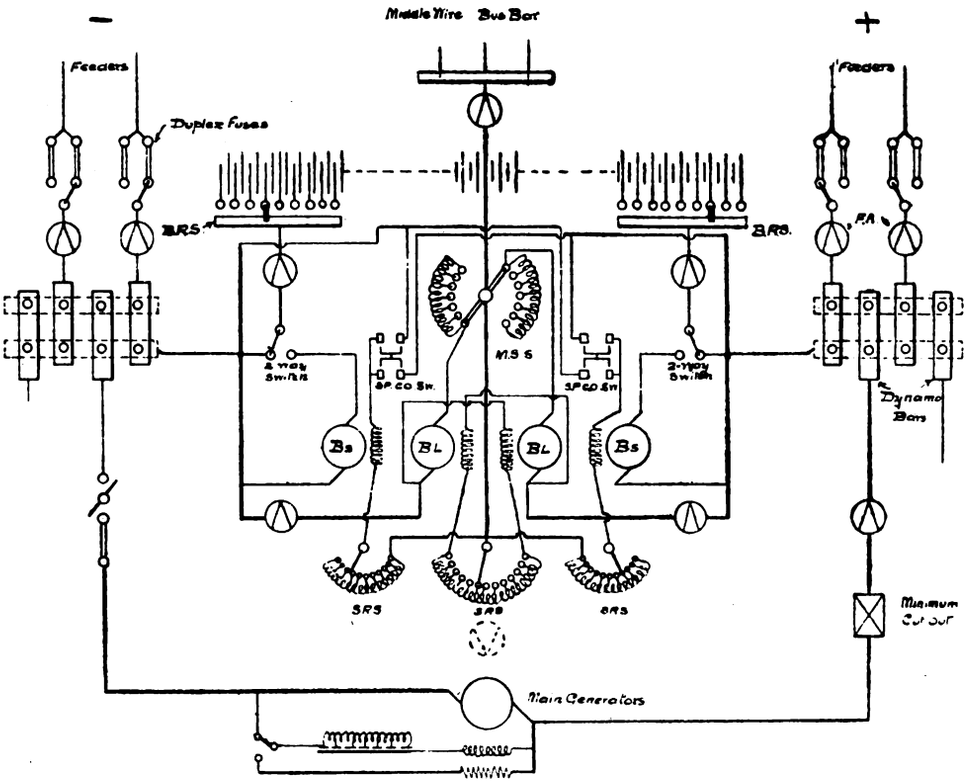
either side of the system equal by supplying the out-of-balance current. In the earlier days this was done by using main generators, two in series across the outers with the point of junction connected to the middle wire, but as the capacity of the generating stations increased, it became obvious that greater economy would be secured if dynamos of double the voltage were used, joined across the outers only, leaving two of the previous voltage to deal with the inequality of load. This had the result of reducing the number of machines to nearly one-half, thereby securing simplicity of switching arrangements, steam connections, etc., and higher efficiency. It may be stated here that the maximum output forms about 10 per cent. of the total station capacity. The remaining two machines of the set—the boosters—are used for battery-charging purposes. These were at first driven by steam or by separate motors; however, it was found that the balancers were not affected in the due performance of their primary duties if they were also made to drive the boosters, being another step towards simplicity of station arrangement. This combination has now become standardised, and is used (or some slight modification of it) in nearly all three-wire direct-current systems.



The diagram and the accompanying reference letters show the connections of the balancer-booster set, together with, for the purpose of illustration, the essential parts of a three-wire system. The following remarks upon the several features in detail must be considered in conjunction with the diagram. The excitation of the balancers, B L, which must have identical characteristic curves, is obtained by means of shunt windings, each of which receives its current from the opposite side of the system of that in which its armature is running. This ensures better regulation for the following reasons: When the demands for current on the two sides are equal, the balancer runs simply as two motors in series. Supposing that the negative side be now more heavily loaded than the positive, the E.M.F. on the negative side drops, while that on the positive increases. As the shunts are reversed, this causes the field, and consequently the E.M.F., of the machine on the positive side to drop, and it commences running as a motor, driving the armature on the negative side as a generator, and supplying the out-of-balance current. A modification which enables the machines to respond the more readily to the variations of pressure is the addition of a few series turns, so wound as to assist the shunt winding when that particular machine is running as a dynamo. These compound machines should, however, still have a drooping characteristic, otherwise the generator would take up a greater load than that required for balance. This overload, in conjunction with the weakened motor field, may be sufficient to pull the set up, blow its fuses, and possibly interrupt the supply. As it is at the feeding points, which may be one or two miles away, that the pressures on the two sides have to be kept equal, artificial regulation is resorted to, the automatic regulation described above not being sufficient. The cross-section of the middle wire is generally one-half to two-thirds that of the outers, and therefore the drop in this cable when the load is out of balance is not inconsiderable, but whatever it may be, it is of importance, as it assists the lightly-loaded side and adds to the drop on the heavily-loaded side. A skeleton diagram with E.M.F. drops set down vectorially will show that this is the case. This artificial regulation is effected by one rheostat as shown, S R S (the middle one). By moving the lever one way resistance is cut out of, say, the generator field, and consequently puts resistance in the motor field. This causes the generator side to run at a much higher voltage at the station than the motor side, compensating for the drop in the middle wire and the loaded outer.

Besides performing the work detailed above, the balancers are utilised to drive the boosters, B S, the only effect being to decrease the generator current and increase the motor current, thus bringing their capacity for balancing purposes down to a lower figure. However, the advantages before mentioned of adopting this arrangement outweigh this objection. The output of each booster should be sufficient to assist in charging the battery at its maximum charging current at any voltage from 20 to 100 volts on a 400 to 460 volt system. The two-way booster switch is so connected that the booster may be put in series with or cut out of the battery circuit, as may be required. It will be noticed that the fields can be reversed by means of the change-over switch (S.P.C.O.Sw.), so that, if necessary, the booster can assist the battery when nearing end of discharge. It also permits the use of battery regulating switches, B R S, with fewer ways, which means a reduction in cost in copper connections between the battery-room and the main switchboard.—Edw. J. Evans.

Answer to No. 359 (*awarded* 5*s.*).—The term "combined balancer and booster" is given to an arrangement of motors and generators used on a three-wire system for maintaining a balance, and adding the excess voltage to that given by the generators for charging the battery. The balancers generally consist of two identical machines,

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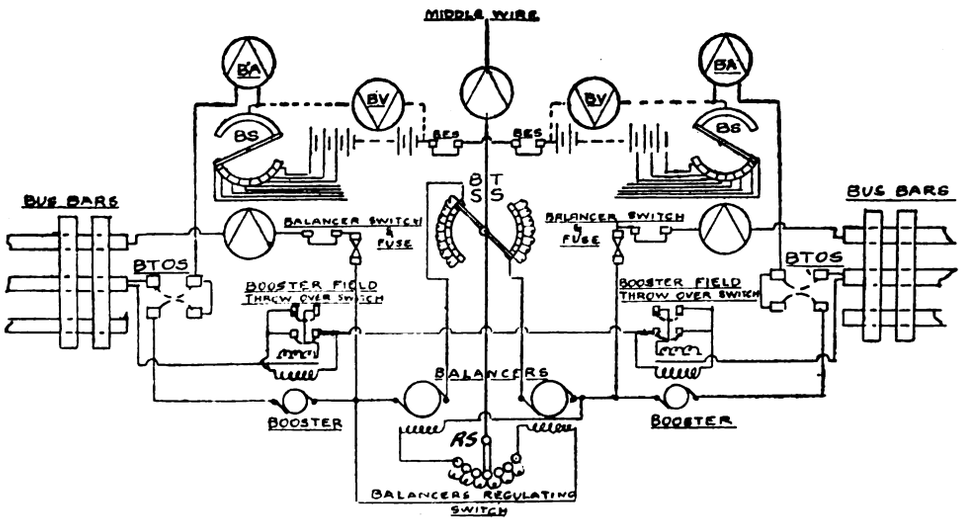
whose shafts are firmly bolted together. These machines should have as nearly as possible equal characteristic curves. On a three-wire system fed on the outers at constant pressure, if more consuming devices are being used on one side of the system than the other, the pressure on the side taking the greater current will be reduced and increased on the other side. The function of the balancer is to keep this pressure equal on both sides and supply the out-of-balance current.

From the diagram it will be seen one terminal of each booster is connected to 'bus bars through a fuse and switch, also having an ammeter in circuit, the other terminals being connected to the middle wire through a starting switch, B T S S, arranged with resistances, so that balancers do not take excessive current when starting. The field windings are cross-connected, and are connected to the middle wire through a regulating switch, R S. The object of cross-connecting is for the automatic regulation. If the current on both sides of the system is equal, each balancer is running as a motor; but if the pressure should rise on one side, this will affect the balancer on the other side, consequently the pressure remains practically constant on each side. The boosters, of which there are two, are connected to the same shaft as the balancers, which make four machines on one shaft. The range of the boosters is from 10 to 100 volts. The object of the booster field throw-over switch is to reverse the field and enable the booster to be run in conjunction with the battery to supply a higher pressure. B T O S is the battery throw-over switch; B E S is the battery emergency switch. The battery is shown connected across the outers, but it is also connected to the inner in some cases, making a battery on each side. There is also a system with only one booster, which is used only for charging the cut-out cells. Another good system is to have a battery in conjunction with a differential or reversible booster, whereby a constant pressure on the outers is maintained and the battery is automatically charged and discharged, the balancers remaining the same as the diagram.—W.



Answer to No. 359 *(awarded* 5*s.).*—A balancer is in most general use in an electric light station distributing the energy on the multiple-wire system, the three-wire system being the most generally adopted in this country. The voltage at the terminals of the consumer's premises is, say, 240 volts. If it is simply the two-wire system, there are only the positive and negative mains. If, now, another main is provided and consumers connected between this and the negative main of the other two, we shall have a three-wire system of distribution. The pressure between the two outer conductors will be double that of the two-wire system, and will be, say, 480 volts. The sketch (Fig. 1) will show more clearly the method. C_1, C_2, C_3 are the three conductors, and C_2 is called the middle wire; G is the main generator, and is generating the current at, say, 480 volts. If there is an equal demand between C_1 C_2 and C_2 C_3, no current will return to or leave the station along C_2, and there will be what is termed a perfect balance; it is the absence of this balance that necessitates the use of a balancer. A balancer usually consists of two similar motors coupled together, and are connected electrically between C_2 C_3, and the other between C_2 C_1. These machines will act as either a motor or generator, according to the want of balance on the positive and negative feeders. Fig. 2 shows the connections more clearly. B_1 and B_2 are the two motor-balancers mechanically coupled, and are connected to the middle wire and the positive and negative 'bus bars respectively. S_1 and S_2 are the field shunt coils, and are shown cross-connected—*i.e.*, the negative balancer is excited from the positive side, and the positive balancer from the negative side. By this means the regulation is more automatic in its action. F_1 F_1 and F_2 F_2 are the positive and negative feeders respectively, M W the middle-wire 'bus bar, and M W A the middle-wire ampere-gauge. b_1 and b_2 are the two boosters, more of which will be written later.

Suppose, now, that there is a greater load on the negative—that is, more amperes are shown on the ampere-gauges, A_2 A_2, than on A_1 A_1, there will be a deflection of the middle-wire ampere-gauge, M W A, equal to the difference of A_2 A_2 and A_1 A_1. This must now be supplied by the balancers, which in this case will have B_2 as a generator, and having an output equal to the difference of the positive and negative loads, and B_1 will act as the motor driving the generator, B_2. Should, however, the greater load be on the positive, then the reverse will take place, and B_1 will be the generator and B_2 will be the motor. By this means it is possible to maintain a constant voltage on each side—*i.e.*, between the positive and middle wire and the negative and middle wire. Were there no means of taking the surplus current on one side and providing for the want on the other, it would be impossible to do so. It is now a very usual custom to add two more machines on to the balancer shaft, and are given the names of boosters. There are two methods which are adopted, the one which is described being the simpler and, in my opinion, the more satisfactory.

In a continuous-current station it is usual to adopt a secondary battery. This battery is split into two sections, one-half being placed between the positive and middle wire (Fig. 1), C_2 and C_3, and the other half between C_2 and C_1, the middle wire and negative. Although this battery is in two halves, it will be seen that it is really one large battery between the positive and negative mains. On each side there is arranged a regulating switch, R S, by which cells may be either put in or cut out as the voltage is either low or high, or as it is required to discharge or charge the battery. If by means of the regulating switch cells are cut out, a charge will commence to enter the battery, and will increase as more cells are cut out. As the charging of the battery proceeds the E.M.F. of the cells will rise, and it will be necessary to cut out more cells to maintain the charge rate. It will now be seen that although the main part of the battery is being charged, the regulating cells which have been cut out have not received the same charge; it

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is to charge these regulating cells that the boosters are used. A booster is usually added to each end of the balancer set, and is in this case really a dynamo of low voltage, but capable of great variation in voltage, as it is often necessary to charge only two cells. As each cell is cut out of the main battery it is put in the booster-circuit. The current of this booster being kept at the same rate as the main charge, the regulating cells will get the same charge as the main cells. A regulating switch is also put in the booster circuit, as it is necessary to cut the top regulating cells out sooner than the lower ones, owing to the less discharge on these cells (Fig. 2). It will be seen that the balancers will either or both act as the motor for driving the boosters. A reference to Fig. 2 will show this

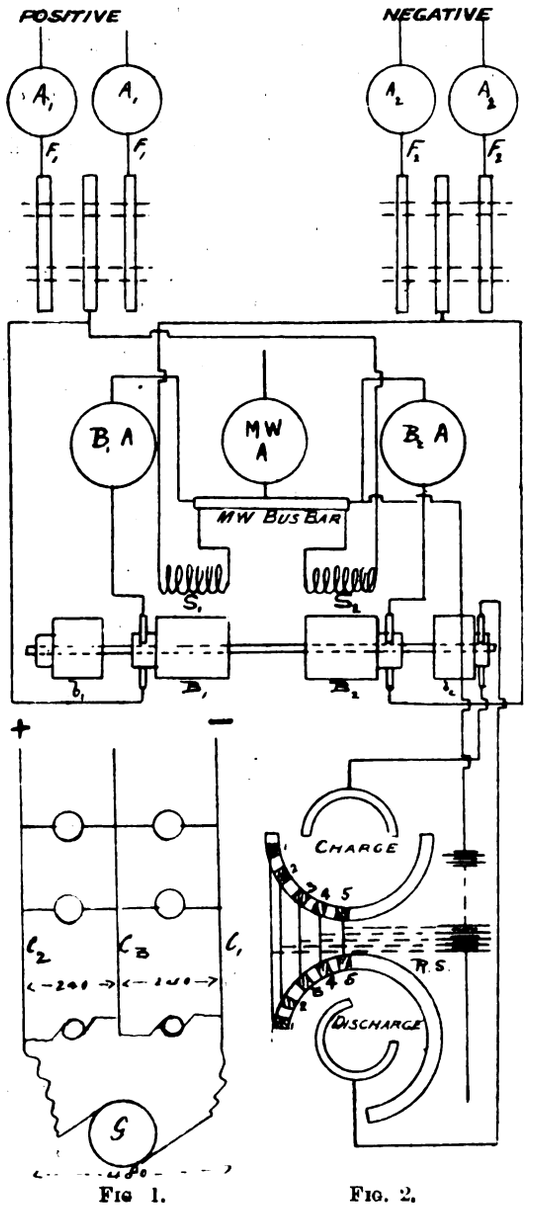
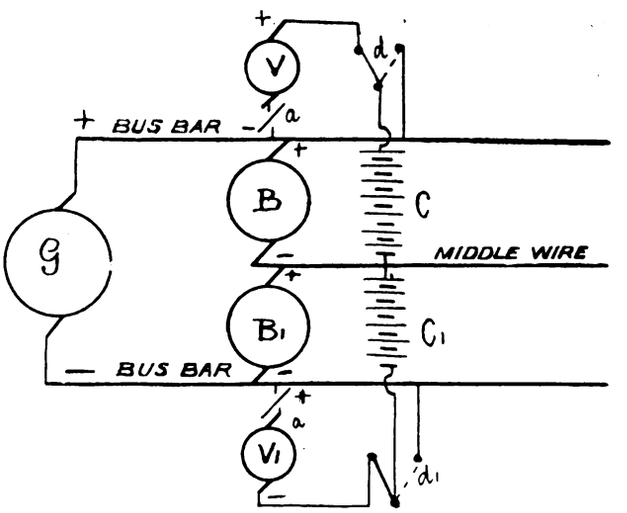


Fig. 1. Fig. 2.

more clearly. R S shows the regulating switches for the negative battery. If to get a charge into the battery the switch has to be put on the contact 5, then all the cells between 1 and 5 will get no charge, but these are charged by means of the small dynamo called in this case the booster.—A. T. S.

Answer to No. 359 (*awarded* 5*s.*).—A combined balancer-booster set is used in connection with a three-wire system. The application of it is so varied that the simplest and most often met with case must suffice, which is a set consisting of four machines coupled together, two of which are the balancer and two are the + and − boosters used for charging the battery. Though all four machines are coupled, the balancer and boosters must be dealt with separately, as each has quite a different function to perform—viz., the balancer to balance the three-wire system, and the boosters to add on the necessary pressure to charge the batteries. The only reason for coupling the boosters with the balancer is that the balancer takes current and runs as a motor, and, therefore, is made use of to drive the boosters. The diagram shows the connections. G is the generator, B and B_1 are the balancer, V the + booster and V_1 the − booster, with main switch, A and A_1, and two-way switch, d and d_1; C is the + battery, C_1 is the − battery, all other details being left out for simplicity. The balancer, as will be seen, consists of two machines coupled in series across the two outers, and the middle wire connected between them. They are started up the same as an ordinary motor with starting resistance, and so long as the system is in balance both machines will take the same current, but if a greater load comes on to one side, say the +, the − machine must pass sufficient current to supply this greater demand on the + side. Example: Suppose each of the two machines of the balancer takes five amperes when the load is balanced, then if 20 amperes comes on the + side, the − machine will motor 25 amperes and the + machine will generate 15 amperes. Suppose only five amperes come on the + side, then the − machine will motor with 10 amperes, while the + machine runs light. An inspection of the diagram will make this easily understood. In order to make one machine take more current, the field must be weakened by the shunt regulating switch.



The booster is used in conjunction with charging the battery. In a three-wire system the middle wire is joined to the middle point of the battery, thus dividing it into two halves, positive and negative, as shown in diagram. Each half has its own booster, which is a small dynamo driven by the balancer, having a pressure of about 100 volts, and capable of passing the full charging current of the battery. It is clear that the battery could not be charged directly from the 'bus bars, as the 'bus-bar pressure is only equal to that of the battery, and as the 'bus-bar pressure must always be kept at a certain constant pressure, the booster is put into series with the 'bus bars and adds on the necessary pressure. The two-way switch is to put the battery direct on to the 'bus bars for discharging.—C. L. E. S.

Question No. 360.—What are the advantages or disadvantages of putting a flexible coupling between the engine and generators of a direct-coupled alternator? State the effect, good or bad, which the introduction of the coupling will have on parallel running.

Best Answer to No. 360 (*awarded* 10*s.*).—In lining up an alternator shaft to that of an engine, two precautions have to be taken: (*a*) that the two centre lines are parallel, and (*b*) that they are continuous to one another. If the first condition be not fulfilled—*i.e.*, if the shafts are at a slight

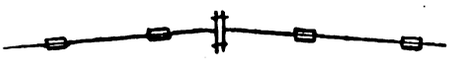


Fig. 1.

angle to one another—as shown exaggerated in Fig. 1, a bending stress is put on the shafts, which, on being rapidly

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reversed on revolving the shafts, tends to break them. If the second condition be not fulfilled, a shearing stress is put on the coupling bolts and a bearing stress on the bearings, as will be seen from the second diagram. The

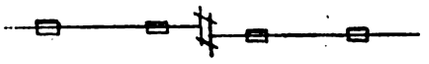

FIG. 2.

slightest deviation from accuracy produces these results in a marked degree, especially with the high speeds now in use. A flexible coupling, if inserted, will, however, minimise these effects by allowing a certain amount of play between the coupling faces, letting them tilt together and move apart in the first case, or permitting a slight rubbing motion between the two faces in the second case. Various forms of flexible couplings were described recently in this column.

There is yet another advantage of a flexible coupling. During each revolution a varying twisting moment is placed upon the shaft of the engine due to the varying pressure of steam upon the engine pistons, and the angle at which the connecting rods are inclined to their respective cranks. The tendency of this is to accelerate the speed of the engine at parts of the revolution and to retard it at other parts. This is partially taken up by the flywheel of the engine, if there is one, or the alternator rotor may be heavy enough to act as its own flywheel. Now, in order to secure good parallel running, the periodic deviation from uniformity of rotation should never exceed 0·5 per cent., some dynamo builders even requiring 0 15 per cent. Should this deviation be exceeded, an auxiliary device is necessary to minimise the excessive synchronising currents that must flow between the machines. The value of a flexible coupling in this respect will be seen from the consideration that the energy of the synchronising currents is spent in transmitting a twisting stress along the crankshaft to balance that of the varying turning moments. The flexible coupling is a device in which this energy can be stored at any given moment (by varying the tension of a spring, etc.) ready to be given out again when required. Strains on the shafts are thus minimised, and surging electrical currents reduced.

It is a moot point whether in using a flexible coupling the flywheel should be placed on the engine or alternator side of the coupling. The greatest variation in turning moment occurs on the engine side, and if the flywheel acts through the coupling, the latter must be made very substantial to stand sharp variations of load. As a matter of fact, the Brush Company, for example, send out their engines and alternators without a flywheel, depending on the inertia of the "claw" magnet for flywheel effect. Their flexible couplings are built very massive. At the same time it appears to be a sound rule that the coupling between an engine and machine should be the weakest part of the mechanical system, as in the event of a smash being inevitable the coupling bolts could then shear asunder, probably saving the more expensive parts of the set. To allow this to be done the flywheel should be rigidly connected to the engine shaft, and the flexible coupling would then feel (with a light armature) the full effect of any variation of load on the machine.—J. A. S.

Answer to No. 360 (*awarded* 5*s.*).—The all-important conditions to be fulfilled in order that alternators may be run in parallel are: (1) the machines must be in synchronism—*i.e.*, they must be running at such speeds that their frequency is the same; (2) they must be in phase or in step—*i.e.*, they must give their maximum E.M.F. (of the same sign) at the same instant.

It is also necessary that their voltage should be approximately equal at the time of switching in. If we suppose two exactly similar machines driven by direct-coupled engines, the engines both making exactly the same number of revolutions per minute, then, obviously, condition (1) is fulfilled, but not necessarily condition (2). If the machines were switched in when in synchronism, but out of phase, a current will oscillate between them, which may be enormous if they are much out of phase. Provided the machines are not damaged, the current flowing from the one which at the moment is acting as generator will slow it down, while the same current will speed up the other alternator, and so cause the two machines to drop out of synchronism and begin the see-saw or hunting action, which will eventually bring them into phase.

Of course, the electrical and mechanical strains will be very considerable, as each alternator in turn is trying to drive the other one with the engine to which the latter is rigidly coupled. If we now substitute a flexible coupling we see at once that these strains will be very much reduced, as owing to the stretching of the couplings, the slowing down of alternator A will not be so much resisted, while B will be more easily accelerated, so that the synchronising effect of the motor action between the machines will be more profitably utilised, as the momentum of the engines will not resist to anything like the same extent the governing of the speeds, and we should expect the same governing power with much smaller oscillatory currents. The above actions should not, of course, take place if the machines are properly synchronised and switched in when in step, but they would always be produced to a greater or less extent by any relative unevenness in the turning moment of the two engines. A flexible connection would then reduce the interchange of current, and prove advantageous by allowing the armature to lag or lead to a slight extent. It plays the part of an electrical flywheel, so to speak.—E. M.

Answer to No. 360 (*awarded* 5*s.*).—The attention which engine builders of the present day bestow on the balancing of their engines, and the production of an even turning moment on the shaft, has obviated to a very large extent the necessity for flexible couplings between the engine and alternator in direct-coupled plants. The more general adoption of high speeds has also helped largely to remove the necessity for using a piece of mechanism, often costly to purchase and maintain, and frequently a cause of much trouble. In the case of an engine with a very bad turning moment coupled direct to an alternator, the adoption of some good flexible connection between the two shafts may make all the difference between the possibility and impossibility of obtaining satisfactory parallel working. A fact also worth considering is that with such a coupling any strain produced on the alternating shaft by paralleling the machine partially out of phase is absorbed by the coupling, and the engine motion is thereby saved from the bad effects of a heavy jar. With regard to the effect of couplings on the parallel working of the alternators, the slight flexibility of the arrangement should assist the mutual control of the machines, enabling them to keep in step better, but, on the other hand, the engine governor is prevented from acting so quickly as regards variations in the load on the machine. In the majority of modern plants, such couplings are entirely unnecessary.—F. T. C.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING.

The annual meeting of the shareholders was held on Friday last at Winchester House.

Mr. J. B. Braithwaite, jun., who presided, in moving the adoption of the report and accounts, expressed the opinion that the result would be regarded by the shareholders as satisfactory in face of two great difficulties with which they would have to contend: the first, the high price of raw materials, iron, steel, copper, and, indeed, all raw material which they had to use; and, in the second place, the enhanced cost of coal. He was glad to say that their new works at Loughborough were now virtually complete, and they anticipated that they would reap very considerable advantages from the expenditure they had incurred—indeed, he might say they were already beginning to reap some of that benefit. They were now in the position of turning out cars of British manufacture throughout, comprising every part of the car, instead of obtaining, as heretofore, a considerable proportion from foreign manufacturers. It would be within the recollection of the shareholders that a special arrangement was entered into with the British Electric Traction Company, and he was glad to say that their expectations in regard to the working agreement had up to the present time been realised. They had every reason to expect that this arrangement would bring a largely increased stream of orders for various things, including tramway rolling-stock, at satisfactory prices, and he therefore anticipated that when he had the pleasure of meeting the shareholders again at this time next year he would be able to place before them still

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more favourable results. Under the agreement with the British Electric Traction Company Mr. C. Shirreff B. Hilton and Lord Vaux of Harrowden, nominees of that company, were elected as directors, but in consequence of an informality that appointment had become void, and the names would be proposed for the approval of the shareholders for re-election that day.

Mr. C. E. Hedgkin seconded the motion, which was agreed to, and the dividends as recommended were declared. A resolution approving the election of the directors referred to above was also adopted, and the retiring directors were re-elected.

An extraordinary general meeting was afterwards held for the purpose of altering certain of the articles of association. The necessary resolutions were approved.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

The ordinary meeting of the proprietors of this Company was held on Thursday week at Winchester House, Lord Rathmore presiding.

In moving the adoption of the report, the **Chairman** said it was a great satisfaction to his colleagues and himself to find that the Company had now reached the stage to which they had looked forward to through some years of difficulty and disappointment, and were able to recommend the payment of a dividend which was to a large extent provided out of the earnings of the two London stations. Last year the directors were able to recommend a dividend from the profits realised by the sale of one of the Company's subsidiary undertakings, but on the present occasion they were able to recommend a dividend at the same rate without anything in that way, which he thought must be regarded as a highly satisfactory matter. Having referred to the subsidiary companies, the chairman said with regard to London the increase which had taken place at their two stations fully came up to what the Board had anticipated this time last year, and it gave them very great encouragement with regard to the profits which they might reap from those districts in the future. The metropolitan stations had always been and must be the backbone of their business, and it was to them that they must look for permanent and, he hoped, increased reward.

The report, having been seconded, was adopted, and a further dividend at the rate of 4 per cent. per annum approved.

NATIONAL ELECTRIC WIRING.

The ordinary meeting of the shareholders of this Company was held at the Westminster Palace Hotel on Monday, Mr. R. S. Bain, C.A., presiding.

The **Chairman** congratulated the shareholders on a comparatively successful year's working. If the increase in their business was slow he thought he might say it was sure, and the report showed that the business was steadily increasing. He had a list containing the names of over a hundred important installations which had been carried out, and he was glad to say carried out with every satisfaction, and the prospect of the continuance of that class of work during the present year was very hopeful. The free wiring portion of their business had not increased in the same ratio as their contract portion, but that was for the reason that the policy of the directors was to sink the capital only in remunerative installations which were well secured. During the year they had entered into free wiring contracts and opened branches at Swansea, Poplar, and Coatbridge, all of which promised to be profitable undertakings both as regarded free wiring and contract work. Having referred to the various items in the balance-sheet, he said the figures showed the progress they were making; but it was not only the amount of business they were doing which was satisfactory, but what was of far greater importance was the efficient manner in which they were carrying on their work, and which was causing them to be entrusted with some of the most important work in the country, including valuable Government contracts.

The report was then adopted, and the dividend recommended declared.

FOLKESTONE ELECTRIC SUPPLY.

The annual meeting of this Company was held at the Company's works, near Shorncliffe Station, on Saturday, the chairman (Mr. George Spurgen, J.P.) presiding. The report showed that the Company continues to make satisfactory progress. Whereas up to Dec. 31, 1899, the Company were supplying the equivalent of 17,834 8-c.p. lamps, on Dec. 31, 1900, the equivalent of 24,190 8-c.p. lamps were being supplied. There was a profit on the revenue account of £2,930. 5s. 2d., which, with £149. 3s. 1d. from last year's accounts, and after allowing for interest on debenture stock and bank charges on temporary overdraft, showed a net balance for distribution of £2,345. 2s. 4d. Out of this the directors recommended payment of a dividend of 4 per cent., requiring £2,000, the balance of £345. 2s. 4d. to be carried forward to next year's account.

The **Chairman**, in moving the adoption of the report, said although the accounts did not show so large a balance as they could wish, this would have undoubtedly been much larger but for the abnormal price of coal during the year. When the Company was started they had no idea that the light would be taken up so freely as it had been. They started on what they thought prudent lines, and put in what was believed to be sufficient machinery for a certain number of years. But the increase had been very rapid, and they had extended their works greatly this year at considerable expense. In consequence they had only £149 carried forward, and that, of course, reduced the amount for ordinary dividend. Their coal bill was £600 more than last year. So far as the prospects of the Company were concerned, at the end of the year they had an equivalent of 24,190 8-c.p. lamps installed, and he was happy to say that for the three months up to date they had installed 2,118 more lamps, making a total of over 26 000, and they had applications in hand for 128 more. No house of any pretensions was now built without it was wired for the electric light. A new estate, called the West Cliff Estate, was being laid out off the Shorncliffe-road, and they had had a proposition to lay down mains there. They were extending their buildings, and had a large amount of machinery on order. They were also putting down a condensing plant, by which they hoped to save something like 25 per cent. on their coal bill.

The motion having been seconded, the report was unanimously adopted.

In acknowledging a vote of thanks, the **Chairman** mentioned that the Company were adopting penny-in-the-slot meters, and were making tests of them at present. They could supply through these meters 5½ hours light for an 8-c.p. lamp for 1d. If the meters proved a success, there would be hardly a house in Folkestone which would not have them.

WINCHESTER ELECTRIC LIGHT.

The annual meeting of this Company was held at the offices, St. Peter's-street, Winchester, on Tuesday last week, Mr. T. F. Kirby, presiding. Mr. H. N. Warburton, engineer and secretary, was in attendance. The report stated that the directors were well satisfied with the progress which the Company had made during the year. An equivalent of over 5,000 8-c.p. lamps had been added during the year, making the total connection at the end of the year 15,126 lamps. Applications for a further 2,500 lamps had already been received this year. Including the balance brought forward from last year's account of £121. 5s. 8d., the account showed a net profit of £1,609. 1s. 7d. After payment of debenture interest, £933. 17s. 9d., and writing off the whole of the preliminary expenses, amounting to £197. 17s. 4d., there remained a balance of £477. 6s. 6d., available for dividend on the ordinary shares. The directors recommended that a dividend be declared at the rate of 3 per cent. per annum on the ordinary shares, which would absorb £333. 16s., leaving a balance of £143. 10s. 6d. to be carried to the next account. The system of free wiring, to which reference was made in the last report of the directors, had proved a success, especially since the introduction of the shilling-in-the-slot meter.

In moving the adoption of the report the **Chairman** pointed out that they had sold more than twice as much electricity than the previous year. That, he thought, was a very satisfactory result, a result that showed that with the fall in the price for coal, which they expected during the year and which had already begun to take place, they would be able to do very much better than they had ever done before. Referring to the system of free wiring, which the Company had introduced, he said that people were now able to have the wires put into their houses without any additional expense to themselves by paying a small annual rent for them. It answered the purpose of the Company very well; they got the interest on their money, and they got a much larger output of current. The directors had some doubt at first as to whether the system would be received favourably in Winchester, but he thought those doubts had now been removed, and everyone was well satisfied with the way in which it had been taken up.

General Montgomery, in seconding the adoption of the report, pointed out that by adding 50 per cent. to the number of their lamps during the year, they added 100 per cent. to their takings.

The report was unanimously adopted, and the dividends recommended were declared. Captain Clayton-Mitchell having been re-elected chairman, the proceedings shortly afterwards closed.

LIVERPOOL DISTRICT LIGHTING.

The annual meeting of the shareholders of this Company was held at the offices, Hackin's Hey, Liverpool, on Wednesday week.

Colonel Arthur Holme presided, and in moving the adoption of the report congratulated the shareholders upon the improved state of the Company's business, and upon having got rid of an unremunerative portion of the undertaking. They had now 7,122 lights at Waterloo, compared with 6,234 in 1900, and 4,243 in 1899, so that they would see the Waterloo and Crosby district was increasing by leaps and bounds. He might say that they had received £10,000 on account of the sale of the Gateacre property, and the balance would be paid on June 1, together with interest at the rate of 5 per cent. They had £4,000 to their credit in the bank, and altogether their property was a valuable one, and increasing in value. Nearly every new house in the district was being wired for the use of electric light, and he thought they might be satisfied to think that if they got no dividend this year it would not be long deferred.

Mr. R. Attwood Beaver seconded.

In reply to a question, the **Chairman** said they were a lighting company and not a tramway company, and if they had undertaken the work of running the tramways they would have had to construct the lines. At all events, no one else, not the Liverpool Corporation, the Liverpool Overhead Railway Company, nor the Lancashire Power Company had any power to light a single lamp in their district. They were absolutely safe in this respect.

The report and accounts were then adopted.

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GATESHEAD AND DISTRICT TRAMWAYS.

At the annual meeting of this Company, held on Friday last at the offices, West-street, Gateshead, the **Chairman** (Mr. C. R. Greene) said the loss on the year's working had been caused by the transition stage of the Company from steam to electrical power. At the same time, if it had not been for the extra cost for fuel to the amount of £580, there would have been a profit. The electrical equipment was now well in hand, and at the next annual meeting the directors hoped to have a very different balance-sheet to lay before the shareholders.

Mr. W. J. Greear seconded the report, which was adopted.

Mr. C. R. Greene, retiring director, having been re-elected, Mr. L. A. Atherley-Jones, K.C., M.P., and Mr. E. A. Paris were elected directors of the Company.

CITY OF BIRMINGHAM TRAMWAYS.

The directors' report for the year ended Dec. 31, 1900, states that the profit for the year amounts to £69,654. 8s. 5d. (an increase of £986. 3s. 8d. over last year), to which has to be added £2,083. 6s. 8d., set aside out of last year's profit to meet the dividend accrued on the preference shares from Oct. 15 to Dec. 31, 1899 (payable on April 15, 1900), making a total sum of £71,737. 15s. 1d. A disposable balance of £46,956. 13s. 1d., after making the necessary payments, remains. Your directors recommend that this balance be appropriated as follows: (1) to carry forward to next year's account the sum of £2,083. 6s. 8d. to meet the dividend on the 5 per cent. preference shares accrued at Dec. 31 last, payable on April 15, 1901; (2) the payment of a dividend at the rate of 5 per cent. per annum, together with a bonus of 5 per cent. (making 10 per cent. for the year), amounting to £6,314. 2s. on the ordinary shares for the six months ended Dec. 31 last; (3) that the balance of £38,559. 5s. 3d. be carried forward to the reserve fund (thereby increasing that fund to £145,687. 14s. 7d.) to provide for depreciation of assets, redemption of debentures, and for general purposes. All the Company's property has been thoroughly well maintained during the year out of revenue. The extension of the Stratford-road tramway to Green Mill Bridge (College-road) has been completed, and was opened for traffic on June 1, 1900, with satisfactory results. Terms have been arranged with the Corporation of Birmingham and the King's Norton and Northfield Urban District Council for the equipment of the Bristol-road line on the overhead or trolley system. The work of reconstruction, which was commenced on Oct. 1 last, is rapidly approaching completion, and the line is expected to be opened for traffic by the new system in the course of a few weeks. A Bill, which has received the approval of the shareholders, is being promoted in the present session of Parliament for extending the Bristol-road line through Selly Oak; for constructing short lines within the city, to afford better terminal facilities for the electric cars; for constructing a tramway from the existing line at Small Heath to Hay Mills, and to connect up the tramways to Yardley, authorised by the City of Birmingham Tramways Act, 1897; and for other purposes. The foregoing items have involved an addition to the capital outlay of £24,646. 14s. 11d., and your directors are sanguine that this expenditure will eventually prove an asset of great value to the Company. In pursuance of the trust deed, the first instalment of £10,000 towards the extinction of the debenture debt has been paid over to the trustees for the debenture holders. Your directors submit with much satisfaction the following comparative statement of passengers, earnings, and profits, which, notwithstanding the prejudicial effect of the enormous advance in prices of fuel, forage, and materials, show an increased profit over previous years:

	Passengers.	Gross earnings.	Net earnings.
1896	31,114,403	£172,071	£45,815
1897	34,181,661	189,190	54,752
1898	36,386,774	202,516	59,896
1899	40,237,298	220,817	68,668
1900	44,594,458	229,292	69,654
Increase over last year:			
Total	4,357,160	8,475	986
Per cent.	10·83	3·84	1·44

The retiring directors in accordance with the articles of association are Messrs. Granville C. Cunningham and John K. L. Ross, and these gentlemen, being eligible, offer themselves for re-election. Messrs. Howard Smith, Slocombe, and Co., the auditors of the Company, retire, and are eligible for re-election.

BABCOCK AND WILCOX, LIMITED.

The directors, in their first annual report since reconstruction, state that the net profit during the year, after deducting depreciation on plant, etc., amounts to £155,764. 3s. 4d., which, after deducting the interim dividends to June 30, 1900, at the rate of 6 per cent. per annum on the 100,000 preference shares, and 1s. per share on the 440,000 ordinary shares, issued in exchange for holdings in the old company, amounting to £25,000, leaves a balance of £130,764. 3s. 4d., from which the directors recommend that the following dividends be paid for the half-year ending Dec. 31, 1900—viz., 6 per cent. per annum on the preference shares (from which income tax is to be deducted), £3,000; 15 per cent. per annum on the ordinary shares (free of income tax), £39,750; and placing to a dividend equalisation fund, £30,000; leaving a balance of £58,014. 3s. 4d.; of which the proportion of profit accrued from Jan. 1 to April 30, 1900 (the latter being the date of registration of the Company after reconstruction) has to be applied in reduction of property account, £42,335. 5s. 6d.; leaving to be carried forward, £15,678. 17s. 10d. In addition to the above, a premium of 10s. per share on the 90,000 ordinary shares issued has been received, amounting to £45,000, which it is proposed to carry to a reserve fund. The reconstruction of the Company sanctioned by the shareholders has been completed, and all the new shares allotted. It was found necessary, owing to the expansion of the business, to obtain larger office premises, and consequently the head office was removed to Oriel House, Farringdon-street, in the course of last year. The directors have also extended the works to provide particularly for extension of business in the Company's patent water-tube boilers for marine purposes; these extensions are now practically complete. The directors retiring at this general meeting are Sir William Arrol and Mr. William James P. Moore, who, being eligible, offer themselves for re-election.

OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The report for the year ended Dec. 31, 1900, states that the total revenue for the year amounts to £23,156. 3s. 7d., and the expenditure (including £1,479. 16s. 4d. for debenture interest) to £18,196. 4s. 6d., leaving a net profit of £4,959. 19s. 1d., which, added to the amount of £617. 12s. 7d. brought forward from the previous account, makes an available balance of £5,577. 11s. 8d., which the directors propose should be applied as follows: amount to be placed to depreciation fund, £1,000; dividend of 5 per cent. per annum on the cumulative preference shares for the year, £2,000; dividend on the ordinary shares of 7 per cent. per annum for the six months ended Dec. 31, 1900, making, with the interim dividend paid on Aug. 15 last, 6 per cent. for the year, £2,400; balance to be carried forward to next account, £177. 11s. 8d. The net profit for the year would have been larger but for the unfortunate strike of motormen and conductors, which seriously affected the traffic receipts during a period of six weeks, and resulted in an additional expenditure by the Company of £1,482. 12s. 4d., which has been charged against the revenue for the year. The total capital expenditure amounts to £127,681. 0s. 2d. The subscribed capital in shares and debentures amounts to £120,000. The directors recommend that powers be taken to increase the nominal capital by the creation of 1,000 ordinary shares and 1,000 preference shares of £10 each. The appeal by the Company against the judgment in the action instituted by the Hyde Corporation to prevent the Company using the feeder cables which have been laid under the footpath was dismissed, and negotiations are pending between the Company and the Hyde Corporation and between the Company and the contractors in regard to the matter. The Company's application to the Light Railway Commissioners for an order for extensions of the lines was refused by reason of opposition on the part of the local authorities, who are now promoting tramways and light railways in the district. The directors are opposing these promotions by the local authorities so far as they are able to do. The directors propose to take the opportunity of the general meeting to ask the shareholders to alter the articles of association in accordance with the requirements of the Companies' Act, 1900. Mr. A. R. Monks has resigned his seat on the Board, and Mr. J. Vincent Kitchener has been appointed to fill the vacancy. The directors who retire by rotation are Alderman Robert Whittaker, J.P., and Mr. L. A. Atherley Jones, K.C., M.P., and they offer themselves for re-election. Messrs. Edwin Guthrie and Co., the auditors, retire, and they offer themselves for re-election.

DOVER ELECTRICITY SUPPLY.

The following report was presented at the seventh annual general meeting of shareholders of the Dover Electricity Supply Company, Limited, held at the offices, Park-street, Dover, on April 3: The results obtained in the year under consideration must be regarded as satisfactory, having regard to the exceptionally high price of fuel and other materials. The directors considered that in spite of the increase in cost of production, the best interests of the shareholders would be served by making no temporary increase in the price of current. During the year applications have been received for an equivalent of 3,002 lamps, showing a steadily increasing rate of expansion. The output to private consumers shows an increase in 1900 of 30 per cent. over that of 1899; and this rate of progress is fully maintained in the present year to date. The directors have also to report with satisfaction the growing use of electric energy for motive power purposes. Electric motors are in use in the town for a variety of purposes, and others are being installed. As will be seen from the accounts, a considerable capital expenditure has been necessitated during the past year by extension of mains and the installation of a large direct-current set for power purposes. Under the terms of an agreement entered into with the Admiralty Harbour contractors, a large amount of energy will be required for their purposes during the present and the next few years. Further capital in 5 per cent. preference shares was created during the past year, and a small amount thereof issued as required, at a good premium. The steady growth of the Company's business will probably render it desirable to issue the balance of these shares during the current year. The directors of the Company have been approached by the Dover Corporation with a view to the transfer of the undertaking by the Corporation but in view of the prospects of the Company as indicated by the progress hitherto made, your directors do not advise a sale to be made. The gross profits of the year amount to £2,986. 10s. 6d

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After paying debenture and other interest the directors propose to include an amount brought forward from 1899 and recommended in their last report to be applied to suspense account. The net profit account will then show a balance of £1,759. 11s. 4d., out of which the directors recommend the payment of a dividend of 3½ per cent. on the ordinary shares. The retiring director is Sir William Crundall, who, being eligible, offers himself for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, but is eligible for re-election.

WOOLWICH DISTRICT ELECTRIC LIGHT.

Directors: J. A. Findlay (chairman); J. C. Wigham; F. E. Gripper. Secretary: W. E. Nicoll.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1900:

The progress of the Company during the year has been very gratifying, the increase in lamp connections having risen from 9,610 to 19,425, and the sale of current having increased from £3,372 in 1899 to £6,109 in 1900. The result of the trading for the year, including £68. 10s. 3d. brought forward from last account, is £2,788. 15s., which, after payment of debentures and loan interest, amounting to £762. 6s. 3d., leaves a profit to be dealt with of £2,026. 8s. 9d. The directors recommend that a dividend be paid at the rate of 5 per cent., absorbing £1,022, that £600 be placed to the renewal fund, and that the balance be carried forward to next account. During the year the works have been largely extended, a lease having been obtained of additional ground adjoining the works. A new 250-kw. dynamo set has been added, and additions to the boiler power, whilst the mains have been considerably extended. Further capital being required to meet the continued increase in the Company's business, a resolution will be submitted that the capital of the Company be increased to £50,000 by the issue of £25,000 shares of £1 each, which will be offered *pro rata* to the shareholders. Of the directors, Mr. J. C. Wigham retires by rotation, and being eligible, offers himself for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal	£1,244	1	10			
Oil, waste, water, etc.	104	16	8			
Salaries	140	18	4			
Wages	326	3	5			
Repairs—Building	12	0	4			
Plant	147	13	8			
Accumulators	46	1	7			
				2,021	15	10
Distribution.						
Salaries	19	5	0			
Wages	0	1	1			
Repairs—Mains, etc.	10	18	10			
Meters, etc.	1	8	1			
				31	13	0
Management.						
Salaries	200	13	8			
Stationery and printing	32	0	6			
General charges	47	4	5			
Auditor	12	0	0			
Directors' fees	72	10	0			
				364	8	7
Rent, rates, and taxes				451	19	5
Law expenses				8	11	2
Insurances				39	7	0
Balance to net revenue account				2,720	4	9
				£5,637	19	9

Cr.	£	s.	d.
Sale of current	6,109	9	6
Rental of meters, etc.	102	1	6
	6,211	11	0
Less rebates and discounts, etc.	627	12	6
	5,583	18	6
Rental of motors, wiring, etc.	3	13	4
Profits on installing, repairs, etc.	49	12	5
Transfer fees, etc.	0	15	6
	£5,637	19	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital—25,000 shares at £1	25 000	0	0
Debentures	10,000	0	0
Sundry creditors on open accounts	14,108	5	2
Net revenue account (balance)	2,026	8	9
Renewal fund account (balance)	100	0	0
	£51,234	13	11

Cr. Assets.	£	s.	d.
Capital account—amount expended	47,817	1	1
Stores on hand: coal, £213. 15s.; oil, waste, etc., £50. 15s. 1d.; wiring, £178. 3s. 10d.	442	13	11
Sundry debtors for current	2 757	3	0
Work in progress	125	0	0
Cash at bankers, etc.	92	15	11
	£51,234	13	11

APPOINTMENTS VACANT.

Assistant Engineer, British Electric Traction Company, Limited. Details in our advertisement columns.

Engineer-in-Charge, Belfast Corporation Electricity Department, £2. 5s. per week, April 9. Details in our advertisement columns.

Clerk and Canvasser, Bermondsey Borough Electricity Department, £140 per annum, April 15. Details in our advertisement columns.

Agent and Traveller, for Ireland and Scotland, by a firm of switchboard and accessory manufacturers. Details in our advertisement columns.

Mains Superintendent, South Shields Borough, take charge of all outside work, £130 per annum, April 10. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Burnley.—Tenders are invited for accumulators, boilers, and economisers by April 9.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the electric lighting of the town for 30 years. Tenders by April 25.

Tavistock (Devon).—The Urban District Council invite tenders for lighting the town from one to three years. Tenders by April 15. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for engines and dynamos, storage battery, and overhead travelling crane. Tenders by April 15. Details in our advertisement columns.

Salford.—The Corporation invite tenders for wiring for motors, dynamo leads, engine-room and switchboard connections, etc. Tenders by April 9. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for the supply and erection of various plant for electricity works. Full details in our advertisement columns. Tenders by April 11.

Halifax.—The Electricity Committee invite tenders for the supply of steel steam-piping. Particulars can be had from Mr. H. F. Street, borough electrical engineer. Tenders by April 11.

Motherwell.—The Electric Light Committee invite tenders for steam dynamo and switches, and steam, feed, and exhaust pipes, etc. Tenders by April 29. Details in our advertisement columns.

Colwyn Bay.—The Urban District Council invite tenders for a water-tube boiler, feed pump, injector, steam, exhaust, and feed pipes, etc. Tenders by April 13. Details in our advertisement columns.

Zagazig (Egypt).—The Local Commission invite tenders for the electric lighting of the town. Specifications, etc., may be obtained from the Public Works Department, Cairo, where tenders may be addressed until April 15.

Dublin.—The Lighting Committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane, and workshop equipment. Tenders by April 22. Details in our advertisement columns.

Poole.—The Town Council invite tenders for connecting the Parkstone section of the borough fire brigade with electric calls. Specification, etc., may be seen at the office of Mr. John Elford, borough surveyor, King-street. Tenders by April 16.

Edinburgh.—The Corporation invite tenders for arc lamp carbons, cast-iron pipes, pavement and road box frames, and covers, etc., for their electricity supply stations for the year from May 15. Tenders by April 20. Details in our advertisement columns.

Burythorpe (York).—Tenders are invited for fixing complete, electric bells and telephone at Burythorpe House. Persons to inspect and take their own quantities up to 6th inst. Particulars may be obtained from Mr. Harry Stevens, builder, Burythorpe, York.

Portsmouth.—The Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, economiser, steam, feed, and other pipes, chequer plating, and sundry ironwork. Tenders by April 16. Details in our advertisement columns.

Metropolitan Asylums Board.—The Board invite tenders for the supply and erection of a complete electrical generating plant and a complete boiler plant for heating at the asylum now in course of construction at Tooting Bec., S.W. Tenders by April 24. Details in our advertisement columns.

Farnworth (Lancs.).—The Urban District Council invite tenders for taking up and removing existing pavement, excavation, concreting, and paving (labour) in connection with the laying of about four miles of tramway, single track. Particulars may be obtained from the engineer, Mr. W. J. Lomax, A.M.I.C.E., 11, Fold-street, Bolton. Tenders by April 8.

Middlesbrough.—The Electric Lighting Committee invite tenders for boiler-house plant—one 30ft. by 8ft. 6in. Lancashire boiler and accessories; engine-house plant—one 300-kw. high-speed steam dynamo and accessories, together with steam, exhaust, and feed pipes, etc.; condensing apparatus—ejector condenser, with circulating pumps. Tenders by April 30. Details in our advertisement columns.

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Leeds.—The Lighting Committee invite tenders for steam, feed-water, exhaust, overflow, blow-off and other pipes, valves, hot-wells, feed-water pumps, economiser, etc., in connection with engines of 4,000 i.h.p. Specifications, etc., may be obtained from Mr. H. Dickinson, manager of the department, Whitehall-road, Leeds. Tenders by April 15.

Bulgaria.—A concession has recently been obtained for an electric lighting installation in a town in Bulgaria. According to the *Bulletin Commercial*, firms desiring to acquire same totally or partially, or those who desire to supply materials, etc., may be placed in communication with the successful applicant through the Musée Commercial, rue des Augustin, Brussels.

Palencia (Spain).—Tenders are invited for the installation and working of a telephone system for not more than 20 years; 10 per cent. of the annual receipts will have to be paid to the Government. Tenders may be addressed to the General Post and Telegraph Department by April 21. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Battersea.—The Borough Council invite tenders for the carrying out of work in connection with the supply of water for condensing purposes to their central electric generating station, Lombard-road, adjacent to the River Thames, as follows: electric pumps, pipework, etc., for condensing water; river work, pipes, and pits for condensing water supply. Specifications, etc., may be obtained on application to the Town Clerk, Municipal Buildings, Lavender-hill, S.W. Tenders by April 30.

RESULTS OF TENDERS.

Woolwich.—The Electricity Committee have accepted the tender of Olive and Sons for the supply of arc lamps and posts, at £2,400.

Llanrwst.—The Hart Accumulator Company, Limited, have secured the contract for the supply of a storage battery required for the electric lighting of Llanrwst, Wales.

Dundee.—The Tramway Committee will recommend the acceptance of the tender of the Lorain Steel Company for the rails required to complete the tramway system, at £9,607. 14s.

Cardiff.—The Town Council have accepted the following tenders: Clark and Co., for the erection of the chimney shafts at the power station, £1,563; and the Maxim Company, steam-pipes, £6,858.

Coventry.—The City Council have accepted the tender of the National Electric Wiring Company, Limited, for the installation of the electric light at the extensions of the city hospital at £156. 14s.

Derby.—The Electricity Committee have accepted the following tenders: E. Green and Son, fuel economiser, £575; Babcock and Wilcox, boiler and purifier, £1,030, and steel piping, valves, feed pumps, etc., £600.

Buxton.—The Urban District Council have accepted the following tenders for extension plant at their electricity works: Electric Construction Company, Wolverhampton, 250 kw. steam dynamo coupled to Belliss engine, £2,606; Sunderland Forge Company, Pallion, Sunderland, 86-kw. balancer coupled to Belliss engine, £1,269.

Leeds.—The City Council have accepted tenders for works required in the construction of a subway for electric cables in Whitehall-road, Northern-street, Wellington-street, and Queen-street as follows: Mr. P. Rhodes, excavator, mason, bricklayer, concertor, and carpenter's work, £9,697; Mr. L. Cooper, smith and ironfounder's work, £2,076.

Bermondsey.—The Borough Council have received the following tenders for Contract No. 8:

Section A.—Main switchboard and instruments.

Brook, Hirst, and Co.	£1,515	0	0
Crompton and Co*	1,573	0	0
Williamson and Joseph	1,573	10	0
Hayden, Harrison, and Co.	1,713	0	0
Cowans, Limited	1,739	0	0
Siemens Bros. and Co.	1,852	0	0
British Schuckert Company	1,853	0	0
Nalder Bros. and Thompson	1,904	0	0
Mechan and Sons	1,978	0	0
B. Thomas	1,993	0	0
General Electric Company	2,045	0	0
Thames Ironworks Company	2,050	0	0
Walsall Electrical Company	2,109	0	0

Section B.—Battery of accumulators and accessories.

Name.	Amount	Maintenance 3 years.	5 years.	7 years.	No. of cel's.
Pritchett's and Gold	£1,595	£100	£120	£120	281
D.P. Battery Company	1,720	—	—	—	279
Hart Accumulator Company	1,761	88	123	158	284
Marquard Accumulator Company	1,762	90	95	106	284
Ashmore, Benson, Pease and Co.	1,799	54	90	135	284
British Power, Traction, and Lighting Company	1,984	100	150	165	280
Electrical Power Storage Company	2,059	140	140	140	282
Tudor Accumulator Company*	2,180	95	95	95	280
Chloride Accumulator Company	2,463	122	133	156	290
Sutherland and Marcuson	2,736	75	141	225	276

* Recommended for acceptance.

Cheltenham.—The following tenders have been received for the completion of the chimney stack at the electric works: W. Cresswell, £750; C. H. Channon and Son, £725 (accepted) The following tenders were received for the construction of a boiler-house at the electric works: C. H. Channon and Son, £1,855 (accepted); Collins and Godfrey, £1,870; W. Cresswell, £1,993.

Belfast.—The Harbour Commissioners have accepted the following tenders: Babcock and Wilcox, Limited, Oriel House, 30, Farringdon street, London, E.C., for supply and erection in the electric light station, Abercorn Basin, Belfast, of a water-tube boiler, combustion chamber, flues, and the necessary connecting steam and feed-water mains; W. Coates and Son, Fountain-street, for lighting by electricity the harbour office and the harbour workshops, Belfast.

Bristol.—The Town Council have accepted the following tenders with regard to carrying out the extension of the electrical undertaking: J. and G. Weir, Limited, pumps, £415; W. H. Allen, Son, and Co., Limited, condensing plant, £3,745; Steavenson and Co., water storage tank, £195; Doulton and Co., Limited, water-softening plant, £1,227. 15s. 10d.; Bumsted and Chandler, induced-draught plant, £1,870: Babcock and Wilcox, Limited, boilers, economisers, etc., £10,476. 8s.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Eastbourne.—It was stated at the last meeting of the Town Council that there was a profit of £800 on the electric light last year.

Damaging Insulators.—A young man who was caught using a catapult with the telephone insulators as targets was fined 10s. on Saturday at West Ham.

Hemel Hempstead.—The Town Council have decided to request the Postmaster-General to establish a telephone exchange at the Hemel Hempstead post office.

Newport.—Under the free wiring system a number of new houses in the eastern district being erected as dwellings for working-men are to be installed.

Ealing.—The Electric Lighting Committee have agreed to reduce their charge for current to 6d. per Board of Trade unit, owing to the fall in the price of coal.

Barnstaple.—The Town Council are consulting Mr. Trentham, electrical engineer, who is to survey the district included in the provisional order and to supply a report.

Derby.—The charge for motive power in cases where motor consumers use the maximum quantity of electricity for an average of over 50 hours per week has been fixed at 1½d. per unit.

Pacific Cable.—The first practical step towards the construction of the British Pacific cable has been taken. A steamer this week started to the West Coast to select a suitable site for the landing of the wire.

Birmingham.—A quantity of rubber gloves are to be purchased for the use of the members of the fire brigade for use in connection with the electric trams and electric lighting. Other corporations are taking similar precautions.

Coventry.—The Electric Light Committee last week considered the applications received for the position of manager at the electric light works in succession to Mr. Ram. Candidates were selected to meet the committee.

Grimsby.—Alderman Dobson, Mr. Alward, and Mr. Jackson, with the chairman and vice-chairman, have been appointed to consider the laying of the wires to supply the town hall with electric current from the power station.

Removals.—Mr. J. E. Austin, electric light engineer, has removed to 40, Upper Baker-street, W.; and Messrs. Merciers Patents, Limited, Manchester, are removing to new works at 252, Chapel street, Salford, near Salford Station.

Southampton.—Colonel Johnston, Director-General of the Ordnance Survey, has received the sanction of the Board of Agriculture to the Ordnance Office receiving electrical power from the Southampton Corporation on terms agreed to.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared a dividend for the quarter ended Dec. 31 of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for 1900.

Fulham.—The Guardians have adopted in its entirety Mr. Medhurst's scheme for lighting the workhouse by electricity. The latest increase in the Council's consumers is equivalent to 211 8-c.p. lamps. This brings the number up to 170, with a total of 12,342 8-c.p. lamps.

Medomsley.—The trustees of the Allendale Cottages Wesleyan Methodist Church last week asked if the Parish Council would put the electric light into their church. The Parish Council have no power to do this, and have referred the applicants to the Consett Iron Company.

Hastings.—The figures relating to the progress of the local municipal electric light undertaking will shortly be laid before the Town Council. In the meantime it is gratifying to know that Mr. L. Andrews, the borough electrical engineer, regards the position as eminently satisfactory.

Stockton.—In the estimate for the year ending March, 1902, the committee have included amounts for the cost of lighting by electricity and painting and decorating the town and borough halls, and also a sum of £120 for the heating apparatus and electrical fittings at the free library.

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Blackpool.—Alderman J. Brodie (chairman), Alderman J. Ward, and Mr. J. Lancaster will represent the Corporation Tramway Committee at the electrical convention at Glasgow in June, while Alderman J. Grime and Mr. R. C. Quin, electrical engineer, will be a deputation from the Electric Lighting Committee.

Sunderland.—At the last meeting of the Tramways Committee, the traffic manager announced that the takings for the week ending March 20 were £750, and for March 27 £746. He also said that 27 of the old tramcars had realised £55. 5s. The takings, it is stated, are £500 per week more than they were last year for the corresponding weeks.

Cable Rates to India.—The Government of India have agreed to a reduction of the cable charges from India to London to 2s. 6d. per word. This reduction, amounting to 1s. 6d. per word, has been assisted by the representations of Sir Edward Sassoon, M.P., and Mr. Henniker Heaton, M.P. The change will come into effect almost immediately.

Isle of Dogs.—The Electricity Committee of the Poplar Borough Council have decided, subject to the approval of the Council, to instal the electric light at the Isle of Dogs. It is estimated that 100 arc lamps will be required, at an estimated cost of £3,277, while the additional charge per annum in excess of the cost of gas lighting will be £877.

Partnership.—We are informed that Messrs. Bergtheil and Young, London and Manchester, have, as from Jan. 1, 1901, taken Mr. Robert O. Ritchie into partnership. Mr. Ritchie, who has for many years acted as manager of the electrical department of Messrs. Greenwood and Batley, Limited, of Leeds, will take charge of the firm's Manchester branch.

Luton.—At a recent special meeting, the Electricity Committee considered the tenders sent in for wiring the public buildings for electric light purposes, and the borough engineer was ordered to communicate with six firms selected for further particulars in regard to their tenders. The committee have received about 40 tenders in all. The voltage is not to exceed 250.

Tipton.—The General Purposes Committee reported on Friday that the Electric Distribution Company had sent in their terms for the supply of electricity in bulk for lighting purposes, and that the committee had deferred consideration of the matter. The company had applied for a lease of the land adjoining the parish offices for the establishment of a branch station.

Nuneaton.—The town surveyor in his annual report mentions that the gross revenue from the electricity works is £686. 15s. 6d., and the annual interest and repayment on the £18,000 loan (borrowed by the District Council for purchasing and extending the works) amount to £1,169. Such figures are unavoidable in the beginning, but they are soon reversed as the consumers increase.

Stafford.—We understand that Messrs. Siemens and Co. have completed the purchase of the land at The Hough which they require for the erection of their extensive new works. The land acquired comprises about 51 acres, and the company are now negotiating for the purchase of a further 10½ acres, upon which they propose to erect about 1,000 dwellings for the accommodation of their employés.

Norfolk.—The County Council have granted applications for leave to erect telegraph poles on the sides of main roads as under: Euston post office to Rushford post office, junction with the rural district road at Worstead to Smallburgh post office; and also an application from the National Telephone Company for leave to erect poles on main road from Coltishall to junction of road to Stratton Strawless Hall.

Union Light and Power Co.—The Reorganisation Committee of this Company have notified to the certificate holders of the first mortgage gold bonds and the consolidated gold bonds that the National Provincial Bank of England, 112, Bishopsgate-street, E.C., is now prepared to deliver to the said holders securities of the Utah Light and Power Company in the terms of the reorganisation agreement of June 30, 1899.

Cheltenham.—The Electrical Engineer has recommended the Town Council that energy supplied in bulk to the tramway company be charged at 1·9d. per unit for a minimum quantity of 200,000 units per annum, 1d. per unit for additional quantities up to a total of 300,000 units per annum, and ¾d. per unit for energy in excess of 300,000 units per annum. The salary of Mr. H. E. Soper has been increased by £18 per annum.

Southwell.—The Rural District Council intend to support the Bill of the Derbyshire and Notts Electric Power Company. The Chairman said at the last meeting of the Council that in these days of progress they should not put a block in the way of such an undertaking. There was no doubt that electrical power could be generated cheaply at the collieries by the use of coal that had been turned to waste for years and years on the pit bank.

Huddersfield.—Major Druitt, R.E., inspected two new tramway lines which have been laid in connection with the Corporation's system on Tuesday. The longer section of the two is that which connects the Sheepridge suburb with Huddersfield, while the other extends from the Market-place by way of Kirkgate to Shorehead. The new routes will be served by steam haulage, but the lines are bonded in readiness for the future electric equipment.

Anglo-American Telegraph Co.—At a meeting of the directors of the Anglo-American Telegraph Company, Limited, on the 29th ult., it was resolved, after placing £6,000 to credit of the renewal fund, to declare an interim dividend for the quarter ended March 31, 1901, of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less income tax, payable on May 1 to the stockholders registered on the books of the Company on March 31.

Imperial Telegraph Committee.—Sir E. Sassoon, M.P., has been elected chairman of this committee. The Australian rate has been reduced from 4s. 9d. to 3s. 6d. per word, and the South African from 5s. to 4s. At the last meeting the hope was expressed that before long the American and Canadian rates would be reduced to 6d. It was decided to ask Mr. Chamberlain to receive a deputation after Easter in connection with rates to West Africa.

Halifax.—The buildings which have been erected at Salterhebble by the Guardians to meet the imperative need for increased hospital accommodation will be opened on Easter Tuesday by Mr. J. W. Tillotson, chairman of the Building Committee. The plans were prepared by the architect, Mr. W. Clement Williams, F.R.I.B.A., of Halifax. There is a complete electric light and power station, placed below the ground level, and electric lifts are provided.

Horsham.—Sanction has been received to the borrowing of £14,006 for purposes of electric lighting. As usual, the Local Government Board have deducted £1,500 for free wiring because, after consulting with the Board of Trade, they had found there was nothing in the order or the Electric Lighting Acts which empowered the undertakers to execute any works on the consumers' premises beyond the terminals. The original application was for £15,506.

Rotherham.—Mr. E. Cross, electrical engineer, in his last report states: "The boilers and generating plant should be ready for preliminary testing by Monday, April 15, and the remainder of the work should be completed four weeks later. Provided no unforeseen delay occurs, you will be able to supply electricity to the town at that time." The Free Library and Technical Instruction Committee recommend the wiring of the institution for electric lighting.

Opening-up Roads.—In the High Courts on Thursday wekk the Brentford District Council sued the London United Tramways for opening up Boston-road for the purpose of laying electric cables without their sanction. The defendants claimed that the latter was not necessary under part 7 of their Act. The Court held that the tramway company had a right to open up the road without obtaining the permission of the Council, and dismissed the action, with costs.

Tracing Cloth.—The Koh-i-Noor tracing cloth, manufactured by Messrs. L. and C. Hardtmuth, is, we hear, giving ample satisfaction among those architects, draughtsmen, and others who have adopted it in their offices. From a sample of the preparation forwarded to us we are convinced of its high qualities and efficiency, both as regards strength and glaze. The fact alone that the Koh-i-Noor tracing cloth is of English manufacture is a strong recommendation in its favour.

"Ark" Lamps.—We are informed that Messrs. Johnson and Phillips, Old Charlton, have received an order for a considerable number of "Ark" lamps for the lighting of the Boer prisoners' camps at Ceylon, the essence of the order being quick delivery, which they were able to comply with, as their works are now turning out lamps at the rate of 100 to 200 per week; good burning qualities, simplicity and durability of construction, combined with a low price, having created a demand.

Underground Telegraph Wires.—The Postmaster-General has addressed a letter to the Associated Chambers of Commerce appreciating the force of the arguments in favour of underground telegraph wires, but pointing out that the system is costly and subject to drawbacks. However, after experience of the line between London and Birmingham, the Postmaster feels justified in extending the underground system, and will lay a section from Preston northwards, where the overhead lines are much exposed to storms.

Cleckheaton.—Colonel Durnford has held an enquiry relative to the application of the District Council for powers to borrow £25,000 for purposes of electric lighting and tramways and the provision of a refuse destructor, and £120 for the purchase of land at Hartshead Moor for the purpose of a depôt. It was shown that there was a general desire on the part of the inhabitants for the introduction of the electric light. The scheme includes the supply of power for a tramway service in the district, for which statutory assent has already been secured.

Manchester Telephones.—It is suggested, according to the *Manchester Guardian* that under the Manchester telephone area scheme to be adopted by the several authorities who have taken part in conferences on the subject, a joint Board should be formed, to consist of representatives appointed annually by the municipal and urban district councils within the area. Manchester would have 10 members, Salford 5, and the Eccles Council and the district councils 3. Suggestions are also made for the provision of the capital and the grant of wayleaves.

Bournemouth.—At last week's meeting of the Harbour Commissioners, the General Purposes Committee reported the receipt of a letter from the National Telephone Company, Limited, asking permission to lay a telephone cable in the bed of the harbour between Sandbanks and Branksea Island, and on the recommendation of the committee the Commissioners decided that permission be given subject to the company undertaking to be responsible for all damage caused to the cable by vessels dragging their anchors, or fishing boats engaged in dredging or fishing.

Royal Institution.—The "E.L.B." system was demonstrated by the representatives of the Electric Lighting Boards Company before the members of the Royal Institution at their meeting on

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Friday last, when all its latest improvements, includings its flexible strips and many accessories, were shown. We are informed that the Irish section of the Glasgow Exhibition will be entirely lighted on the "E.L.B." system. The whole of the work is being provided by the Electric Lighting Boards Company, and is being installed by Messrs. Wm. Coates and Son, of Dublin and Belfast.

New British Incandescent Electric Lamp Co.—Mr. Justice Buckley in the Chancery Division on Tuesday, heard a motion *in re* Carroll *v.* New British Incandescent Electric Lamp Company for the appointment of a receiver, plaintiff being the holder of debentures for £175. The company had executed a mortgage on leasehold premises at Willesden Junction in favour of Messrs. Ely and Everett which took priority of the debentures. Counsel said that the affairs of the company had suffered very much in consequence of certain police court proceedings. His Lordship granted the applicati n.

Merthyr Tydvil.—At last week's meeting of the Lighting Committee a discussion took place on the proposed lighting of the town hall and streets by electricity. A sub-committee was appointed to deal with the matter, and it was resolved to write to the four local gas companies for tenders for the supply of gas for a period of years, and also that the surveyor should report as to streets in the town which could be suitably lighted by electricity. Messrs. Handcock and Dyke, electric specialists, sent in their report on the system proposed to be adopted by the electric lighting company at Merthyr Tydvil.

Stock Exchange.—The Stock Exchange Committee have appointed April 17 as a special settling day for Baker-street and Waterloo Railway's 34,601 ordinary shares of £10 each fully paid and £6 paid, within Nos. 1 to 34,601, and 66,000 4 per cent. preference shares of £10 each fully paid and £6 paid, within Nos. 1 to 66,000. They have also ordered W. T. Henley's Telegraph Works Company, Limited, further issue of 5,000 ordinary shares of £5 each, fully paid, Nos. 30,001 to 35,000, and 5,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 30,001 to 35,000, to be quoted in the official list.

Telephoning by the Slot System.—The *Liverpool Courier* says the street corners in New Haven will soon be adorned by public telephone boxes, after the fashion of fire-alarms. Each box will ordinarily be locked, but the simple process of dropping a coin into a slot will open it. A connection can then be obtained by the same method as at any public pay station, a directory being hung by the side of the instrument. The door of the box will be so arranged that it will shut automatically when the receiver is hung up after use. It is not explained how it is proposed to prevent the user from being shut up in the box until the next customer comes along.

Hampstead.—The Borough Council have decided to apply to the London County Council for a loan of £17,229 for the further extension of plant at the electric lighting station. At last week's meeting the Works Committee reported that they had considered a report from the surveyor on the subject of motor traction and vehicles for slopping, dusting, and road-watering purposes, and they recommend that the Council do purchase two motorcars with dust or slop tanks, and also fitted with water-tanks and distributors, at a cost of £1,500. Owing to the lateness of the hour at which this recommendation was reached, it was resolved to defer its consideration.

East Ham.—Last week the surveyor submitted a design and estimate (amounting to £231) for the erection of a close brick wall in front of the electricity works, with oak gates and small gate for the entrance to the offices, which the committee approved, and directed the surveyor to proceed with the work forthwith. The electrical engineer reported upon the staff that would be required at the electricity works. The committee recommended that a salary of £2. 2s. per week be paid to the shift engineers, and that advertisements be inserted in various electrical papers for a fully-qualified central-station clerk at an annual salary of £120. Both clauses were referred back to the committee.

Twickenham.—At the last meeting of the District Council a letter was read from Edmundsons' Electricity Corporation to the effect that they had received an offer of ground for the erection of their generating station at Twickenham in Edwin-road. It was about five acres in extent and as they only needed about one acre they suggested that the Council might be desirous of purchasing the rest for the purposes of workmen's dwellings. The Surveyor said the Council would have to consider the height of the machinery shafts in the new works. The matter of the shafts was referred to the Highways Committee, and the question as to the offer of the ground to the Housing of the Working Classes Committee. The Council approved of the site.

Rubber Trade Amalgamation.—An extraordinary general meeting of the Rubber Tyre Manufacturing Company is to be held shortly to consider a proposal for amalgamation with the Dunlop Rubber Company, Limited. A resolution will be submitted for winding-up the company voluntarily, and authorising the liquidator to enter into an agreement with the Dunlop Rubber Company to dispose of the business and assets, the consideration being £120 000 of 4½ per cent. debentures, redeemable at £103 per cent. in 1925. The Rubber Tyre Company's shareholders will receive for each £1 share, either preference or ordinary, £1 of debenture stock of the amalgamated company. The assets of the combined companies amount to £328,000, and the total profits last year were £55,721.

Accidents.—A fatal accident occurred at the South-street, Manchester-square, station of the Metropolitan Electric Supply Company on Tuesday at about 5 p.m. A short length of steam-pipe, running between a boiler and a stop-valve, burst, killing a stoker and scalding another, who with two others, who were less seriously injured, was removed to Middlesex Hospital. Another accident, which caused more commotion than its nature warranted, also occurred on Tuesday—viz., an explosion at the large transformer station of the City of London Electric Lighting Company which is partially underneath the disused churchyard of St. Nicholas Acons, and partly under the roadway of Nicholas-lane. In the chamber there were a very large number of pipes coated with indiarubber and cased in wood. These are supposed to have become ignited through the fusion of electric wires.

Presentations.—Mr. W. T. Golledge, A.I.E.E., who has for the past 4½ years acted as resident electrical engineer at the Royal Agricultural Hall (representing Messrs. F. A. Glover and Co., of 97, Queen Victoria-street, E.C.), was presented on Friday last by the staff of the firm with a very handsome combination cabinet, suitably inscribed, on his relinquishing his appointment to take over the management of the electrical department of Messrs. Anblet, Harry, and Co., Limited, of 53 and 55, Curtain-road, E.C. Mr. W. S. Toplis, mains superintendent, who is leaving the employ of the South Shields Corporation to take up a more important appointment at Manchester, was on Saturday last the recipient of a handsome black marble timepiece as a mark of esteem and respect from the staff, workmen, and contractors connected with the Corporation electricity works. Mr. Jeckell, borough electrical engineer, in a few appreciative remarks, made the presentation.

Worthing.—Mr. E. W. Monkhouse (of the firm of Messrs. Burstall and Monkhouse, the consulting engineers to the Corporation) last week delivered a lecture on the electric lighting work now being executed in that town. The lecture was illustrated by limelight views. The Mayor (Councillor F. E. Ovenden), who presided, said the Council had embarked upon an undertaking involving a great capital expenditure in order to place Worthing in line with all the prominent and progressive towns, not only in this country, but all over the world, and he believed the result of their labours would be to bring a very great deal of profit to the ratepayers. The more people who took the electric light the cheaper electricity could be supplied, and the greater the profit to go to the reduction of the general district rate. Mr. E. W. Monkhouse mentioned that the price proposed to be charged was 6d. per unit for lighting and 3d. per unit for any current used for driving motors or heating purposes. Some 111 arc lamps of about 1,000 c.p. would be used for lighting the principal streets. Along the esplanade these columns would be 60 yards apart. Subsequently a hearty vote of thanks was accorded Mr. Monkhouse for his lecture.

Richmond.—The Mayor reported on Thursday week as to the meeting of representatives of local authorities affected by the application of the Richmond Electric Light and Power Company for a provisional order to supply places outside the borough with electricity, and also as to the withdrawal of the application in consequence of the decision of the Board of Trade. He said he had learnt that the company were proposing to supply electric lighting from the Richmond works to the Heston and Isleworth District Council without the knowledge or consent of the Corporation. The works of the company were none too large to adequately supply Richmond with electric light, but if the company were allowed to go out of the borough matters would be very complicated 20 years hence, when the Council could exercise their right of purchase. He moved that the company be asked to state before the next meeting of the Council whether the reports in the local Press that they were about to make arrangements with the Heston and Isleworth District Council were substantially true, and also whether it was their intention to use any part of the Richmond works in supplying electric current to outside districts. The motion was carried.

London Gazette.—The last day for receiving proofs in the estate of the Electric Exploitation Company, Limited 37, Walbrook, London, is April 22. Mr. G. S. Barnes, senior official receiver and liquidator, 33, Carey-street, Lincoln's-inn, W.C., is trustee.—The following estates have been released from trusteeship: A. R. Earle, 1, Theatre street, Norwich, and H. L. Howard, trading as Thompson Howard and Co., 16 Stonegate, York.—At an extraordinary general meeting of the Bute Electrical Manufacturing Company on March 25, Mr. R. Leyshon, 12, Mount Stuart-square, Cardiff, incorporated accountant was appointed liquidator. A receiving order has been made out *re* G. I. Lloyd, trading as G. I. Lloyd and Co., Castle Mill street, Bristol, on creditors' petition. The first meeting in the estate of the above will be held on April 12 at 12.30 p m.. at offices of official receiver, Baldwin-street, Bristol, and the public examination on April 19, at 12 noon, at Guildhall, Bristol.—A second and final dividend of 1s. 6½d. per pound has been declared in the estate of E. J. Paterson and C. F. Cooper (trading as Paterson and Cooper), European Works, Pownall-road, Dalston, London, payable April 17 or on any subsequent Wednesday, between 11 and 2, at Crosby-square, London.—A first and final dividend of 2s. 1½d. has been declared in the estate of L. Francis, 13, Corporation road, Southwold, Sussex, payable from April 4 at official receiver's office, 8, King street, Norwich.

Brighton.—The accounts of the Corporation electricity works for the year ended Dec. 31, 1900, will be found in another column. From this it will be seen that the fuel question has played a prominent part; in fact, the rise in the price of coal accounts for an increase in the coal bill of £1,500. The whole of Mr. Wright's salary as consulting engineer for the new power station at Portslade has been charged to revenue account, although this is an item that might properly be charged to capital account. The reserve fund has almost been entirely absorbed by extraordinary expenditure on account of (1) change of voltage and (2) special inspection of mains under

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the wood-paved tramway tracks. Thus, instead of charging the cost of doubling the standard pressure of supply in the outlying districts to capital account, as many corporations have done the whole of this cost up to the present has been paid out of reserve fund; and further, owing to the tramway works now in progress, the Corporation had to remove their cables from under the tramway tracks in many places. Instead of the Tramway Committee bearing the cost of this, the Council have decided that it should be borne by the electricity undertaking. In addition to the information given on the balance-sheet, the following figures might be of interest: maximum load on station, 2 968 kw.; capacity of plant installed, 4,710 kw.; number of consumers connected, 2,855; number of 8-c.p. lamps connected, 158,884.

Ludlow.—Mr. John Parker, of Hereford, the consulting engineer, has presented his report and plan for the electric lighting of the borough. He proposes to adopt the three-wire low-pressure distribution system, worked in conjunction with accumulators, and he states that an opportunity is now afforded of disposing of the town refuse by consuming it and employing it in the production of steam for the generation of the electric current. He proposes to provide for 2,450 lamps of 8 c.p. each for private premises, and 16 arc lamps nominally of 2,000 c.p. each and 32 incandescent lamps for street-lighting. The boilers would be in duplicate, and arranged for the destruction of refuse. There would be two engines and dynamos, and the boilers would have sufficient power to run a third if required. Provision had been made for an economiser. The estimated cost of the installation is as follows: machinery, £5,000; buildings, £600; meters, services, and fittings, £450; lamps, £300; law costs, engineering charges, etc., £500—total, £7,350. He estimated an annual revenue of £593 from private services, £240 should be allowed for public lighting, £60 trade profit on wiring, and the disposal of the refuse would relieve the ratepayers of another £150—total £1 043. The yearly expenditure would include: labour, £160; fuel, £20; salaries, £140; incidentals, £78; rates, etc., £60; repayment of principal and interest on loan at 3 per cent. for 25 years, £430. 14s. 3d.—total, £888. 14s. 3d.; leaving a balance to the good on the first year of £155. The report was adopted on the 28th ult. The Council's provisional order expires in July.

Shannon Water and Electric Power Bill.—A conference of the County Councils of Clare and Limerick, and the Borough Council of Limerick, was held on Saturday relative to the provisions of the Shannon Water and Electric Power Bill as it affects the interests of the above bodies. It was resolved: "That as the Shannon Power Bill is of the very greatest importance, and consequently requires to be safeguarded as regards the future interests of the people, and that in order to protect and facilitate the great work of the Shannon, it is desirable that the Councils of Limerick, Clare, and Tipperary, and the Borough Council of Limerick, should have representation on the future Board of the Shannon Electric Power Company after flotation. And further, that a clause be inserted in the Bill to the effect that at any time after 30 years it should be open to the people of the counties and city (as before mentioned) to purchase the entire works or scheme at its then value, such value to be decided by arbitration." It was further proposed to add to the resolution: "And that we request our members of Parliament to support the Bill on the conditions laid down in the resolution." This having been withdrawn, it was proposed that the Irish members of Parliament be asked to support the Bill in its passage through the House of Commons. The Mayor refused to accept the proposition. What was the use of having members in Parliament if they were not prepared to support everything that would be for the benefit of the country without perpetually appealing to them. The Irish Party would not be advertised through him by he accepting such a resolution. The proposition was not persisted in, and a vote of thanks being proposed to the Mayor for presiding the meeting terminated.

Yorkshire Electric Power Bill.—This Bill was under consideration at a conference of local authorities held last week in the Guiseley Town Hall, the authorities represented being the Guiseley, Yeadon, and Rawdon District Councils, and the Menston Parish Council. Mr. S. Barraclough, of Rawdon, presided. The *Leeds Mercury* states that since the previous conference the promoters of the Bill had agreed to an important amendment of Clause 40, so as to preserve to local authorities the right to generate and distribute electrical energy within their own areas. A letter was also read the other night to the effect that it having been pointed out to the Yorkshire Company that the opposition company (South Yorkshire) had a lower scale of charges for small quantities of unite, they had agreed to adopt this scale as an alternative one. A deputation from the company attended the meeting, consisting of Mr. A. G. Lupton and Mr R. Hudson (directors), Mr. Sturgeon (engineer) and Mr, A. R. Chorley (Barr, Nelson and Co. solicitors, Leeds). Mr. H. Claughton asked if six authorities combined together, would the company bring the current to six different distributing centres? He understood they would do that from the answers given by Mr. Lupton at the last conference. Mr. Lupton, after consultation with his colleagues, said that if he gave that impression, he was afraid he went further than he ought to have done. If six authorities made themselves into one distributing authority, they could demand the power at one central place, and they would get the whole quantity at the reduced price; but to have to put down six different stations would add to the expense of the company in the provision of separate distributing mains. He was not prepared to pledge the company to do that. Mr. Sturgeon, however, had suggested that some compromise might be come to for two or three stations to be put down. Mr. Lupton went on to say that Leeds would smother the company if they could, and they asked for the assistance of local authorities to enable them to get through the city of Leeds, and thus bring within the reach of small places what they were confident would be a great benefit to the community. A resolution was passed recommending the delegates to advise their respective Councils to present a petition in favour of the Yorkshire Electric Power Company's Bill, and also to jointly appoint one or more gentlemen to give evidence in Parliament in support of the Bill on behalf of the various Councils.

London County Council.—At Tuesday's meeting it was decided to lend the Stepney Borough Council £10,000 for electric light installation, and the Hampstead Borough Council £4,385 for dust destructors. The following applications have been granted: by the Postmaster-General, to take pipes for telephone purposes into the Charing Cross-road subway; by Charing Cross, Euston, and Hampstead Railway, two plans showing the arrangement as regards entrances and exits of the proposed station at Chalk Farm; by the Westminster Electric Supply Corporation, to lay extra high-tension mains along Robert-street, Gilbert-street, Providence-court, North Audley-street, Green-street, Park-lane, Hamilton-place, Hyde Park-corner, Grosvenor place and gardens, Ebury-street, Belgrave-road, Eccleston-place, Charlwood-street, Vincent-square (two sides), Carey-street, Regent-place, Horseferry-road, and Millbank-street, and to construct underground chambers; Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay low-tension mains along portions of Old Dover-road and Kidbrooke Park-road; County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, of intention to lay low-tension mains along a portion of Herne-hill; the same company, under the Wandsworth Order, 1892, of intention to lay low-tension mains along and across Thrale-road, and to construct a transformer box in that thoroughfare; Charing Cross and Strand Electricity Supply Corporation, under the Strand District Order, 1896, of intention to lay mains (*a*) across the Strand and along Bell-yard, and (*b*) across Carey-street from Bell-yard; Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1889 and 1895, of intention to lay mains (*a*) along a portion of Holland park-avenue, and across High-street, Notting Hill, Campden-hill-square (two crossings), and Aubrey-road and (b) along a portion of Campden House road. The Woolwich District Electric Light Company has given a notice, dated March 14 (received March 18), 1901, under the Woolwich District Order, 1891, of intention to lay mains along Hare-street, Powis street, Wellington-street, Thomas-street, Green's-end, and Cross-street. The receipt of notices under orders granted to local authorities was reported as follows: from the Council of the metropolitan borough of Hammersmith, under the Hammersmith Order, 1893, of intention to lay mains from the Borough Council's electricity works across Great Church-lane, along Union-street, Hammersmith-road, and Brook Green-road to the town hall; and from the South London Electric Supply Corporation, under the Lambeth Order, 1892, of intention to lay mains of high and low tension along both sides of Felix-street.

Gravesend.—At the last meeting of the Town Council the following minutes were adopted: "(1) At a conference held on March 21, the clerk stated that although Gravesend had obtained an electric lighting provisional order, the order for Northfleet had not yet received parliamentary confirmation though it had been passed by the Board of Trade. In all probability, however, such confirmation would be given by the month of August next. On consideration of the subject comprised in the letter from Northfleet of Feb. 20 last, and referred by the Gravesend Council—namely, the expediency of the borough and urban district uniting to generate and supply electricity—the clerk stated that so far as he could ascertain neither the Board of Trade nor the Local Government Board had heretofore sanctioned any similar union of two or more bodies, and that so late as last year an application made to them by Teddington and Twickenham had been refused. It was suggested that if the following principles were adopted it was possible that the objections of the Board of Trade and the Local Government Board might be overcome—namely, that a joint committee be formed of the two authorities, composed of two-thirds of Gravesend and one-third of Northfleet members, and that Gravesend contribute two-thirds of the capital and of the loss, if any, taking two-thirds of the profit, if any, and that Northfleet contribute one-third of the capital and loss, if any, and taking one-third of the profit, if any. The clerk was directed to endeavour to obtain the views of the Board of Trade and the Local Government Board with regard to a union on that basis. On the motion of the chairman and the vice-chairman of the Northfleet Council, a vote of thanks was accorded to his Worship for presiding over the conference, and in responding the Mayor expressed the pleasure the Gravesend members had in receiving the representatives of Northfleet. (2) The Electric Lighting Committee met on March 21. Alderman Paine was unanimously appointed chairman of this committee. The town clerk read the letter, dated March 11, from the National Electric Traction Company, Limited, referred by the Council, and after careful consideration of the subject the town clerk was instructed to reply that the Council had not yet finally matured their plans, and that owing to the suggestion of the Northfleet District Council that the borough and urban district should unite to generate and supply electricity, the Gravesend Council were not in a position to finally deal with the proposals of the company contained in their letter of Jan. 14 last, but that if the negotiations are kept open it is to be definitely understood that the delay as from Jan 11 last, occasioned by the Council having taken, or in the future taking, time to mature their plans and

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reply to the said letter, shall be added to the period given to the company under their agreement and order in which to complete the works. The last-mentioned date was fixed by reason of the Paving, Lighting, and Works Committee having then requested the company to record their views with regard to the terms on which they would accept to receive a supply of electricity for working the tramways. In view of the foregoing it was resolved not to consider the subject of sites for an electric station, nor proceed with the application to the Local Government Board until communication has opened with the Board of Trade and Local Government Board."

Belfast.—Mr. P. C. Cowan has held an enquiry into an application of the Corporation for sanction to a loan of £95,000 for the purpose of carrying out certain works in connection with the electric lighting of the city, which, with the balances of outstanding loans contracted by the Council under the Sanitary Acts and the Public Health (Ireland) Act, 1878, would exceed the assessable value for one year of the premises within the district in respect of which the sum might be borrowed. The Town Clerk said that the estimates for the rates in the current financial year were 6d. in the £, as they estimated an increase in the valuation of the city of 15 per cent. The total valuation of the city was £1,623 926. 10s. 6d. They had power to borrow £180 000 for the erection of the city hall, and £89,000 of that sum had been expended. The Gas Committee had advanced a sum of £32 500 to the Electric Lighting Committee, and the latter committee had repaid the interest on the sinking fund to the end of 1899 on that amount, although there was no liability to do so. That sum paid back amounted to £5,000. Mr. George Andrews said that he had been chairman of the Electric Lighting Committee from 1896 until 1900, when it was amalgamated with the Gas Committee. In 1895 the output was 82,000 units, and in 1900 824,000 units, which showed an increase in the output of ten times and in money value of about five times. At the moment the machinery could meet the demands, but if the demand increased in anything like the ratio of the last few years it would be absolutely necessary to extend the machinery and the mains. There had been applications from the Strandtown district and from Fortwilliam district. He thought the extension would be profitable. The original price was 7d. for lighting and 4d. for motor purposes, and now it was 6d. for the first hour and 2d. for subsequent hours for lighting, and 3d. for the first hour and 1½d. for subsequent hours for motor purposes. There was a great increase in the demand for power for motor purposes for a number of small industries, and he looked upon that as very advantageous to the city as a whole. A surplus remained after paying the interest on the sinking fund, which they decided to give to the Finance Committee to deal with as they chose. In reply to Mr. Dempsey, witness said that the surplus, after paying £5,090, was about £2,000. The gas-engines, etc., in the Chapel-lane works had not been used for some years, and although they were for sale he thought it would be advisable to keep them at present as they would probably be required. Mr. Victor A. H. Cowen, electrical engineer, said that they intended with the loan to expend about £35,000 before the end of the year on additional plant, which was absolutely necessary. The capacity of the present plant was 2,450 kw., which would allow of about 1,800 kw. for supply, representing 100,000 8-c.p. lamps connected with the mains. The average lamps lighted at one time was about 60 per cent. At present they had 78,000 lamps connected, and applications for another 9,000, while up to December 31, 1899, the total was 51,000. Progressing at the same rate they would have 110 000 at the end of this year, and 150,000 at the end of 1902. They had about 660 h.p. for motors connected and applied for, but the equivalent was included in the amount of lamps he had given. With the additional plant they would have a capacity of 4 050 kw, or a safe working capacity of 3,200 kw. Of the £95,000 applied for, a sum of £43,000 would be devoted to additional plant, and the remainder to motors, indicators, and mains, which would be laid in Donegall-place, Royal-avenue, Mountpottinger, Bridgend, Strandtown and Rosetta district. At present they were in communication with a firm for the supply of 1,000 h.p. for motor purposes. There were also 12 applications from Strandtown district.

TRACTION.

Orkney and Shetland.—It is proposed to introduce a motorcar service into both of these islands.

Southampton.—It is proposed to place Post Office collecting boxes on the tramcars for the collection of letters.

Workington.—The Town Council resolved on Friday to oppose the West Cumberland Electric Tramways Bill.

Light Railways.—In the House of Commons on Monday, Mr. G. Balfour introduced a Bill to continue and amend the Light Railways Acts, 1896.

Plymouth.—Major Pringle, R.E., of the Board of Trade, has made the official inspection of the permanent way and cars of the Compton electric tramways.

Cheriton.—The Urban District Council have struck out tramway No. 1 and portion of No. 2 from the provisional order applied for under the Tramways Act.

Liverpool.—The Corporation have now 269 electric cars on the city streets, only 17 horse vehicles surviving, and these will shortly be superseded by electric cars.

Poole.—It was announced at the last meeting of the Town Council that if the certificate had been received from the Board of Trade the electric trams would commence running to-day.

Falkirk.—The Scottish Private Bill Commissioners have held an enquiry in connection with the application for a provisional order by the Falkirk and District Electric Tramways Company.

Paris.—Advices from the French capital state that during the recent bad weather the snow attained a depth of several inches in the suburbs, bringing the electric trams to a standstill and stopping all traffic.

Nottingham.—The work of constructing the tramway extension to Basford has been very much delayed by the bad weather. Steps are being taken in the endeavour to run the trams to Hyson Green in about a fortnight.

Surbiton.—The District Council have granted permission to the secretary of the Ratepayers' Association to examine the agreement between the Council and the London United Tramways Bill with a view to opposing the company's Bill.

Belmont Tramways Co.—We understand that at the meeting of the Belmont Tramways Company on the 8th ult., the offer of the Canadian syndicate to take over the company's undertaking, to which we referred in our last issue, was accepted.

Swansea.—In the order of the Light Railway Commissioners authorising the construction of the new tramways, the length of the lease the Corporation has agreed to give the tramways company was not specified. The Corporation are taking steps in the matter.

Baker-street and Waterloo Railway.—The work of pulling down part of the Hospital for the Blind, St. George's-circus, S.E., has commenced in order to effect a clearance for the erection of the electrical generating station for the proposed extension of the railway.

Tipton.—At a meeting of the Town Council on Friday the opinion was expressed that the Council had been remiss in not obtaining a provisional order to enable them to carry on the business of the tramways within the parish. The matter was deferred.

Tramway Receipts.—The following are the latest traffic receipts: Brisbane Electric (to Feb. 13), £155 increase; Buenos Ayres and Belgrano Electric (to March 3), £375 increase; Barcelona, £89 increase; Perth Electric (to March 29), £317 increase.

Underground Railways Enquiry.—The House of Commons representatives on the Joint Committee to consider the London tube railway schemes before Parliament are to be Sir William Arrol Mr. Ashton, Mr. Cawley, Sir Michael Foster, and Sir John Dickson-Poynder.

Dudley.—The Tramways Committee have approved of a scheme submitted by the tramways company for bringing all the tramway traffic into the Market-place, with a new line on the south side, subject to satisfactory compensation being made by the company for the loss of market tolls.

Longton.—The establishment of electrically-driven passenger cars independent of rails for use in this district on the roads where rails have not been laid down is being actively pushed forward by the Potteries Electric Traction Company, and very soon the cars are expected to be in operation.

Southport.—During the recent stormy weather a heavy snowstorm swept over Southport, causing serious damage to the telephone and telegraph wires. Although wires fell over the tramway routes in some of the streets, any personal danger was obviated by the guard wires, and men with rubber gloves were employed to secure and cut the fallen wires.

Municipal Motorcars.—Replying to a question at the meeting of the London County Council on Tuesday, the chairman of the Highways Committee said that something might be done towards the introduction of municipal motorcars. The Highways Committee had added to its numbers by the election of Mr. Hayhew, who was an expert in motorcars.

Gateshead.—A successful experimental run was made the other day over a section of the new tramway system, the route being by way of Felling, past the gates of the depôt in Sunderland-road. A considerable speed was attained on clear stretches of road, and it was demonstrated that the car was under perfect control, and could be stopped within a few feet.

Isle of Thanet.—Mr. A. P. Trotter and Major Pringle inspected the permanent way and plant of the new light railway on behalf of the Board of Trade on Friday last. As regards the fares to be charged when the line is opened for the public (which may be expected within the next few days), special arrangements are being made for workmen and school children.

Cardiff.—At a meeting of the Cabs Committee last week attention was called to the inconvenience caused to the docks residents during the summer time by the monopoly of the tramcar system at intervals during the day by pleasure-boat passengers. The Chairman concurred that it was a matter that should be seen to, and the head constable was asked to report upon it.

Fenton.—At the last meeting of the Urban District Council it was mentioned that the question of transferring the powers of the Council to supply electricity for lighting and other purposes in the district to the Potteries Electric Traction Company had been further discussed between the representatives of the company and the Lighting Committee. No agreement has yet been come to.

Cleethorpes.—The tramways company are doing their best to hasten on the arrangements for supplying the public with a service of electric cars. A number of standards have already been placed in position on the Grimsby-road, and the work of doubling the lines for the electric service is being rapidly proceeded with. The erection of the electric power station is also being pushed forward.

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The ironwork has commenced to arrive, and a siding is being constructed off the main line to Cleethorpes to the power station in Pelham-road.

Bournemouth.—The Corporation Bill came before the Select Committee of the House of Lords presided over by Lord Stanmore last week. The Bill asks for power to construct tramways, to deviate and widen streets, to compulsorily purchase lands, to supply electrical energy for public lighting and traction purposes, etc. Several of the clauses having been amended, the Bill was reported for third reading.

Sheffield.—A somewhat serious electric car accident occurred last week at Sheffield, resulting in the collision of two electric cars. A car was standing in High-street, and as the trolley boom was being removed the guard by mistake released the brake. The car at once dashed down the hill and crashed into another car standing lower down. Both cars then jumped the lines and tore down the hill, ultimately being brought up by running into the kerb. There were no passengers in either car at the time, and the only person hurt was one of the conductors.

Birkenhead.—The traffic returns from the electric cars on the New Ferry route continue of a satisfactory nature. During the four weeks ending 24th ult. 162,722 passengers were carried, the total receipts being £788. 17s. 4d. The total number of passengers carried since the route was opened are 276 937, the total receipts up to date being £1,339. 8s. 11d. The Finance Committee will ask the Council to consent to the borrowing of £100,000 from the Prudential Assurance Company, Limited, for the purpose of defraying in part the expenses incurred in the construction of the tramways.

Edinburgh.—At the last meeting of the Tramway Committee it was reported that crossings had been completed at either end of the London-road section of the new electric tramways, the one at Leopold-place and the other near Abbey Church, so that it would now be possible to use both lines of rails instead of only a single line as hitherto, and thus greatly facilitate the traffic on that portion of the system. It was suggested that the section should have the advantage of through tickets transferable to adjoining parts of the system, or, better still, that it should be worked on a separate halfpenny fare.

Halifax.—The Tramways Committee propose to grant the use of special tramcars to pleasure parties. There are several popular resorts about Halifax, especially the Ogden Moors, which are now able to be reached by the municipal trams, and last summer difficulty was experienced in obtaining accommodation on the ordinary cars. What the committee suggest is that picnic parties desiring private cars shall be granted the privilege at the charge of 2s. 5d. per 1d. stage run (prepaid), with a minimum charge of 10s. Much dissatisfaction is being caused at Elland by the delay on the part of the Corporation to extend their tramway system to that place.

Kingston-on-Thames.—The Corporation on Tuesday sealed an agreement with the London United Tramways, Limited, for the construction and working of tramways in the borough. The agreement provides that the company shall pay to the Corporation £15,000 towards street widening; shall concede the right to buy the lines at the end of 25 years at "old iron" price; and shall pay a yearly rental of £250 for the first five years, £450 for the next 10 years, and £700 for the following 10 years. The line will be 3½ miles in length, and the motive power will be electricity by means of the overhead trolley system. The company also agree to contribute £10,000 towards the widening of Kingston Bridge.

Ayr.—Very satisfactory progress continues to be made with the laying of the rails for the electric tramways between Ayr and Prestwick. The completed portion of the line from the new bridge to the grammar school nearly a mile, is double, and beyond that to St. Leonard's Church it is single. This section, it is intended, will be continued single out to Burns Monument at Alloway, and the continuation out to Prestwick will be double. A commencement has also been made with the additions to the electric works in Hill-street for the accommodation of the additional electrical machinery, and with the car station on Prestwick-road. It is hoped to have the line in operation before the end of the forthcoming season.

Hanley.—At the monthly meeting of the Town Council a letter was reported to have been received from the engineers to the tramways company setting out the concessions which the company were willing to make to meet the objections raised by the Town Council to some of the proposed extensions in the Potteries. The Town Clerk reported the result of the enquiry before the Light Railway Commissioners had been that all the objections raised on behalf of the Council, with the exception of one relating to purchase, had been met and complied with. With regard to the purchase clause, a period of 31 instead of 35 years had been granted to the company for running powers prior to the time for compulsory purchase by the local authority.

Southwick.—At the last meeting of the Urban District Council a report was presented on the result of the conference to discuss the proposal of the Hove and Shoreham Tramway Company to run their trams by electric traction. This report showed that it had been unanimously decided by the members from the interested districts that it was not expedient to grant an extension of time to the tramway company, and that it was desirable that each authority should either acquire the tramway in its own district or else arrange for one of them to take control. The idea was that the authority should lay down the electric tramway and then lease it to a corporation or company for a period of years. The report was adopted, and representatives were appointed to act for the Council in the matter.

Metropolitan Railway.—Mr. Weir asked the President of the Board of Trade in the House of Commons last week whether he was aware that under Section 23 of the Metropolitan Railway Company Act, 1898, the railway company was enjoined either to adopt a system of electric traction or to arrange artificial means of ventilating the railway otherwise than by openings within a period of three years from the passing of the Act; and would he ascertain what steps the company had taken with a view to carry out those conditions, and would he consider the expediency of enforcing them. Mr. Gerald Balfour said that was not quite the fact. It was, however, common knowledge that the company were taking steps to select a satisfactory form of electric traction.

St. Helens.—A special meeting of the Electricity Committee was held last week to consider the question of allowing goods to be carried over the St. Helens tramways. The committee resolved that it was expedient to grant the company permission to carry goods on suitable terms being arranged, and the town clerk was instructed to enter into negotiations with the company as to such terms. The tramways company have written to the committee in regard to the suggestions of the latter for the doubling of the line from Cropper's-hill to the Toll Bar, stating that they do not think it wise to carry out the work at present. The company also informed the committee that the question of the service of the trams generally is receiving the very careful attention of the directors, who hope shortly to introduce changes which will be satisfactory to everyone concerned.

Bury.—The Corporation Tramways Bill came before Mr. J. W. Lowther, chairman of the Ways and Means Committee of the House of Commons last Thursday week as an unopposed measure. The Bill authorises authority to construct additional tramways within and adjacent to the borough and also to make certain street and other improvements. The additional tramways are expected to cost £132,000, the additional electricity works require £39,000, and the street improvements £114,000. There are 25 new sections of tramways proposed to be laid, but all are short lengths, and cover only about nine miles altogether. The only portions outside the borough are in the districts of Tottington, Unsworth, and Whitefield. The Corporation take power to carry light and heavy goods on the tramways, goods even exceeding eight tons in weight. They desire by the Bill to be able to supply electrical energy outside the borough. The preamble was passed and the Bill reported for third reading.

Lancashire Tramways.—As we announced in last week's issue, the Blackpool, Stannes, and Lytham Tramway Company have been bought up by a syndicate of outsiders at £111,000. From particulars to hand we gather that the company run trams between Blackpool and Lytham, taking in Stannes and Fairhaven *en route*. The motive power has hitherto been gas, which all along has failed to give satisfactory results—so much so that horses have been used as well. The company for some time have been in a languishing condition. Last year, for instance, the highest number of passengers in the history of the concern was carried, but no dividend was paid to the ordinary shareholders, and only one of 3 per cent. on the 5 per cent. preference holders. The total capital is £136,868. The syndicate which has made the purchase is going to do away with gas and substitute the overhead electric trolley system. The line will then be extended to Freckleton, where it will be converted into a light railway which will carry to Preston. There will then be electric tramway and tramroad from Preston as far north as Fleetwood, all along the sea and river coast, a distance of over 20 miles.

Bilston.—At the monthly meeting of the District Council on Thursday week, the Chairman referred to the question of tramway communication between Wolverhampton and Bilston. He denied that Bilston had taken up a hostile position against the Wolverhampton Corporation. Bilston, in their negotiations with the British Electric Traction Company, had secured the following: (1) a line from the Fighting Cocks, through the Parkfield-road, to Bilston; (2) a line from Bilston to Willenhall; (3) a line from Bilston to Bradley; (4) a line from the Bull's Head Inn, Wolverhampton-road, to Ettingshall, connecting with the Parkfield-road; (5) a substantial street improvement; (6) through communication with the South Staffordshire system of 50 or 60 miles of tramway traction. He thought that was something substantial, and Bilston were satisfied with the bargain. The Wolverhampton Corporation had tried to cover their own folly by making charges against the outlying authorities, and they objected to such assertion. However, if Wolverhampton were not smart the electric cars would be running in and around Bilston before they were running in Wolverhampton to the borough boundary.

Barnes.—At a special meeting of the District Council on Friday last the heads of agreement between the Council and the London United Tramways Company were placed before the members. Several of these are of a similar nature to those placed before the Richmond Corporation. With regard to the clause dealing with the purchase of the tramways at the end of 25 years by the local authority, all that part referring to the Surrey County Council was cut out. That in which the tramway company agree to pay the Council £200 per annum in respect of tramway No. 9, and £150 for tramway No. 1, was agreed to. It was decided to alter the period after the opening of the tramways in which the company shall make additional wideninge, if considered necessary, from one to three years; and it was also decided to ask that Section 46 of the Tramways Act of 1870 should be included in the Bill; and also that Sub-Section 5 of Section 12 of the London United Tramways Act of 1899 should not apply to the Barnes district. In consideration of these things it was decided that the Council testify their consent to the Bill passing Standing Orders, and a resolution was passed to the effect that the chairman should have

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authority to seal the consent to the Bill, provided that Richmond passed a similar resolution.

Private Bills.—The West and South London Junction Railway Bill came before the Standing Orders Committee of the House of Lords presided over by the Earl of Morley, in respect of non-compliance with Standing Orders. This Bill, which seeks to authorise an electrical underground railway, about five miles in length, from Paddington to Kennington Park, joining up the termini of the Great Western, Central London, London, Brighton, and South Coast, and London and South-Western Railways, was reported by the examiner as having failed to comply with Standing Orders, notice not having been given to the Duke of Northumberland, Lord Iveagh, and the Hon. W. F. D. Smith, owners of property in Grosvenor-place, within the line of deviation. The committee ultimately decided to allow the Bill to proceed on the condition that the protective clause offered by the promoters should be inserted with the addition of the words, "subsoil in such cellars or vaults." The Standing Orders were also dispensed with in the case of the London County Council (Tramways and Street Widenings) Bill, on the condition similar to that laid down in the Commons—namely, that the tramways to which the consent of the local authorities interested had not been obtained should be struck out, with the exception of the tramway (No. 6) which is to pass along the Farringdon-road. It was mentioned that in connection with this line, which closely approaches the City boundaries, an arrangement had been come to with the City Corporation which would involve a slight diminution in the length of the line. The Bill will therefore proceed. The Metropolitan Railway Bill was read a second time in the House of Commons on Monday.

Newcastle.—The question of the tramway company's lease came up for consideration at the meeting of the committee last week. Some time ago the company received notice that their lease would expire on April 13, but the committee and company are in communication as to the continuation of the running of the traffic, but on a different basis to that at present existing. Under the present arrangements, the Corporation are not allowed to open out more than 100 yards of a street, and this, with several other reasons, led the Corporation to give the company notice to terminate their present contract on the date stated. The Corporation now ask that there should be no limitation as to the opening out of streets; that they should have the right to deviate the traffic from one street to another for making of alterations in the roadway; also to have the right of stoppage of through running cars, if necessary, and the right to run electrical cars on the rails when ready on trial. On the other hand, the company ask to run the cars on the new extended lines at Osborne-road. This the committee are willing to grant, on condition that the company run to the borough boundaries of Elswick-road and Westgate-road, so that whilst they get the advantage of patronage in the thickly-populated districts of Jesmond, they should see to the wants of the more thinly-populated districts at the boundaries mentioned. Should an amicable agreement not be come to, a condition of affairs may arise which will seriously affect the convenience of the general public. As we go to press, we learn that the Tramways Committee have decided to stop the tramcar service of the city on the 13th inst., subject to the approval of the Council, owing to the refusal of the tramway company to agree to certain conditions in the new lease.

Richmond.—The negotiations between the Special Tramways Committee of the Corporation and the London United Tramways, Limited, have resulted in an amicable agreement, and, in consequence, the Town Council have assented to the Company's Bill in Parliament. The heads of the agreement are as follows: The company will not adopt within the borough the overhead trolley system, but some other system of traction which may be approved by the Corporation before the works are commenced. So far as the Corporation are concerned, the company will agree that the purchase clause shall be the same as Section 43 of the Tramways Act, 1870, the option of purchase arising after the expiration of a period of 25 years from the passing of the present Bill, and of every subsequent period of seven years. That if Richmond fails to exercise their option it shall be competent for Barnes to purchase the tramways in both the Richmond and Barnes districts, and, similarly, if Barnes fails to exercise their option, Richmond may purchase the tramways in both districts; and in the event of both authorities failing to exercise their right, then it shall be competent for the Surrey County Council to purchase the tramways in both districts. The company agree to pay the Corporation £500 per annum for the use of the roads for the length of tramways now sought to be authorised. The maximum fare for any route within the borough shall be 1d. for ordinary passengers and ½d. for workmen travelling by workmen's cars. With the consent of the Corporation and the Barnes Urban District Council, the company undertake to apply in the next session of Parliament for power to construct a tramway from Richmond along the Lower Richmond-road, through Mortlake, to Hammersmith Bridge. The fare for ordinary passengers from Richmond to Hammersmith, or from Richmond to Putney, over the company's system, shall not exceed 2d. The company will pave with approved hardwood paving the whole of the tramway area of the tramways, and will maintain the same. The company agree not to make application for further extensions of their tramways within the borough except with the consent of the Councill Before opening the tramways the company agree at their own expense to carry out street or road widenings within the borough at an expense estimated by them at £30,000, and in the event of further widenings being required, they will, under certain conditions, execute them also.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Derbyshire and Nottinghamshire Electric Power Syndicate, Limited.—Capital, £10,030. Object: to carry on throughout the whole of the counties of Nottingham and Derby (except those parts of the county of Derby which lie to the south of the River Trent and to the north-west of the boundary between the unions of Bakewell and Chapel-en-le-Frith) and elsewhere the business of an electric power supply company in all its branches.

New Orleans Motor Company, Limited.—Capital, £20,000. Object: to acquire the business of engineers and motorcar manufacturers, now carried on by Burford, Van Toll, and Co., to adopt an agreement with F. A. Rodewald and the Société Anonyme les Ateliers Vivinus, and to carry on the business of carriers, electrical, oil, and other motor engineers and contractors, suppliers of electric and other power, etc.

New Electric Lamp Regenerating Company, Limited.—Capital, £80,000. Object: to carry on the businesses of C. W. Milne as lamp manufacturers, electrical and mechanical engineers, etc.

Manual of Electrical Undertakings, Limited.—Capital, £5,000. Object: to carry on the business of newspaper proprietors, printers, publishers, advertising agents, and contractors, etc.

Electrites Company, Limited.—Capital, £500. Object: to acquire certain existing inventions and a registered design from F. B. Lacy, and to carry on the business of makers of electrical apparatus, surgical appliances, etc.

T. C. Williams and Sons, Limited.—Capital, £20,000. Object: to acquire and carry on the business of T. C. Williams and Sons as manufacturers, ironfounders, heating and ventilating engineers, mechanical and electrical engineers, etc.

PROVISIONAL PATENTS, 1901.

MARCH 25.

6191. **Improvements in electric light and power appliances.** Robert Ley Wood, 1, Lansdown-terrace, Cheltenham.

6207. **Improved method of and means for automatically switching off the current in trolley wires used for electric traction in case of a breakage or other accident.** Richard Swales, Fred Stamford, and Richard Arthur Swales, 8, Quality-court, Chancery-lane, London.

6242. **Improvements in or connected with electric demand indicators.** William Cowderoy, Norfolk House, Norfolk-street, Strand, London.

6258. **Improvements in electrical switches and like contact devices.** John James Glass, 46, Lincoln's-inn-fields, London.

6271. **Improvements in or relating to telegraphic or telautographic apparatus.** Alfred Julius Boult, 111, Hatton-garden, London. (Ernst Karl Gruhn, Germany.) (Complete specification.)

MARCH 26.

6280. **Improvements in electrically-controlled switches for electric circuits.** August Eckstein and David Barclay Mellis, Peel Works, Adelphi, Salford, Manchester.

6317. **Improvements in apparatus for the manufacture of electrical insulating material and for the testing of the insulation of electric conductors.** Ernest Alexander Claremont, 4, Bloomsbury-square, London.

6352. **Improvement in electric accumulators.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

6358. **Improvements in or relating to electric ignition devices for internal-combustion engines.** Alfred Frank Aldridge and Charles Montague Linley, 111, Hatton-garden, London.

6363. **Improvements in electric accumulators.** Arthur Carter, 115, Cannon-street, London.

6370. **Improvements in electrical means for preventing collisions on railways, tramways, and the like.** Jacob Wanner and Franz Wanner, 18, Buckingham-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on April 20.

1900.

5569. **Electric storage batteries.** Thompson. (Sperry.)

5751. **Storage batteries.** Sperry.

6694. **Speed-changing gearing.** British Thomson-Houston Company, Limited, and Samuelson.

6794. **Electrical combined switch and cut-out.** Eckstein and Krause.

6948. **Polyphase induction motors.** Lamme. (Date applied for under International Convention, Sept. 14, 1899.)

7062. **Printing telegraphs.** Cerebotani and Moradelli.

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7373. Formation of drum windings for dynamo-electric machines. Langdon-Davies and Soames.

9133. Process for manufacturing thin homogeneous plates more particularly applicable for use in electrical condensers. Lombardi. (Date applied for under International Convention, Oct. 31, 1899.)

10029. Distribution of electric current. Storer. (Date applied for under International Convention, Nov. 1, 1899.)

10124. Calling appliances for telephone switchboards. Kingsbury. (Western Electric Company.)

10270. Arrangement of voltaic battery for use in firing explosives. Evans.

12721. Systems of electric motor control. British Thomson-Houston Company, Limited. (Perry.)

15169. Rectifying alternating electric currents. British Thomson-Houston Company, Limited. (Thomson.)

16127. Dynamo electric machines. British Thomson-Houston Company, Limited. (Steinmetz.)

18617. High-potential electric circuit breakers. British Thomson-Houston Company, Limited. (Hewlett.)

20311. Electrical connections for tables and the like. Banks.

20797. Sound-magnifying appliances for telephones, phonographs and the like. Rieger.

23649. Electric bell. Kraus.

1901.

393. Electrolysis and apparatus therefor. Newton. (National Electrolytic Company.)

3061. Electric generator. Stretch.

3494. Electrical glow lamps. Couch.

4007. Telephonic apparatus for central stations. Abel. (Siemens und Halske Aktiengesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Mar. 23	550	518	+ 32	28,116	24,565
Birmingham Trams.	,, 30	3,999	4 033	− 34	51,517	—
Blackburn Corp'rat'n	,, 29	426	376	+ 50	5,089	4 598*b*
Blackpool Corporatn.	,, 28	202	156	+ 46	30 579	22,534
Blackpool-Fleetwood	,, 30	147	201	− 54	1,883	2 073
Bolton Corporation..	,, 31	1,206	945	+ 261	17,745	10,155
Bradford City Trams	,, 24	800	350	+ 450	9,167	4,189
Bristol Tramways Co.	,, 29	3,581	2,552	+1,029	—	—
Carlisle Tr'mw'ys Co	,, 30	122	—	—	1,459	—
Central London Ry.	,, 30	6,228	—	—	79 235	—
City & South London	,, 31	2,115	1,360	+ 755	26,351	15,939
Cork E. T. and L. Co.	,, 29	339	314	+ 25	4,240	3 805
Dover Tramways ...	,, 30	153	145	+ 8	1,998	1,868
Dublin & Lucan E.R	,, 30	78	73	+ 5	923	763
Dublin U.T., elec. cars	,, 29	2,929	2,886	+ 43	—	—
Dublin S.D. Electric	,, 29	620	653	− 33	—	—
Dundee Tram Co. ...	,, 13	569	350	+ 219	—	—
Glasgow Corporation	,, 30	7,999	8,177	− 178	—	—
Halifax Corporation	,, 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	,, 23	680	575	+ 105	35,328*b*	32,351
Hull Corporat'n E.S.	,, 30	1,543	718	+ 825	71,933*b*	—
Liverpool Corporat'n	,, 16	8,048	7,014	+1,034	85,905	73 516
Liverpool Overhead	,, 31	1,462	1,277	+ 185	19,206	18,137
Portsmouth Corpn...	,, 30	453	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 31	2,926	—	—	—	—
Southampton Trams	,, 28	537	315	+ 222	—	—
Southport Corporat'n	,, 16	*a*443	—	—	7,011*d*	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. *b* Since April 1, 1900. *d* From July 18, 1900.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Electric Railways.—			
Central London, Ordinary	10	–	8¾-9¼
—— Pref. Half-Shares	5	–	4¾-5¼
,, ,, deferred	5	–	4-4¼
City and South London, Consolidated Ordinary	100	–	46-50
—— Ordinary	10	–	4-5
—— 4 per cent. Debenture Stock	100	–	112-117
—— 5 per cent. Pref. Stock '91	100	–	132-137
—— ,, ,, ,, '96	100	–	122-127
Liverpool Overhead, 5 per cent. Pref.	—	–	13-13½
Waterloo and City, Ordinary	100	–	94-97
Telephones.—			
National Telephone, Ordinary	5	–	8¼-8¾
—— 6 per cent. Cum. First Pref.	10	..	11-13
—— 6 per cent. Cum. Second Pref.	10	–	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	–	4¾-4¾
—— 4 per cent. Deb. Stock, Red.	100	–	97-100
—— 3½ per cent. Deb. Stock, Red.	*100	–	90-93
Oriental Telephone and Electric Company	1	–	¾-1¼
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	11/16-13/16
British Electric Works, Ordinary, 50,001-95,000	1	–	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	–	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	103	–	85-90
British Insulated Wire, Ord., 1-70,000	5	–	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	–	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4¾-5
Brush Electrical Engineering, Ordinary	2	–	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	–	2¼-2⅜
—— 4½ per cent. Debenture Stock	100	..	103-108
—— 4½ per cent. 2nd Debenture Stock	100	–	101-103
Callender's Cable, Debentures	100	–	109-113
—— Ordinary	5	–	15-16
—— 5 per cent. Pref.	5	–	5¼-6
Crompton and Co.	2	–	2½-2¾
—— 5 per cent. Debentures	—	–	100-105
Edison and Swan United, Ordinary	2	–	1¾-2
—— 5 per cent. Debentures	5	–	5-6
—— 4 per cent. Deb. Stock, Red.	100	–	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	–	96-100
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	–	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-130,000	1	–	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	–	15-16
—— 4½ per cent. Preference	5	–	5¼-6
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	21-22
—— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	12	–	37-41
—— 5 per cent. Bonds	100	–	101-104
Telegraph Manufacturing, Ordinary	5	–	11-12
—— 5 per cent. Cum. Pref.	5	–	5¼-6
Willans and Robinson, Ordinary, 1-80,000	5	–	11¼-12½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	–	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	–	103-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	–	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	–	70-75
Bournemouth and Poole, Ordinary	10	–	12½-13½
—— 4½ per cent. Cum. Pref.	10	–	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	–	7¼-8
—— 7 per cent. Preference	5	–	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	–	6¾-7¼
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	–	5¼-5¾
Chelsea Electricity Supply	5	–	5¾-6¼
—— 4½ per cent. Debentures	100	–	109-112
City of London, Ordinary	10	..	7-8
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	–	101-103
County of London and Brush Provincial, Ordinary	10	–	8-9
—— 6 per cent. Cum. Pref.	10	–	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	–	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4¾-5¼
—— 4½ per cent. First Mort. Deb.	100	–	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	–	4¾-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-5¾
Howe Electric Lighting, Limited, Ord., 1-11,000	5	–	7¾-8¼
Kensington and Knightsbridge and Notting Hill	100	–	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	2	–	1¾-1¾
—— 6 per cent. Pref.	5	–	3-4
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	12-13
—— ,, 85,001-98,769	5	–	9-10
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	–	97-100
Notting Hill Electric Lighting	10	–	15¾-16¼
Oriental, 1879	1	–	1¼-1⅜
—— £5 Shares	5	–	7-7¼
—— £4½ Shares, New	4½	–	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	–	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	–	65-75
Royal Electrical Company of Montreal	$100	–	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	–	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 4 per cent. Debenture Stock	100	–	80-90
South London, Ordinary	5	–	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	13¾-14¼
—— 7 per cent. Pref.	5	–	8¾-9¼
—— 3½ per cent. Deb.	100	–	98-101
Westminster, Ordinary	5	–	11¼-12¼
—— 80,001-109,437	5	–	11¼-12¼
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	–	3-4
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	–	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	–	98-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	–	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	–	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	..	100-102
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	–	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10	–	11¼-12¼
—— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4¾-5
—— 5 per cent. Deb. Stock, Red.	100	–	104-107
—— Prov. Cert., all paid	100	–	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	–	1⅛-1⅜
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	–	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	–	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	–	98-102
Kidderminster and District Lighting and Traction, Pref.	5	–	3¾-4
London Street Tramways, Nos. 1-31,000	4	–	1⅛-1⅜
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	..	102-104
New General Traction, Ordinary	5	–	3-3¼
—— 6 per cent. Cum. Pref.	10	–	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10¼-10¾
—— 5 per cent. Cum. Pref.	10	–	11¼-12¼
Potteries Electric Traction, Ordinary, 25,667-40,000	10	–	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
—— 4½ per cent. Debenture Stock	100	–	107-109

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NOTES.

Electric Furnaces.—Two large electric furnaces taking a current of 100 amperes at 110 volts were recently installed at the McGill University, Montreal.

Royal Institution.—A general monthly meeting of the members of this institution was held on the 1st inst. Sir James Crichton-Browne, treasurer and vice-president, occupied the chair, and in the course of the evening made the gratifying announcement that his Majesty the King had graciously consented to become patron of the Royal Institution.

Electrical Combines.—From some remarks made by the chairman of the Thames Ironworks, Shipbuilding, and Engineering Company at the annual meeting, it has been assumed by some that three of our electrical firms had amalgamated. This assumption is quite false, and has arisen out of the fact that the three firms in question sent in a joint tender for the provision of electric plant to the Metropolitan District Railway. The joint tender would, if accepted, have allowed of more prompt delivery than if either of the firms had undertaken the whole of the work.

Production of Steel by Electricity.—The United States Consul at Bergen states that successful experiments to produce steel by electricity in Sweden are being carried on at Gysinge factory, and about 25,000lb. of steel are produced in six drafts daily. The steel is stated to be of an excellent quality. As the electrical power is limited, the output is insignificant. To overcome this drawback plans have been formed for the erection of a large electric plant near the Dalalfuen River, the water power of which will be utilised. This will enable the company to carry on the manufacture of steel by electricity on a large scale.

Novel Telegraphic Communication.—Electricity will bear an important part in the ceremonial attending the opening of the Pan-American Exhibition in May by President McKinley. The Temple of Music and the executive offices of the presidents of all the republics in the Western Hemisphere and the Governor-General of Canada will be in direct telegraphic communication with the President's train, and at a prearranged time all these dignitaries are to touch electric buttons which will each start a piece of machinery of the exhibition, sending a message of greeting at the same time. President McKinley himself will start the great fountain pumps by this means from his private car.

Electric Fire-Alarm.—A new electric fire-alarm has recently been invented in the States. The arrangement consists of a metallic case containing a charge of a Bengal light surmounted by an igniting charge, in which is buried an electric fuse. The whole is made watertight, and is arranged to be put in position on a cornice or other prominent part of the building. The fuse is connected through thermostats to the battery. When the temperature rises unduly the circuit is closed, the igniting charge is exploded, and the compound is ignited, making a brilliant light in the neighbourhood. The *Scientific American* points out that a device of this kind will doubtless prove of considerable value in sparsely-settled districts where there is no fire-alarm system, but obviously it is only serviceable when the fire occurs at night.

Competition.—The *Electrical Review* of New York, with praiseworthy enterprise, offers a prize of £20 for the best article upon the subject of the electric lighting central-station superintendent sent in before May 1 next. The scope of the subject is sufficiently wide, embracing as it does the duties of this official, how he may best fit himself for them, what steps he must take to ensure success in that profession, and what type of man is best fitted by character, experience, education, and brain texture for employment under conditions of great responsibility by owners of such installations. The article must not be less than 3,000 nor more than 5,000 words in length. Only articles written by members or associate members of the American Institute of Electrical Engineers or members of the National Electric Light Association will be considered.

Electrical Distribution.—A lecture was delivered recently by Mr. W. Hartnell in Leeds before the Dewsbury branch of the Yorkshire Engineers' and Firemen's Association. After some interesting introductory remarks to make his audience familiar with the technical terms he would use later on, and also with the general facts connected with power distribution, Mr. Hartnell went on to refer to the large transmission schemes which have now been successfully started in various parts of the world. The lecture was illustrated by lantern slides. In conclusion, Mr. Hartnell spoke of the obstacles which were thrown in the way of electrical power distribution schemes in England. In view of the fact that thousands of horse-power had been transmitted commercially over distances up to 80 miles abroad, he predicted that such schemes, having their power stations on the coalfields, would be commercially successful in this country if only the legislative restrictions and the hindrances imposed by the municipal authorities could be overcome.

The Marconi Patents.—There is no longer any doubt as to the validity of the wireless telegraphy patents granted to Mr. Marconi, Judge Alfred C. Coxe, of the United States Circuit Court, having decided that Marconi is the real inventor of the apparatus. The complaint was made by Mr. L. C. Learned, whose main point of contention was that wireless telegraph apparatus had been invented by A. E. Dolbear so long ago as 1882, and that the patents came into his possession in July, 1899. Amongst the English expert evidence given in the course of the proceedings was that of Prof. J. A. Fleming, who testified that he had experimented with apparatus under the specifications of the Dolbear patent and had failed to obtain results. Again, Marconi's apparatus depended for its action upon the production of electric waves, the essential element used for this purpose being the spark-gap. In the Dolbear specifications no mention was made of this arrangement. In consequence of this and other expert evidence, Judge Coxe declared for the validity of the Marconi patents.

The Bell Telephone.—The figures contained in the annual report of the Bell Telephone Company furnish ample indication of the rapid growth of this branch of the electrical industry. For instance, in the three main items of revenue—viz., dividends from sub-companies, rental of instruments, and telephone traffic—the receipts for the year amounted to £1,860,000, or £374,600 more than in 1899. This state of things is the more satisfactory in face of the fact that the telephone opposition in the States at present serves more telephone subscribers than does the Bell system. One is forced to the conclusion that the introduction of competing exchanges in the same centre is beneficial to the industry as a whole, in spite of the old theory that only one exchange can exist in any given district. An interesting point in connection with this subject, as pointed out in the *Electrical World*, is that in the States there are nearly three times as many telephone subscribers as in the whole of Europe. The Bell subscribers number 800,000, and if these be added to the 1,500,000 subscribers claimed by the independent undertakings, the total figure stands at 2,300,000 for the United States.

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St. Marylebone Lighting Order.—We note that the suggestions made by the London County Council in regard to the St. Marylebone electric lighting order applied for by the Borough Council have been adopted by the Board of Trade, and the maximum price per unit, after the first 20, which are to be paid for at the rate of 7d., has been fixed at 6d. The County Council suggested to the Board of Trade that the application of the Marylebone Electric Supply Corporation for an order in respect of that borough should not be entertained, or that, if it were allowed to proceed, certain amendments should be made in it, and most of these have been adopted. The Board has intimated that, after full consideration of the circumstances, it has decided to grant both the orders referred to, and to leave to Parliament the decision of the question whether any, and if so what, supply of electricity is to be authorised in the borough in competition with the supply now given by the Metropolitan Electric Supply Company. We understand that both the orders have been inserted in an Electric Lighting Orders Confirmation Bill.

A New Fuse Box.—Mr. John F. Lyons is the inventor of a fuse box that automatically closes the circuit again after the fuse has been blown. He was recently granted letters patent in the United States for this device, details of which are given in the New York *Electrical Review*. The inventor first provides a pair of terminals, to which are fastened the line wires, and are connected by the usual fuse wire. Pivotally mounted upon one of these terminals is a bridge which is adapted to be swung so that it will make contact with the other terminal. A spring secured to this bridge is adapted to force the same into its operative position. This bridge is made of some insulating material, the contacting portions being of metal and connected by a fuse wire. It is normally held open by means of a rod that bears against its under side and rests upon the fuse wire that directly connects the terminals. As long as the fuse wire is unbroken, therefore, the pivot bridge will be held open, but should the fuse be blown the rod will drop from under the bridge and the spring will throw it into contact with the opposite fuse block, whereupon the current will pass through the fuse wire carried thereby.

Accumulators for Automobiles.—A second exhibition and trial of accumulators for automobiles is being arranged, under the patronage of the Automobile Club of France and of the Society for Encouraging the Development of the Automobile Industry. The exhibition, which will be of an international character, will be held at 128, Rue de Bois at Le Vallois, on June 1 next and following days. At the exhibition trials will be made to ascertain the industrial efficiency of the batteries submitted, the dependence of the same on the frequency of charge and the duration and nature of the load which the accumulators have to provide. The weight will, of course, enter largely into the comparison between the various types, as will also the price of upkeep per kilowatt-hour, after which will be considered the capital outlay on the first cost of the battery. The full conditions as to the number of cells to be sent in, the entrance fee, etc., can be obtained from the Automobile Club of France. We understand that the entrance fee for two batteries, if the application be made before May 1, will be £20, but that after that date the fee will be doubled. We trust that an English firm will again obtain the premier position for its batteries, as happened at the last international show in Paris.

Electrical Moving Platform.—The moving platform which attracted so much attention at the Paris Exhibition last year, was described at length by Mr. Jovignot in a recent issue of the *Bulletin de la Société Internationale des Electriciens*. We have given full particulars of this platform in previous issues of our journal, but we are now able to give from the above source some further details as to the cost of constructing the platform and of working it for a period of about seven months. The length of the moving platforms, of which there were two, was 3,680 yards, or just over two miles. The cost of the platform came out at about £4. 4s. per yard run, including everything. During the seven months it was at work it carried 7,000,000 passengers who paid for their places, the price of entry being about 5d. The fastest platform ran in the season about 12,000 miles. The weight of the moving part was 1,800 tons. The energy supplied for the electric motors under the tramway was charged at the rate of 1·44d. per kilowatt-hour, and the daily cost for energy for working the platform came out at about £10. The whole cost for energy, for upkeep and repairs, and for staff totalled to about £7,200, while the capital charges came out at about £10,000. It follows from the above that the cost per ton-mile on the line was 0·019d.

American National Standardising Bureau.—In our issue for Jan. 25 last we shortly referred to a proposal in favour of establishing a national standardising bureau for electrical and other instruments in the States. We are pleased to see from a note in the *Electrical Review* of New York that the Bill which was being promoted at that time has passed Congress, and it has been decided to erect the bureau in the district of Columbia. The Bill appropriated £20,000 towards providing a suitable building, the entire cost of which must not exceed £50,000. It is probable that the site will be chosen in some suburban neighbourhood, where it will be possible to escape earth tremors and the influence of heavy electric currents in the vicinity, and its construction is to be commenced forthwith. For a long time the great value and importance of such an institution has been urged upon the United States Government by scientific societies and others, and the decision of Congress in the matter is greeted in the States with acclamation. The direct beneficial effect which the establishment of the bureau will have on all the engineering industries is generally appreciated and admitted. The functions of the bureau consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognised by the Government; the construction, when necessary, of standards, their multiples and sub-divisions; the testing and callbration of standard measuring apparatus the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such data are of great importance to scientific or manufacturing interests, and are not to be obtained of sufficient accuracy elsewhere.

The Andrew Carnegie Research Scholarship.—Mr. Andrew Carnegie, vice-president of the Iron and Steel Institute, has presented that body with 32 1,000dol. Pittsburg, Bessemer, and Lake Erie Railroad Company 5 per cent. debenture bonds for the purpose of founding an annual research scholarship. The object of this scheme of scholarships is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum, or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. The National Physical Laboratory, on the governing body of which the Iron and Steel Institute is represented, would for many reasons be a very suitable place in which such a research could be carried out. There is, however, no

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restriction as to the place of research which may be selected, whether university, technical school, or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship is to be for one year, but the council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research must be communicated to the institute in the form of a paper to be submitted to the annual general meeting of members, and if the council consider the paper to be of sufficient merit the Andrew Carnegie gold medal shall be awarded to its author. The value of the scholarship, which will be awarded irrespective of sex or nationality, will be fixed by the council from time to time as may appear expedient to them. Candidates, who must be under 35 years of age, must apply, on a special form, before the end of April, to the secretary of the institute.

Yellow Journalism.—The following is an extract from a note in our contemporary, the *Morning Leader*, which is dated Berlin, Sunday: "Prof. Slaby, of the Berlin Technical University, Germany's greatest authority on the subject of electro-technics, has an interesting article, called 'Electro-Techniche Zeitschrift,' on the economics of wireless telegraphy. The Baudot system of telegraphing which was employed by way of experiment between Berlin and Paris has been attended with complete success, the whole of the telegraphic communication between the two cities, which previously had required five separate cables, being now dispatched with ease on one wire. Prof. Slaby's experiments, however, carried him so much further that a danger exists that the Baudot apparatus ordered by the German Government will be consigned to the Post Office museum. The technical possibility of conducting all the telegraphic intercourse of the country has been proved to be undoubted by Slaby's experiments, and he demonstrates that the Government will save millions by the use of his system. A hundred pounds would be required to convert each telegraph station to the new system, but this would soon be balanced by the immense sums saved by the fact that there were no wires requiring maintenance. The professor prophesies that the golden age of telegraphy is at hand." It is a great pity that the special correspondent of our contemporary in Berlin is unable to read the language in which Prof. Slaby has expressed his views on wireless telegraphy. The knowledge of our contemporary's correspondent on the subject is to be gauged by a translation of the name of the interesting article said to be written by Prof. Slaby. We shall hear next that Mr. Nikola Tesla has written an interesting article called the "Daily Mail."

Insulating Iron Laminations.—Mr. H. Leconte contributes to *L'Electricien* a description of a new proposal for insulating the iron laminations of an armature core the one from the other. The usual means employed up to now have been either to varnish the plates, or to insert between each plate a thin layer of paper or other insulating material which has sufficient resistance to prevent any current circulating from the one iron plate to the next. The new suggestion—which, we gather, is protected—consists in covering the plates with a layer of blacklead. The blacklead, or graphite, is mixed with water and applied with a brush, and the plates are left to dry. The author suggests that it is also worth while to brush the plates after they are dry, in order to get a thin polished coating of blacklead over the iron. He has had some armatures built up with plates insulated in this way by one or two firms on the Continent. In the first example the core of a certain machine when insulated with paper contained 435 plates of a thickness of 0·55mm., giving in all a thickness of 239mm. of iron. The thickness of the insulation was 20·75mm., or 8 per cent. of the total thickness. With the plates insulated with the graphite covering 20 more were inserted in the same space, so that the thickness of insulation was only 3·85 per cent. of the total length of the core. In this way 4 per cent. is gained in the volume of iron. Some experiments were then made after the coils of the armature windings had been put on, from which curves have been drawn. We gather from the information given that the loss in the iron is slightly more when the plates are insulated with blacklead than when paper is used. In the first case the iron losses were 620 watts, as against 510 watts lost in the second, while the induction through the iron was practically the same. The author states that other materials could also be used as well as blacklead, provided they could be applied in the same way.

Underground Telegraph Wires.—A communication has been received by the Liverpool Chamber of Commerce on the matter of laying all telegraph wires underground in preference to the existing system of overhead wires. A few weeks back the Chamber made a representation to Lord Londonderry complaining of the interruption of telegraphic communication by storms. In his reply, his lordship does not fail to appreciate the great inconvenience to trade and commerce arising from any dislocation of the telegraphic service of the country. The matter is one that has engaged the serious attention of the Department for many years, and it is the desire of the Postmaster-General to do all in his power to mitigate the inconvenience. But while the storms which have occurred have sometimes undoubtedly caused serious disorganisation of the service, it is very seldom that there is a storm of such severity as that of February of last year. It is the practice of the Department, whenever the service is interrupted by a storm, to issue notices of delay for public information, but it is very unusual for such a notice to be in force for more than one or two days, and it seldom happens that any town is completely cut off from telegraphic communication. Taking the case of the towns in the North of England for example, the Postmaster-General finds that during the past six years the number of occasions on which it has been found necessary to give notice of delay has averaged six a year only, the average duration of the notice being 1 hour 23 minutes. Last year seems to have been singularly unfortunate. A large number of reserve wires have been provided simply for the purpose of making good sections of lines liable to interruption, and these reserve wires have as far as practicable been taken by alternative routes. The Postmaster-General then goes on to refer to the underground line between London and Birmingham, again expressing the hope, as in the case of Glasgow, Bristol, and other cities, that within a short time the difficulties and drawbacks still connected with an underground system will be so far surmounted as to allow of the extension of the Birmingham line.

Gas Polarisation in Lead Accumulators.—Under this title Mr. C. J. Reed severely criticises an article by Nernst and Dolezalek on this subject. The problem proposed by these authors was: Why can a lead accumulator with an aqueous electrolyte and an E.M.F. exceeding two volts exist, since the electrolyte is decomposed rapidly between platinum plates when the E.M.F. reaches 1·7 volts? In his paper, an abstract of which appears in the *Journal of Physical Chemistry*, Mr. C. J. Reed makes statements which he says leaves the theory propounded by Nernst and Dolezalek "not only without facts to stand on, but without any object or anomaly to explain." The theory proposed by them was that the liberation of hydrogen from a given

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combination and condition does not require the absorption of a fixed quantity of energy, but that, besides the free formation energy, there is a variable quantity required, the value of which depends upon the occluding or absorbing capacity of an adjacent body. Against this theory Mr. Reed states that hydrogen gas is evolved electrolytically in unlimited quantities from dilute sulphuric acid with electrodes of pure metallic lead when the E.M.F. is less than 0·5 volt. To prove this, he uses as an anode lead in a state of very minute division, as in a charged accumulator plate or in an electrolytically-deposited lead tree. As a cathode he uses a clean strip of sheet lead. The E.M.F. required to maintain a steady current between electrodes of pure metallic lead is less than 0·01 volt. This occurs without the agency or presence of lead sulphate in the solution or on the cathode. The E.M.F. required to charge an accumulator is in no way dependent upon or related to the evolution of hydrogen or oxygen on a lead electrode, nor is it dependent upon the occluding capacity of lead. He shows that Nernst and Dolezalek, while working with lead sulphate electrodes, instead of pure lead electrodes, have not considered that the conversion of the lead into lead sulphate has produced an entirely new apparatus. He discusses the different electrochemical actions which can occur in this new condition, and calculates the corresponding E.M.F.'s. When the electrodes of an electrochemical system constitute also the electrochemical reagents, as in the case with the lead sulphate, lead peroxide, and metallic lead of an accumulator, the decomposition tension of the intervening electrolyte is not necessarily a factor in determining the E.M F. between the electrodes. It will usually be a factor if the constituents of the electrolyte are actually set free, but it cannot be a factor if none of the constituents of the electrolyte is liberated by the electrochemical action, because the decomposition cannot then cause the absorption or evolution of the formation energy.

Notes on Electric Wiring.—Mr. G. A. Clark read a paper on the above subject before the Glasgow Local Section of the Institution of Electrical Engineers on Wednesday last. In doing so, the author had to deal with a much-written subject, but we congratulate him on having taken new views, certain of which will commend themselves to electrical engineers. In the first place, he deals with four systems as representing the present practice in electrical wiring work. These are: the use of screw tubes, of Simplex tubes, of wood casing, and of lead-covered twin cables. Under these headings can be included practically all systems of wiring work carried out in the United Kingdom. Mr. Clark then proceeds to deal with the requirements which have to be complied with in order to obtain a perfect system, and he allots under 10 heads what he considers a fair proportion of marks, making up as a whole 100 per cent. efficiency. These 10 heads are: water-tightness, safety from internal condensation, mechanical protection, certainty of electrical continuity in the metal sheathing, accessibility of cables in a completed job, first cost, ease in making additions, freedom from cutting away in old buildings, difficulty of wilfully concealing bad work, and safety from danger of injuring the cables during erection. To the first of these headings he allots 20 marks, which seems to us to be rather excessive as compared with only 15 marks for mechanical protection. As a result of the author's adjudication, the screw tubes receive 65 per cent. of the possible 100, Simplex tubes 52·5 per cent., lead-covered twin-wire cables 75 per cent., and wood casing 46 per cent. As the author points out, the values arrived at are not of absolute practical use, from the fact that there are other properties in the systems which make them especially applicable for certain kinds of buildings. He proceeds to warn installers of electric light against using mixed systems of wiring, which, as he rightly points out, are apt to have the faults of all and the advantages of none. Where a mixed system is absolutely necessary, the change over should always be made at the distribution boxes. He also deprecates the use of screw joints between conductors, which are not so serviceable as the soldered joints. The vexed question of uniformity in requirements is then dealt with, but we are afraid that while the individuality of an engineer in charge of town installations continues to exist, so long will there be individuality shown in the requirements from wiring contractors in different towns. One novel suggestion, which we are sure will not come into service, is that the retention money for wiring work should be the fee of the consulting engineer employed, and that out of this fee the consulting engineer should make good at the end of the year any defects which have arisen. While agreeing with the author that in many instances the retention money is held for a year without much reason, it must be remembered that if such a clause were put into specifications all contracts would be working on the same basis, and could make provision in their first cost representing the interest on the money which they would be out of pocket. In conclusion, the author protests against an installation test being looked upon as a criterion of the value of the work done, and advocates, in the interest of honest contractors who do good work, that proper precautions should be taken for supervising all work, which can only be done when visiting the installation while in course of construction.

European Developments.—We have just received from Mr. W. J. Hammer a complimentary copy of his address on important European electrical and engineering developments at the close of the nineteenth century delivered before the American Institute of Electrical Engineers. We had the pleasure of meeting Mr. Hammer before he returned to the States, and of gathering from him beforehand his ideas of certain new engineering undertakings which he had been investigating. His description, however, as presented to the American Institute contains a large number of details concerning those various inventions which are worthy of most careful perusal. He heads his paper with some notes on the telephonograph, an invention of Mr. W. Poulsen, of Copenhagen. This instrument, which records sound by permanently magnetising a steel wire, is classed by Mr. Hammer as one of the most interesting novelties exhibited at the recent Paris Exhibition. Amongst the special information collected by the author concerning this are details as to the design of the small electromagnet which is used for magnetising the steel wire. He states that it was found advantageous not to use a complete magnetic circuit, but that two independent bar magnets, with their adjacent poles placed on either side of the wire, give much more satisfactory results than an arrangement employing the usual horseshoe magnet. This, perhaps, is to be expected from a consideration of the exceedingly rapid alterations in magnetisation which have to be set up by the current passing round the wire surrounding these magnets. Mr. Hammer had the privilege of inspecting a number of instruments in Berlin, at the factory of Messrs. Mix and Genest. It was there found that when one wanted to obliterate a message in a steel wire, it could best be done by passing it between the poles of an electromagnet. Unless this be done, the wire could be subjected to a considerable mechanical treatment, such as being cleaned with emery paper, without appreciably affecting the record. Mr. Hammer proceeds

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in his address to deal with the various ways in which a telephonograph could be used to give an increased volume of speech by using a number of instruments connected on the one receiver. He comments also on the great advantage which the instrument has over the previous methods of recording speech, in which the influence of the recording stylus is so apparent when certain notes and sounds are being dealt with. The next subject to be dealt with is that of the Langen monorail suspended railway, the first section of which—between Barmen and Elberfeld—is now open. Of the Nernst lamp Mr. Hammer has a good deal to say, having observed lamps of the Nernst type manufactured in Germany, Bavaria, Hungary, London, and America. He expresses the opinion that the American lamps are well to the front. He gathered incidentally from an installation of Nernst lamps in Berlin that their life was by no means great, as out of an installation of 54 there were usually from two to four lamps out in spite of frequent renewals, which were carried out by the company supplying the lamps. He believes, however, that the difficulties connected with the commercial success of the Nernst lamp are quite as surmountable as those which in the early days so much retarded the development of the carbon-filament lamp. With respect to ordinary incandescent lamps, the author states that the Electricitäts-Gesellschaft, of Berlin, now use iron leading-in wires for all their carbon-filament lamps. In that case the iron wire is sealed into the glass in an atmosphere of carbon monoxide. The next big division in the paper deals with European developments in steam-engines, and specially in gas-engines of a large size for the utilisation of blast-furnace gas. We propose to give some liberal extracts from Mr. Hammer's address at an early date. His remarks on steam-turbines also fairly deal with the developments by the two great rivals in steam-turbine work—viz., the Parsons steam-turbine and the Laval steam-turbine. The paper is concluded by notes on electric railways working at high voltages, both the Ganz system and that laid down for trial by Messrs. Siemens and Halske being explained in detail. While congratulating Mr. Hammer on the wonderful amount of information he collected on his European trip, we think the American Institute of Electrical Engineers are to be even more congratulated on the fact that one of their members has so ably represented for them as a whole what was to be seen in engineering developments in Europe at the close of the nineteenth century.

Power Transmission in Utah.—Mr. J. R. Cravath contributes to the *Electrical World* a most interesting article on the experience gained in the operation of long-distance power transmission in and around the Salt Lake City. Three large undertakings, which were originally commenced in opposition one to the other, have now been merged under one control. These are respectively the Big Cottonwood Power Company, which has its works some 14 miles to the south-east of Salt Lake City, and was opened in June, 1896; the Pioneer Electric Power Company, which has its works in the Ogden Cañon, some 37 miles away from Salt Lake City, and which commenced working in July, 1897; and the Utah Power Company, which has its works in the Big Cottonwood Cañon, which were laid down, in 1897, originally for the transmission of power for the Salt Lake City railroads. The engineer of the combined system is Mr. R. F. Hayward, and his experience of large transmission schemes must, in consequence, be exceedingly valuable. He has given some most interesting notes from his experience to Mr. Cravath, and these are incorporated in the article. In the first place, after the consolidation, Mr. Hayward's idea was to get a uniform system of distribution. Fortunately, the frequency in all the plants was the same, but there the uniformity ended. It is now arranged, however, that all the secondary system is uniform, so that all the plants can be worked in parallel. It is contemplated in the near future to raise the voltage on the transmission lines of both the Ogden and the Big Cottonwood stations to 24,000. This can be done on the Ogden line without rewinding the transformers by changing over from the delta system of connections to the star system. The transformers of the other line will have to be rewound. The distribution to the small sub-stations is done by means of 2,300-volt mains. The sub-station transformers have delta-wound primaries; but the secondaries have the star connection. All motors under 10 h.p. are connected to the outside legs of the stars at 200 volts. Motors over 10 h.p. are supplied from separate transformers. The private lighting is balanced equally between the outside connections of the star and the neutral, which gives 115 volts on the lamps. It is usual to run the neutral wire and one of the others down each street, and to balance one street against the other in the first instance, but as the consumers increase, the third and fourth conductors are put in and connected. Mr. Hayward favours a complete system of a network throughout the town. As regards the voltage regulations, it has been found necessary to run certain arc-lighting machines by means of synchronous motors. These synchronous motors can have their excitation varied, and it is found by doing so the voltage on the line can be varied by 10 per cent. We gather from the writer's remarks that there has been some considerable trouble in connection with the water-power stations, due to falls of snow and rock injuring the flumes or actually causing temporary dams in the streams which supply the station. In consequence of this, reservoirs are being constructed to make the undertakings independent of small obstructions lasting from 16 to 20 hours. Mr. Hayward, in connection with this, expresses the opinion that if the development of a water power is so expensive in proportion to the power produced that the cheapest construction of flume, etc., must be chosen on account of its cheapness, it is not worth developing, owing to the interruptions that are sure to ensue. Another point which this gentleman strongly insists upon is that all transmission lines should be in duplicate, so that repairs may be made on one set of wires while the other is supplying the power. He considers that in a mountainous country a No. 4 wire, or No. 5 wire at least, is the smallest that should be used for mechanical strength, and that a 10 per cent. drop is allowable. Aluminium wire has been tried by the company on a six-mile length, with reasonable success. Again, Mr. Hayward is in favour of placing the line wires in accessible positions rather than running them straight across the mountains to save length. He adds that the cost of the pole line, independent of the copper, is very great in crossing mountains, so that increasing the voltage to reduce the copper does not proportionately reduce the total expense. As regards insulators, Mr. Hayward finds that a punctured insulator does not cause a direct short-circuit. What happens, however, is that the small arc that is formed through the hole in the insulator gradually burns away the pin, and, in consequence, the pin breaks, and the crossing of the wire causes the trouble on the line rather than the original puncture. He has found no instance of the pins of insulators being burnt away without a puncture having occurred, and his experience deals with voltages up to 16,000. The whole article is one which is worthy of careful perusal by any engineer having the design of transmission lines in hand.

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THE CONSUMERS' DEPARTMENT OF A CENTRAL STATION.

A great amount of matter has been written during the past few years by wiring contractors and manufacturers regarding the numerous regulations which are issued by our various municipal and supply companies' engineers to which the wiring of lighting and power installations has to conform before it is allowed to be connected to the mains.

The necessity of certain tests and regulations being conformed to is indisputable if the supply is to prove satisfactory from both the engineers' and the consumers' points of view, for in almost nine cases out of ten faults which develop on installations could have been avoided had a proper inspection and test been made of the work before the current was put on in the first instance. There are always a number of people ready to find fault with the electric light, so that it is the duty of our engineers to take every possible precaution to avoid the failure of the light on a consumer's installation, and there is not the slightest doubt that the use of good materials and proper wiring being insisted upon contributes to the success of the installation, from the consumer's point of view, to a very large extent. The unfortunate part of the business is, however, that almost every station engineer has some particular idea as to what are the best rules to be followed, with the result that it is almost impossible for a contractor to carry out work in two separate towns, although the systems of supply might be identical, without some trivial objection being raised to his work by the inspector, and in all probability the contractor has endeavoured to put in the best possible job. It would, indeed, be an excellent plan if all our engineers would agree to adopt one set of rules—say those drawn up by the committee selected from the members of the Institution of Electrical Engineers—and then if there happened to be anything out of the common about the system of supply, one or two regulations could be introduced. In the case of a small station, the work in connection with the testing and inspecting of consumers' installations is usually carried out by the assistant engineer, but when the undertaking is one of any magnitude, a separate department is generally formed to deal with this work, having an installation inspector for its chief, who has a number of assistants under his control. It would, perhaps, be as well if we now considered the work for which this department is responsible, and then proceed to show some of the points which have to be attended to, with the hope that it might prove of use to some of those gentlemen who take up any of the many appointments which are certain to be made within the next few years, as the importance of this department becomes more apparent to our municipal authorities and private companies.

The service mains for the consumer are, of course, put in by the mains engineer, who also, as a rule, fixes the main cut-out, since this is looked upon as a protection to the service as well as for the meter. It is, therefore, beyond this cut-out that the work of the installation department commences—viz., with the fixing of the meter and also of the maximum demand indicators if any be employed. The head of the department should, therefore, be quite familiar with the construction and working of the meters which are to be fixed, as the satisfactory working of them on the circuit largely depends upon them being properly installed; and it is very essential that this work should be carefully inspected after the meter-fixer has completed his work, care being taken to see that the meter is perfectly plumb, and that all terminal screws are screwed up tight. If the meter is one containing mercury, it should be examined to see that none has been spilt during the journey from the stores. When the current is put on to the meter for the first time on the consumer's premises, it should be tested to see that it will start with the smallest load on which it is likely to be called upon to register—say, for instance, an 8-c.p. lamp. In the event of the meter being a watt-hour instrument, shunt running must be guarded against, for it is very frequently found that, although the meter has been carefully adjusted in the test-room, it will have a tendency to run on the shunt when fixed and connected up ready for work, probably owing to the increased vibration to which it is subjected. The reading of the meter should also be taken immediately before the installation is connected, although it is usual for a note to be made of this before the instrument leaves the test-room. If, however, the inspector makes a practice of doing this, it will serve as an additional check, and if at some future date he has to settle a disputed account with the consumer, it will prevent any doubt being raised in his own mind as to whether the original reading of the meter had been correctly recorded. Of course this original reading of the meter would be useless after some time had elapsed, and the fingers had worked completely round. It is very rarely that the fingers of the meter are at zero when fixed, as a number of units are generally put through the coils before leaving the test-room in order to check the counting gear, and the fingers would probably be loosened if they were set back. The installation inspector should have had practical experience in the wiring of installations and should preferably have had charge of carrying out work; for if the station with which he is connected is a municipal one, he will very likely be called upon to get out schemes and draw up the specifications for the lighting of municipal buildings, and if the work be let out to contract he will have to arrange the work with the contractor who is carrying out the job. It is here that he will find his practical experience standing him in good stead, for although it is, comparatively speaking, a very simple matter to decide upon the best runs for mains and the most central positions for distributing centres (from an electrical point of view), it is very often found that to run to the points so decided upon necessitates crossing steel girders and, perhaps, drilling through a few concrete walls, when, perhaps, a little more consideration would have discovered another way, which, although requiring a little extra length of cable, would have been the means of saving a lot of money in labour.

It is not proposed in these articles to discuss the merits and demerits of the various regulations which are issued by different engineers, as it would not only take too long, but the author does not think it would serve any good purpose to do so. They will probably, however, contain references to certain regulations which should be strictly enforced, not so much for the protection of the installation from breakdown as for the use which they may be to assist the engineer to keep up an equal pressure of supply on the network. It is a very good plan, if it can be arranged, for the inspector or some of his assistants to visit installations whilst the wiring is in progress, but it very often happens that the department is so very busy the time cannot very well be spared to make a test and inspect the work until it is ready for connection to the mains. This, however, renders the making of a very searching inspection a very difficult matter, but the author has found that if pieces of capping are taken off at various points on the installation, and the wires are examined between floors and at points where they pass through walls, a very good idea is obtained of the class of work which has been put in. If, however, any little point leads the inspector to think that some of the work has been scamped, the whole of the wiring should be carefully examined. The author's experience with contractors has been that if they are approached in the proper manner (and it must not be forgotten that it is to these men that the station engineer is indebted to a large extent for the connections to his mains, owing to the energetic way they canvass the district), they will, as a rule, do all in their power to facilitate the inspector's task, and be only too willing to carry out any reasonable suggestions which he might make to them. When it can be arranged, a joint should be taken at random and the insulation of it cut open, for there is no doubt that the joints are, as a rule, the weakest points of an installation. Bad joints are perhaps the most difficult faults to find out on an installation, as it is impossible in the course of an inspection to critically examine every one, and unless the joint be actually uncovered its weak points are not discovered, for generally the outside appearance is all that one could desire. It is

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very rarely that one comes across an installation which is absolutely bad, and when this does occur the contractor is usually found to be of the plumber or ironmonger class, who leaves the carrying out of his work entirely in the hands of a wireman (for the simple reason that he does not know anything about it himself), who does not trouble himself as to how the work is done as long as he can get it connected and draw his wages at the end of the week. The risks of breakdowns on wiring installations due to bad joints, however, are not nearly so great now as they were a few years ago, as owing to the introduction of certain fittings, such as "looping-in" ceiling roses, and the more general adoption of the "distribution" system of wiring, their number is considerably reduced.

With regard to the testing of installations, we find that the requirements of the various engineers are almost as varied as the other regulations. In some cases a certain insulation resistance per lamp is required irrespective of the candle-power, whilst in others the required insulation resistance required varies according to the amount of current taken when all consuming devices are in use. The great advantage of the latter method is that the insulation resistance required increases with the pressure of supply. The following will serve as an example: Supposing an installation consists of 20 lamps of 16 c.p. and the pressure of the supply mains is 100 volts; the current taken when all lamps were in use would be about 12·8 amperes, the insulation resistance according to the standard set forth by the Institute of Electrical Engineers would have to be 1·9 megohms. If, however, the pressure of the supply was double—viz., 200 volts—the current taken would be only 6·4 amperes, and the insulation resistance would have to be about 3·9 megohms. It has, however, the disadvantage that if the contractor should make a test of the installation before the undertakers' inspector appears on the scene and finds it to come out slightly below that which is required, it is a very simple matter for him to change a few of the lamps for ones of a higher candle-power, and so adjust the current of installation to suit the insulation resistance. He can then change the lamps back to their original candle-power as soon as the inspector's back has turned. The insulation resistance of an installation must not, however, be relied upon to indicate the class of work which has been put in, as it very often happens in the case of a new building that although the very best of material has been used, and only first-class workmen have been employed, the insulation resistance comes out very low when the work is completed, the reason of this being almost invariably due to surface leakage across cut-outs, ceiling roses, and distributing boards, owing to the general dampness of the building. In those cases where electroliers are used, the dampness of the plaster used for fastening the collar of the lamp in position is often quite sufficient to bring down the insulation resistance of an installation. When it is found that these conditions exist in a building, and where it is very probable that the low test is not due to either bad workmanship or inferior material having been used, the installation should be connected to the mains on the understanding that the supply will be discontinued if the insulation resistance does not improve after the current has been on for some time. When this arrangement is carried out, the precaution should always be taken of informing the consumer the conditions under which the connection has been made, which will be the means of avoiding trouble if at some future date it is found necessary to cut off the supply owing to the insulation resistance not improving as was expected. The installation so connected should then be tested from time to time—say, once a month—and if the insulation resistance is found to have fallen on any of these occasions below what it was when tested previously, the contractor should be called upon to put the matter in order.

The following is an actual case of an installation which was connected under the above conditions. The installation consisted of incandescent lamps, and the wires were run in wooden casing let into the plaster, and when the work was first tested the insulation resistance was only 1·0 megohm instead of 5 megohms.

Date.	Insulation resistance.
March 16, 1900 (date connected)	1·0 megohms
April 4	1·3 ,,
May 11	1·4 ,,
June 17	2·5 ,,
July 2	3·7 ,,
Aug. 15	4·0 ,,
Sept. 9	7·0 ,,

The insulation resistance of motors is also very liable to be low when the first test is made, for it is very likely that the windings of the motors will not have had any current through them since the final tests in the works of the manufacturers. In all probability some considerable time will have elapsed between the date when it left the works and when it is ready for the supply company's inspector to make the test, and during this period it will have had plenty of opportunities of getting damp. One generally finds in the regulations of the supply company special reference being given to the insulation resistance of motors, and in some cases one finds the exact opposite required from that which is required by others. The author remembers one rather amusing case which came under his notice some few years ago. The engineer of one of our largest municipal stations, in revising the regulations which were issued by him, required that the frames of all motors should be permanently connected to earth. A few weeks afterwards a large motor was connected to the mains, the contractor earthing the frame in accordance with the requirements. Shortly after the connection had been made the consumer wrote to the chief engineer to say that the insurance company with whom his premises were insured had made an inspection of the installation, and had refused to pass it owing to the frame of the motor being earthed, the reason being that the insulation to earth would be certain to be low, since the insulation resistance between the windings and the frames of motors was, a as rule, rather poor. The result of this was, of course, a correspondence between the insurance company's engineer and the municipal engineer, which resulted in the end that the motor was still left connected, although the earth wire remained on. If it is not compulsory to earth the frames of motors, the insulation resistance between the windings and the frame does not matter so very much, as if the motor is only a small one, it can be bolted down to a wooden floor and the holding-down bolts of coach screws may be bushed with fibre or other insulating material. The permanent earthing of the frames of motors is a practice for which there is much to be said, and which the author has found to work very well in practice. The great advantage is that if the insulation between the windings and the frame breaks down and the system of supply is a three-wire one, with the middle wire earthed, the fuses of the motor are at once blown, thereby indicating that something is wrong. Now, if the frame of the motor was insulated from earth, it might be raised to a potential sufficiently high above that of the earth to become not only annoying to any person touching it, but positively dangerous under certain conditions. And, to take an extreme case, if driving chains were used instead of belts, whole lengths of shafting might become charged, which would almost certainly lead to an accident of some kind or other. When power installations are to be connected, it is always advisable, if possible, for the contractor who has carried out the work to be present when the inspector makes the connection. If, however, it is impossible for this arrangement to be made, the inspector should very carefully examine all connections to the motor and starting resistances and switches before switching the current on, as great damage might very easily be done to the motor if it is not connected up properly. The author has come across a great many cases of mistakes in the connections of motors, but it is only fair to say that in nearly every case the contractor was of the type which has been previously alluded to. It is a surprising fact, however, that a large number of wiremen, who are perhaps very good men as far as ordinary lighting installations are concerned, are absolutely ignorant when they come to have to connect up, say, a

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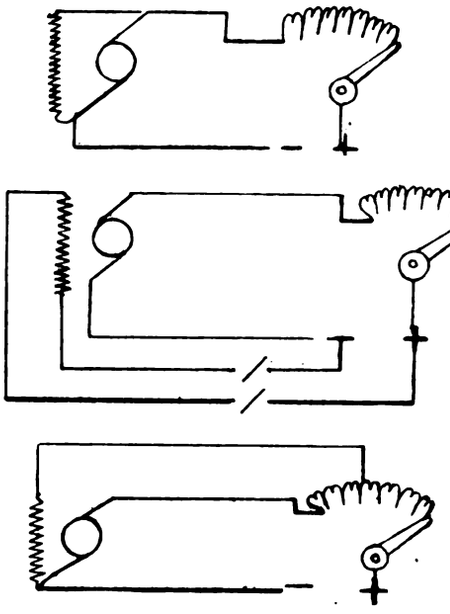
shunt-wound motor. The following will give an illustration of the kind of thing that is sometimes to be met with. The wiring contractor had purchased the motor, which was a shunt-wound one, from a well-known firm of manufacturers, and obtained the starting resistance from a local firm. The starting resistance consisted merely of a series of coils, which could be cut out of circuit by means of a movable arm actuated by means of a worm and wheel. No provision was made on the starting switch for connecting the free end of the shunt in order to obtain the full field at starting. If the starting switch had been properly constructed, and a separate terminal provided for the shunt, no doubt the contractor would have managed to have connected the motor up all right. As he did not know, however, that there was anything missing, he proceeded with the work, and connected the starting resistance in series with the main circuit. The result of this was that the motor refused to "mote" until about three-quarters of the resistance coils had been cut out of circuit, at which point the spirals were in great danger of being fused. Needless to say, the arrangement was not permitted. The next time the inspector went he found that a separate circuit had been run from the main to supply the shunt circuit, and an ordinary double-pole switch fixed to control it. Of course, if this arrangement had been used, the chances are 10 to 1 that the insulation of the field winding would have been pierced, there being no path for the discharge. The only thing that could be done with the apparatus available was to connect the shunt on to a point about half-way along the starting resistance, so that sufficient field could be obtained for starting. The speed of the motor was, owing to this, higher than it was designed for, but the contractor was quite satisfied so long



as he had got the motor to run. The accompanying diagrams will show the three attempts made by the contractor.

(To be continued.)

BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the inaugural address of the chairman, Prof. Oliver Lodge, D.Sc., F.R.S. (member), delivered Feb. 27, 1901:

The first thing it behoves me to do is what my magnificent friend Fitzgerald did on opening the Dublin Section—viz., congratulate the parent society on its wisdom and enterprise in forming these local branches. And I congratulate them not only on the idea, but on the way they are executing it: on the free constitution they give, and on their system of publishing and utilising papers communicated. A multiplicity of publishing centres is bad for science: the more unified publication can be the better. At the same time, excessive centralisation and lack of stimulus to exertion at local centres is bad, too. If anything, it is the greater evil of the two. But by the present action of the Institution of Electrical Engineers both evils are avoided. Local ability and energy are stimulated and encouraged, and at the same time the advantage of central publication is secured. I hope that the good example thus set may be followed by other societies. If the experiment succeeds, it will be followed. A successful experiment is a splendid thing, for it can be repeated and can develop unimagined advantages.

Next, I would thank my good friend, the President of the Institution, for coming down to give us his support and encouragement at this our inaugural meeting. Prof. Perry is an educational authority and a great educational enthusiast. He is an engineer, but he is also a physicist and a mathematician, and he is a great many things beside those. Catechise his students, and you will find that they learn from him not engineering and mathematics alone—they learn much of those, but they learn a good deal about other things as well. They are even guided by him in their miscellaneous reading. I can tell you that things are, or used to be, lively in Perry's classroom; and when he got workmen to come and hear him, men who were familiar with engines and machinery, but ignorant of the laws of motion, they were not treated to high and dry principles or to abstract science, but the machine which they knew was taken as the basis, and fundamental principles were dissected out from it by the hand of a master. Not everyone can do that, nor is it equally suitable to all grades and kinds of students; but to the artisan it is suitable, and the work which Perry did at Finsbury had the most admirable results. Now he is engaged on reform of school education and primary education, and he is full of vigour and originality and plain-spokenness in these things, too. Nor would he be for a moment backward in dealing with university education. If we do not go straight in developing this university on sound lines, you may depend upon it that Perry will let me know. Well, he has plenty to do where he is, and I recognise in him a man genuinely anxious to serve humanity, full of energy, full of knowledge, full of enthusiasm, and, what is more, full of goodness—one of the kindest-hearted Irishmen of them all. In the rough-and-tumble of London life, people are so busy they neither give nor take credit for the more human virtues. He has to come down to the provinces to hear his character, and I daresay he is astonished to hear it. But I mean what I say; and I say no more.

The society has to do with electrical applications—a large subject, if ever there was one. It began as the Society of Telegraph Engineers, and dealt chiefly with cable enterprise; then it took over the telephone, then electric lighting, then transmission of power, then tramcars, and now it is likely to take over nearly all underground locomotion. In time, and in some countries at any rate, it may take over the railways themselves. Nor is it confined to civil engineering. A ship of war is full of electric contrivances, and the society sent a corps of experts to add to the land forces in South Africa. There are, indeed, other engineering societies, notably the Civil and the Mechanical, both powerful, well-established organisations; and very kind, hospitable, and helpful has that ancient and distinguished body, the Civil Engineers, been to their younger Cinderella sister, the electrical branch of the profession, whose future is destined perhaps to rival in brilliancy, though by no means ever to eclipse, their own services to humanity.

Concerning applications of science, there seems to be a fallacy still abroad in this country, judging by the tone of some recent presidential addresses and public utterances designed to controvert it. Some misguided persons seem to hold that general education and mathematics are unpractical and useless encumbrances. What they really mean is that if a youth has them, and nothing else, he is less useful than if he failed to possess these but did possess many other powers and aptitudes. Quite true, if the two are mutually incompatible. But why try and compare two evils and choose the lesser? Why not go for a positive good? Why not advocate all the business

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virtues and the engineering genius if you can get them, and advocate all the mathematics and physics and acquired learning as well? Well, if you do, you get John Hopkinson and men like him (not to speak of the living), and that I take it is the type of man you want. But the objection arises from a suspicion that mathematics is often so badly taught that by the time a man has acquired a great deal of it he is somewhat unfitted for anything else. If that is so it is a grievous fault, and I know that the fault does exist. The training of a pure mathematician is one thing, the training of engineers and physicists is another. No one would be the worse for a commonsense mathematical training, some even of pure mathematicians would be a great deal the better for it; but an engineer must have it or must invent it for himself—no light task. Well, this reform of mathematical teaching has been taken in hand by several. All of us recognise the need of it: nearly all physicists and engineers, I mean. I realise it strongly. But no one has more vigorously and recently taken up the cudgels and belaboured opponents than our president: so that now the old mathematical Tory dare hardly raise his head. We only wish he would. He is always being coaxed to put his head out, like Kruger's "tortoise," and then the bludgeon will descend. But he stays in his shell, and perseveringly conducts the patient English youth by roundabout paths over that asinine bridge and other antiquities, the continued school use of which is a monument of modern education folly.

I wish someone would advocate teaching Greek methods of arithmetic as well, for then surely rebellion would set in; but, unfortunately, Euclid's arithmetical books were lost. Euclid himself was splendid. So was his book; for its day and generation, and its purpose as a system of geometrical philosophy, admirable; but like some other good things, it has had its day, and for elementary and popular purposes should cease to be. We are too busy; there is too much to learn nowadays to leave time for us to cross every river by ascending to its source and walking down the other side. Professional guides along the old river-path still attempt to hide the bridges, because if they were too easily seen their occupation would be gone; but the bridges are there, and sooner or even later schoolboys will be permitted to make use of them and enjoy the country on the other side, without spending all their days in a toilsome and deterrent mode of getting there over a route approved by the ancients. If there be any workers in engineering or any other branch of technology who affect to despise pure science and say that its pursuit is needless, they are hardly worthy of notice. It must be affectation. Even so might a coal-miner affect to despise the sun, on the ground that he did not need it below ground, that he could do his work quite well without it, not realising that it was the sun which put the coal there. And if any man is so immersed in what I may call black-country undertakings as to forget the smiling face of his mother-earth, let him realise that his health and sustenance are the outcome, not of his useful burrowings and grimy surroundings, but of the sunlit surface and the peaceful agricultural pursuits he has been compelled to abandon, and which at present seem so foreign to him. So it is with those immersed in practical applications, who forget their indebtedness to and dependence on the past, the present, and the future of pure and undiluted science.

But, on the contrary, it is to be heartily admitted that the enlarged experience and the large scale experiments rendered possible by the wealth of communities who apply science to their own convenience, reacts with immense advantage on the pure science itself. The thing is manifest, and needs no enforcing. But those large scale experiments are hardly like experiments proper; they cannot readily be tampered with (one is rather nervous about interfering with the traffic or the illumination of a district to observe, say, the capacity rushes in mains); they remind one of astronomical observations rather than of laboratory experiments. The essence of an experiment is that it shall be modified in all sorts of ways, and shall be lived with on terms of familiar intimacy, not that it shall be regarded from a distance through a telescope furnished by inspectors' and workmen's reports, with illustrations drawn from letters of indignant consumers to the public press. To understand the blaze of a new star and disentangle its meaning with a spectroscope demands first that the spectroscope shall have been invented and comprehended by laboratory physicists and chemists and mathematicians; let us say by Kirchhoff and Bunsen and Stokes; and, without similar purely scientific work, the large scale occurrences witnessed in industrial enterprise would not be rightly and readily understood. Yet it is not to be urged that pure science should really be studied simply and solely for its own sake, apart from the needs of humanity: as the cant phrase used to run a few years ago, "Art for Art's sake."

The pursuit of pure science for its own sake is a good and wholesome formula up to a certain point, because the tendency of unregenerate man has always been opposed to it. The usefulness of scientific applications needs no preaching, but, strangely enough, there is a great tendency to forget or ignore the scientific foundation on which they rest. And the human mind is so constituted that, as a rule, the necessary powers and aptitudes for both do not go together. The man who can pursue pure science does so best, as a rule, when he is not distracted by considerations of utility. The applier of science, on the other hand, soon gets so immersed in practical details and pecuniary considerations, which are clearly vital, that he has neither leisure nor inclination, nor always the right kind of ability, for advancing the pure science itself. Pure science must always advance into territory which appears for the moment rather useless and barren and aloof from humanity. It must be so, since it is new ground never open to humanity before. Consequently, there is a weird unearthliness about it which, to people engaged in the turmoil of business, may feel cold and repellent, if ever they allow themselves to be assisted to breathe its atmosphere for a moment. But the strange, new, unknown, bracing air has a fierce fascination of its own akin to that of the lone ice packs of the Arctic seas, to the healthy and intrepid explorer, or as the mountain tops are to a member of the Alpine Club. So enticing does the atmosphere of pure science become to those who frequently breathe it that to them sometimes it feels the only air worth breathing, and the everyday atmosphere of humanity strikes close and stifling in comparison. Let such men alone, encourage them in their quest; they are not too numerous, and whither they show the way others hereafter will follow. Moreover, the region which they enter is no limited Arctic Circle in reality; it is, as it were, the arctic entrance to another world, whence, if we penetrate further in pursuit of the pioneers, we shall reach ultimately the temperate zones of work and livelihood and applied science; nor need we doubt but that at some date, as yet far distant, the human race may at length make its way on through these regions too, and attain, even by this apparently arid path, the rich tropical belt of luxurious verdure and bright sunshine, where conflict ceases and art and enjoyment and emotion and religion begin.

Facts known to few, with effort, are science; but those same facts when known to all, without effort, are æsthetic; they can then be appreciated in a fuller and higher way, can be seen in an altogether new light, so that they become fit subjects for poetry, for music, and for art. Meanwhile the justification of all pure dry science lies essentially in its ultimately human bearings. If a subject could be proved to be never capable of any human influence, or any relation to humanity, however developed it might become, then its pursuit would be rightly condemned. But such proof can never be given. Again and again have the most unlikely channels developed into fruitful watercourses; we must trust the instinct of our leaders, and let them advance unhampered, in faith that where they feel so much enthusiasm, where they seem to see their way so clearly and so well, we, too, in time, or our descendants, shall be able to enter with their aid, and shall realise that the remote and at first sight hopelessly inaccessible region is full, after all, of human interest and of that which contributes to the enrichment of life. We are in the beginning of a great era in connection with the pure science of electricity. The almost despised and neglected subject of electrostatics, as known to Franklin, is rearing its head again, and is pressing to the front. The experiment of a charged rod and pith balls is typical of much, perhaps typical of all that goes on in electricity: and how

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much this means some of us are beginning to guess. We must look to Larmor and FitzGerald to explain to us, if they can, the nature of an electric charge—that blank, that absolute void, so wisely left by Clerk Maxwell in his scheme, left also by Helmholtz in his, a void occupied by the isolated brilliant surmise contained in the phrase, "one molecule, or atom, of electricity." But even before we understand the nature of an electric charge, we shall find that the labours of J. J. Thomson have enriched the science of our times with what appears likely to be a unifying and comprehensive generalisation, such as philosophers of all time have groped after, for which some of them have strongly hoped.

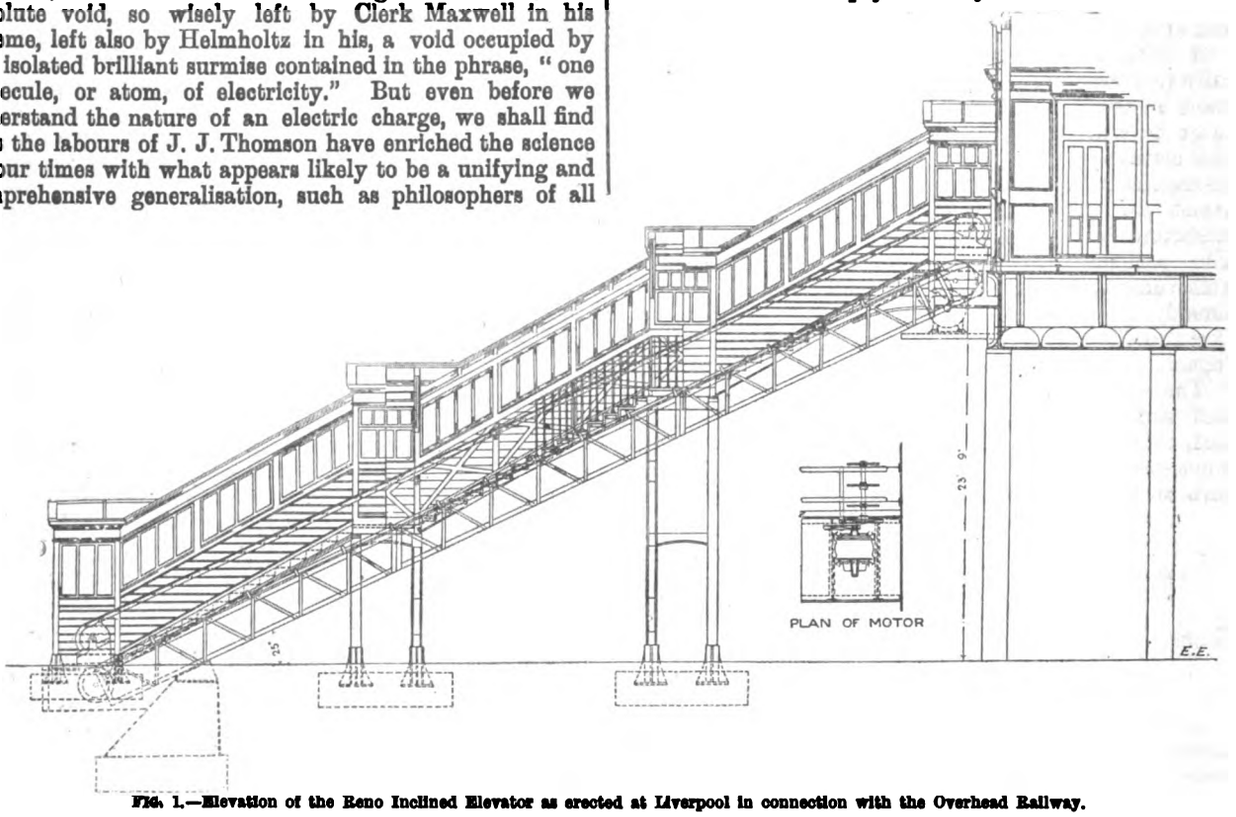

FIG. 1.—Elevation of the Reno Inclined Elevator as erected at Liverpool in connection with the Overhead Railway.

LIVERPOOL OVERHEAD RAILWAY.

Although originally designed as a railway to serve the docks alone, the Liverpool Overhead Railway has gradually been extended north and south to two important suburbs, and, by means of electric trams owned by the company, to other outlying districts. The number of passengers carried per annum on an average exceeds 11,500,000, and to meet this demand has required no little exercise of skill on the part of the officials in the organisation of the traffic arrangements, etc. With that enterprise characteristic of them, the company have recently installed at their Seaforth Sands station an inclined elevator which is of American type, and was supplied by the Reno Inclined Elevator Syndicate, of Finsbury-pavement, E.C. The convenience of such an arrangement to the general public as a means of conveyance from the ground level to platform level cannot be over-rated.

The elevator proper consists of a continuous moving platform 55ft. long, travelling upwards at an angle of 25deg. and at a speed of 110ft. per minute. As will be seen from the accompanying drawings, it is provided with a moving handrail. This travels at the same speed as the elevator itself, and presents no difficulty whatever to persons getting on and off, special provision being made in the construction at the top and bottom which takes off and lands a passenger with the greatest ease and without the least shock. The apparatus is capable of carrying as many as 3,000 persons from one level to the other in one hour. As a sign of its popularity we are informed that 95 per cent. of the passengers make use of the elevator in preference to the stairs, which run side by side with it. The construction of the elevator is of considerable interest to engineers. It consists of a lattice steel truss having a steel angle pathway carrying the moving platform, the gear to operate which is fixed to the head of the truss. The chain wheel is of chilled cast iron ground to exact shape, while the tooth wheels, first motion, are machined moulded steel, and second motion cut cast iron, and motor pinion raw hide. The motor employed to drive this elevator is of 10 h.p., at 480 volts, and has a speed of 700 revolutions. It was supplied by the British Thomson-Houston Company, Limited, and is controlled from the pay office by a Cutler-Hammer automatic switch and from the railway platform by a double-pole knife switch, thus enabling the elevator to be stopped from either end, but only started from the pay office. This is the second elevator of this make that has been erected in this country, and the first one for railway purposes, the other being at the Crystal Palace. In New York, however, the Manhattan Railway have been using these elevators with success for a considerable time, and, it is said, they

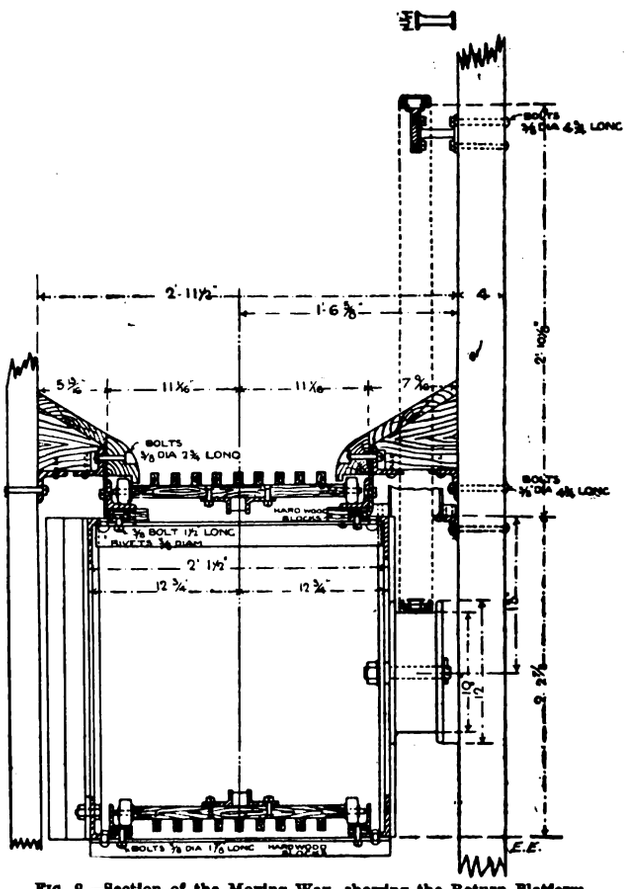

FIG. 2.—Section of the Moving Way, showing the Return Platform, and also the Moving Handrail.

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have increased their passenger traffic in consequence. An ingenious estimate is that the average passenger climbs in the ordinary way of travel on elevated roads some 24,000ft. vertically per annum, thus spending 13½ hours in climbing, and expending 1·85 h.p.

A considerable part of the passenger traffic on this railway comes from the docks, and as all the dock hands leave off work practically at the same hour, the company must be prepared to meet a rush. The introduction of this elevator will doubtless go a long way in helping the management to attain this end, and, further, the danger which has hitherto been experienced on this line in mounting the stairs in a crush will be obviated. The company are to be congratulated on their latest achievement, and we trust that the success which has already attended the working of the elevator will lead the directors to consider the propriety of installing similar ingenious apparatus at other stations on the system.

The contractors for machinery, constructional steelwork, and the electrical equipment were Messrs. G. Aston and Son, of London, and the whole was carried out under the supervision of Mr. S. B. Cottrell, engineer and managing director of the Overhead Railway Company.

INSTITUTION OF ELECTRICAL ENGINEERS.

Some Notes on Polyphase Sub-Station Machinery.

BY A. C. EBORALL, MEMBER.

(Concluded from Supplement, March 29.)

There are certain conditions of working which tend to cause hunting, or which make hunting worse should it be set up. An example of the former is difference in the form of the E.M.F. waves of generators and rotaries, which is in itself sufficient in some cases to start hunting, but such differences are, as a rule, not sufficient to give rise to serious trouble. On the other hand, machines with strong armature reaction, or working much under-excited, are more liable to hunt than those with strong fields, because the magnetic flux is more readily distorted. For this latter reason it follows that over-excitation of the rotaries is a condition favourable to good operation. Again, the momentum of the converters should be kept as low as possible, for this apparently indirectly assists hunting, and in any case impairs the action of any device that may be used for damping the oscillations in their early stages. Some engineers state that hunting on the part of the sub-station plant is increased by the impedance of the lines, but the author has not as yet found this, and considers that a moderate amount of self-induction in the lines is directly beneficial. Capacity in the feeders, on the other hand, does appear to have some influence. In practice, however, it is generally difficult to separate the causes that assist hunting from one another. The main cause will generally be found to lie with the engines, and when this is removed, or when the effects of field distortion set up by it are neutralised, the troubles generally disappear. Synchronous motor-generators are far less likely to hunt (with the given generating plant and transmission system) than rotary converters. This is because there is considerable armature reaction in the synchronous motors, which tends to damp the pulsations in the armature current should hunting be set up, and also because the field system is fed at a steady pressure, which is totally independent of the pressure at the ends of the feeders; but with unsuitable engines synchronous motors will hunt badly, the pressure on the direct-current side being practically unaffected thereby, which is a point to be noted. The characteristic pulsations in the feeder pressure will, of course, occur to just the same extent as with rotary converters.

From what has been said above, it will be seen that to ensure the perfectly satisfactory operation of synchronous sub-station machinery two points must be attended to. The first is to take great care with the selection and operation of the generating and sub-station plant, particularly the former, so that the tendency to set up hunting will be as small as possible; and the second is to provide means for getting rid of the hunting—that is, damp the armature oscillations in their earlier stages—should it be set up. Some considerations relating to the design of the generating plant will be given later, while regarding the means for damping the oscillations a few remarks may be made here. As these oscillations are actual speed variations it is evident that it might be possible to reduce them considerably by mechanical means, but the cost of devices for this purpose would be out of the question, to say nothing of other objectionable features. On the other hand, the oscillations are accompanied by, and intimately connected with, the field distortion as described above, and consequently if this distortion could be done away with, hunting would be prevented. Happily, very simple and effective means are available for suppressing the distortion of the field flux. All that has to be done is to fit the synchronous motors or rotary converters with "damping coils." This device, which is one of the many excellent ideas in polyphase working which have reached this country from the Continent *vid* the States, is of the greatest value in such cases, and rarely fails to stop the worst cases of hunting. All that has to be done is to bridge the poles of the synchronous motors or rotaries from horn to horn by copper plates or strips. These will have the effect of wiping out the distortion of the main magnetic flux, and therefore damping the armature oscillations, by reason of the eddy currents produced in them by the flux due to the large leading and lagging armature currents—that is to say, as soon as the armature of the rotary or synchronous motor starts swinging, accompanied by the field distortion described above, the opposing flux produced by the eddy currents in the copper strips blows it away from between the pole-horns, and the oscillations are thus damped out magnetically directly they commence to form. It will be observed that the damping coils

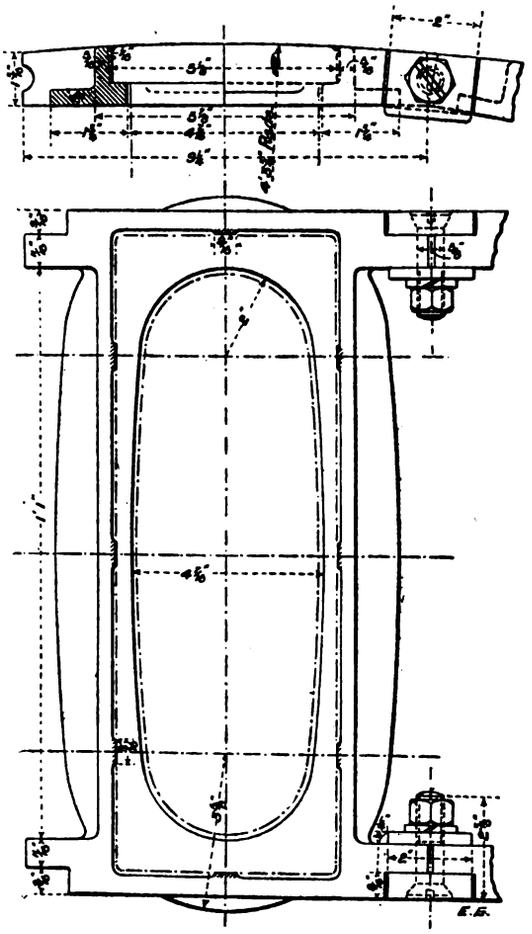

FIG. 7.—Combined Damping Coil and Field Coil Support for 725-b.h.p. Synchronous Motor. Speed, 212 revolutions per minute frequency, 50 cycles; peripheral speed, 5,560ft. per minute.

produce their effect just where it is wanted—namely, between the pole-horns. It is relatively of little use to put damping coils *round* the pole-pieces. The dimensions of the copper strips connecting the poles of the motor or rotary can be varied within wide limits without making much difference to the damping action. The losses in them with actual rotary converters are found to vary from 0·5 to 1·5 per cent. of the output of the machine, depending upon circumstances. An idea of the actual dimensions of damping coils used in practice is given by Fig. 7, which illustrates the bronze damping coils, combined with the outside cheeks of the field bobbins, for the synchronous motor of the 500-kw. two-phase motor-generator shown in Plates II. and III. The damping strips bridging the pole-horns of the rotating magnet wheel are cut away centrally, partly because the centre portion is not very effective, but principally in order to prevent the ventilation of the magnet wheel and armature being impaired.

As rotary converters will hunt upon slight provocation, such machines should always be fitted with damping coils whatever the nature of the engines. They need only be used with synchronous motor-generators when the power station engines are badly designed, unless lighting is done from the same feeders. In this case it will generally pay to use them. With water-power plants they are generally unnecessary for either

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class of plant. On the other hand, if the engines are very bad they should be used on the generator field poles as well, where they will have a precisely similar effect (for the case is similar), and will reduce the synchronising current between the generators practically to zero. One result of hunting in the sub-stations is that the current in the high-pressure feeders pulsates. As a matter of fact, in accordance with what has already been said above, these pulsations occur to a certain extent even when hunting is absent, for they are due to the inherent properties of the machines. This pulsation of current in the feeders, accompanied as it is by corresponding pulsations in the pressure, become highly inconvenient if lighting has to be done directly from the feeders in question. This case might arise, for instance, with a transmission and distribution by three-phase currents for lighting and power, combined with a direct-current distribution from sub-stations for the tramways. The remedy, first put actually into practice by Mr. Kolben in connection with the electricity supply for the town of Prague, is to insert choking coils in the high-pressure sub-station feeders, these being of the three-phase type with common core for three-phase working. The output of the choking coil in circuit with each feeder should be about 3 per cent. of the maximum power absorbed by the synchronous machinery connected to it. Thus in Prague, for instance, in one case a 900-kw. sub-station (with 450 kw. in reserve) is connected by a three-core cable to the power-house 3¼ miles away, a three-phase choking coil of 25 kw., having an air-gap adjustable (by packing pieces) to about 0·375in., being in series with it. The principal dimensions of this coil are given in Fig. 8. The fluctuation in the pressure at the sub-station end of the feeder when working under the worst conditions (no load) is about 3 per cent. with the coils cut out, and nothing that can be detected when they are in circuit. When the coils are in use the synchronising current between the two synchronous motors of 650 b.h.p. is 8 to 10 amperes with an input of 60 amperes and 5 to 10 amperes at full load (100 amperes), but when they are cut out the motor synchronising currents are more than double. At another sub-station 2¼ miles from the power station, having a smaller equipment—namely, two 180-kw. synchronous motor-generators (one as reserve), there is no synchronising current at all between the 260-h.p. motors as long as the choking coils are in circuit. The current in this feeder when the sets are well loaded is as steady as it would be if asynchronous motors were in use.

The use of choking coils in the sub-station feeders has proved to be of the greatest value in Prague, because all the lighting

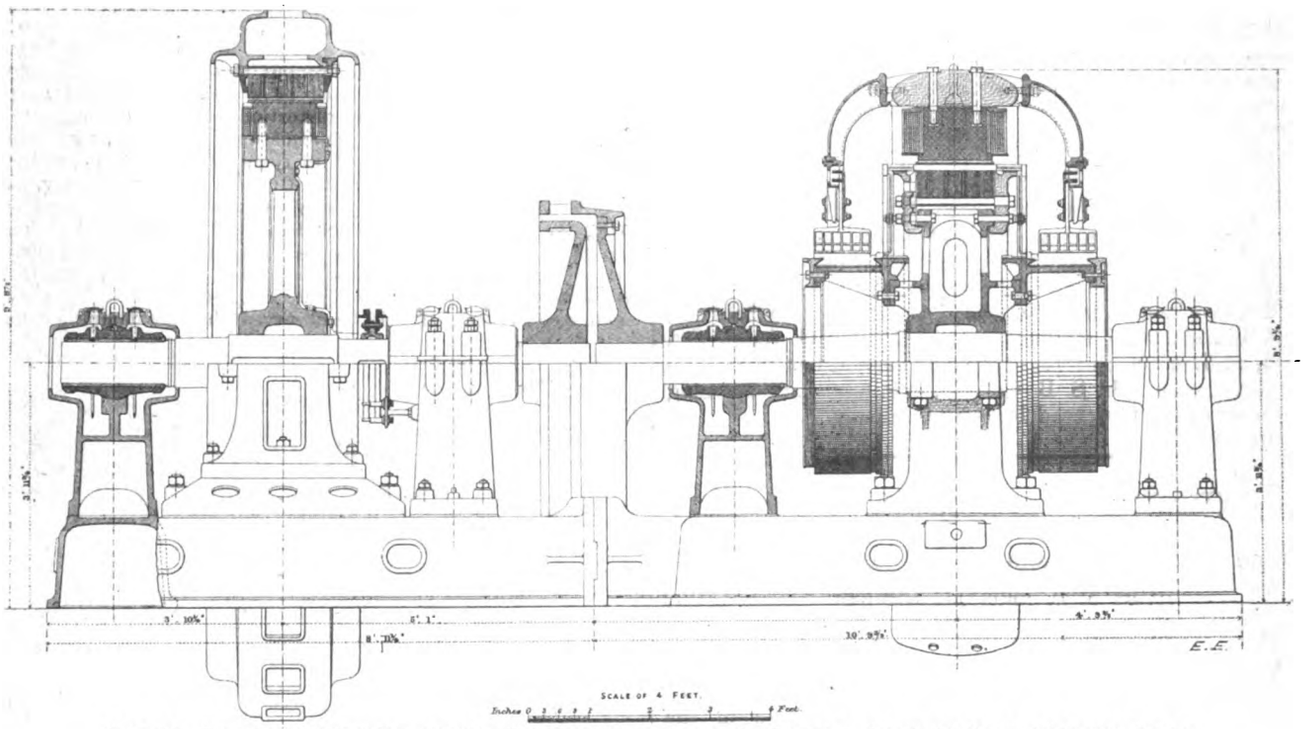

PLATE II.—Front Sectional Elevation of 500-kw. Two-Phase Synchronous Motor Generator.—Manchester Square Sub-Station, London.

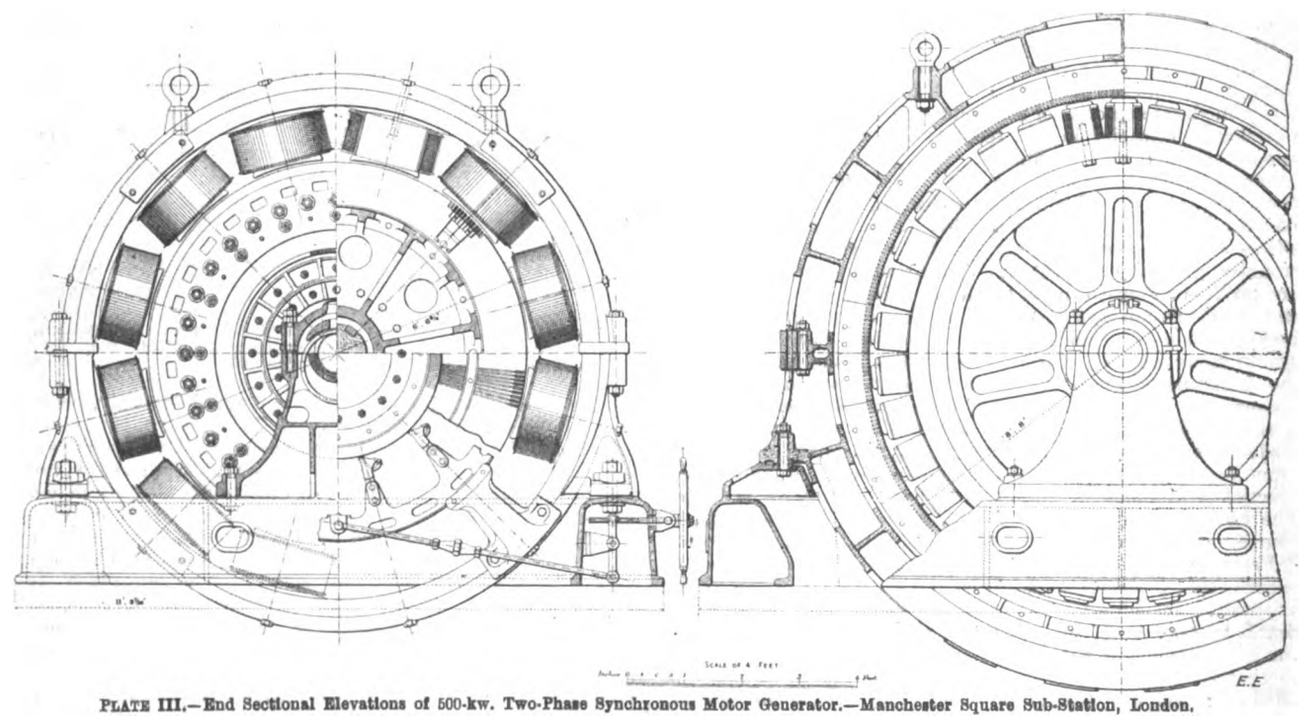

PLATE III.—End Sectional Elevations of 500-kw. Two-Phase Synchronous Motor Generator.—Manchester Square Sub-Station, London.

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and motor work is done from the same three-phase mains, the direct-current sub-stations serving only for the tramways. The pressure variation at the 900-kw. sub-station—that is, on the terminals of the 650-b.h.p. motors—only varies between 2,900 and 2,980 volts, and does not change with the load, because the synchronising currents of the motors do not alter appreciably with the load. The excitations of the motors are hardly altered, being 62 amperes at no load and 65 to 70 amperes at full load, the latter figure being attained when heavy momentary overloads are expected, such as at holiday times, when extra car services are run, etc. The town of Prague (250,000 inhabitants) has one of the best combined services in Europe. The whole of the very extended lighting, power, and tramway service is carried out from a single power station of 15,000 h.p. ultimate capacity, 5,000 h.p. being now at work. There are about 26,000 8-c.p. lamps at present connected directly to the three-phase mains, as well as 400 kw. of public lighting and many

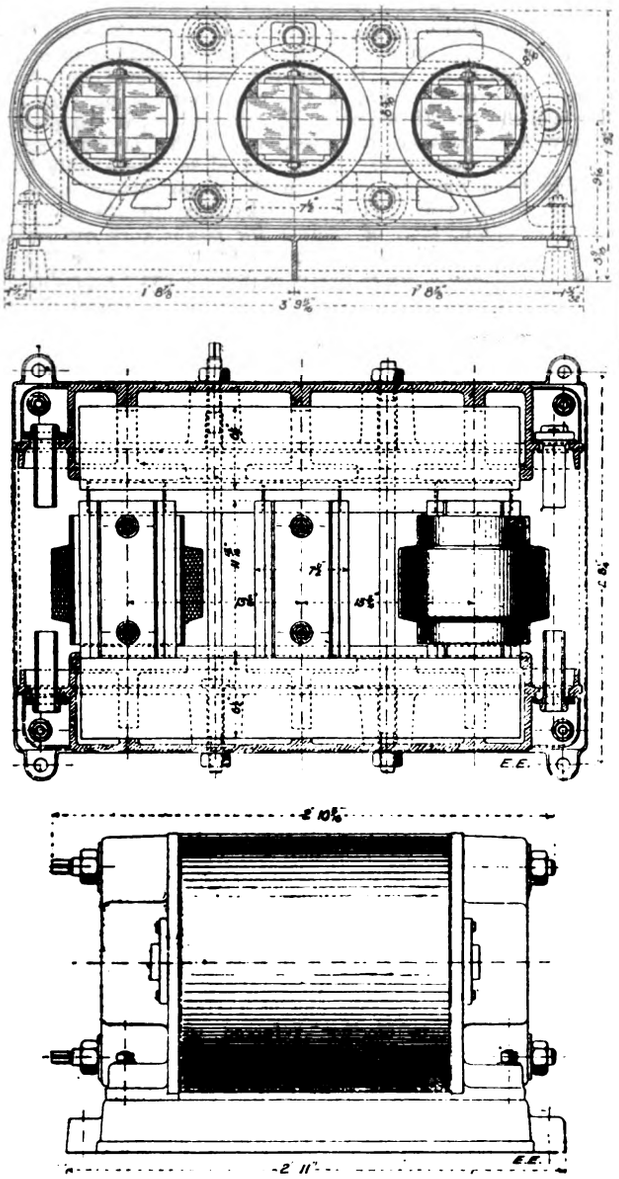

Fig. 8.—Three-Phase Choking Coil. 25 kilowatts; 50 cycles.

induction motors, including several of 100 b.h.p.; about 160 American-type cars are supplied from the sub-stations at 550 volts, the average output for traction being about 1,300 kw. at the present time. Every consumer having more than 16 8-c.p. lamps connected up has the three conductors taken to his premises; three-phase transformers in street boxes are used in all cases. The declared pressure is 120 volts at 50 cycles, and the minimum and maximum pressures any consumer gets at any time of the day are 118·5 volts and 123 volts respectively. The electric lighting, power, and traction services in Prague form a combined municipal undertaking of assured financial success, although but recently set to work. The transmission and distribution is carried out with three-phase currents throughout, with perfect success, balancing troubles (so much feared in this country by those unacquainted with the practical working of three-phase systems) being entirely unknown.

Great care has been taken by Mr. Kolben with regard to the design of the power-station engines at Prague, as the successful operation of such a combined system depends first of all upon their good qualities. With regard to governing, they are practically faultless, while the speed variation in one revolution—that is to say, the total variation above and below the mean speed—does not exceed 1 in 250. The engines are of the triple-expansion horizontal two-crank type, rated at 1,000 b.h.p. at 90 revolutions per minute, the flywheel effect being 12,700 foot^3-tons in order to attain this. (By "flywheel effect" is to be understood the true flywheel effect (not the kinetic energy of the rotating magnet wheel)—namely, $W \times D^2$—where W = the weight of the wheel in tons, and D = mean diameter of the flying masses in feet.) The use of choking coils in the sub-station feeders may, perhaps, be thought objectionable, on account of the increased losses and pressure drop brought about by their use, but a little reflection will make it evident that this disadvantage is but trifling, and far more than counter-balanced by the advantage of doing away with all pulsations in the pressure. The full-load loss in a large choking coil is not more than about 3 per cent., and the inductive drop under usual working conditions, say 4 per cent. With the above-mentioned 25-kw. choking coils the full-load loss is only 800 watts, and the pressure drop 60 volts (assuming the motors to be working at minimum excitation), and consequently their influence in impairing the efficiency or regulation of the system is insignificant. Naturally it is far better to place the required reactance outside the generators than to design the latter with large reaction and consequent drop.

From what has been said above, it will be readily seen that if rotary converter or synchronous motor-generator sub-stations have to be supplied from a steam-driven power station, very great care must be taken to prevent oscillations in the relative motions of the generators running in parallel, with the consequent interchange of synchronising currents. These oscillations can be started by the natural variations in the turning moment during the revolution, or by the after-affects of a bad parallel, or short-circuit, etc., and are assisted by field distortion, by insufficient armature impedance, by quick-acting governors, by very heavy magnet wheels, and, of course, by faulty design, such as short connecting rods, defective steam distribution, want of balance, etc. Given well-designed engines, it will generally be found that the trouble, when it is present, is due entirely to the governors assisted by the momentum of the magnet wheels and by the attempts of the generators themselves to attain their proper phase relations; the cure for it consists in adjusting the governors in such a manner that they are absolutely unresponsive to very quick variations in the speed. The reason is probably as follows. If the governors are extremely sensitive they will endeavour to compensate for the unavoidable momentary speed variations due, for instance, to the steam impulses; as the speed increases during the impulses the cut-off will be earlier, while as the speed falls between the impulses the cut-off will be later. But the governor will overdo this, as is well known; it admits, for instance, more steam than is wanted to bring up the speed, causing the engine to accelerate, and *vice versâ*, and in this matter it is helped by the momentum of the magnet wheels. What appears to happen is that a small relative oscillation of the revolving magnet wheels is started from unavoidable causes—that is, it is brought about by variations in the turning moment which would, under ordinary circumstances, be completely taken care of by the momentum of the magnet wheels. Owing, however, to the sensitive governors of the engines in parallel, the oscillation is not only kept going, but is actually increased by the lag of the governors in conjunction with the action of the periodic puffs of steam admitted to the engine cylinders by them. Of course, these oscillations of the moving parts of the generators cause phase displacements between the respective E.M.F. waves, which may be sufficiently large to cause the machines to become unstable. In any case large synchronising currents will pass between the machines, and the oscillations reappear in the sub-stations, starting hunting of the motors or rotaries, as above described.

It is found in practice that the amount of the relative motions of the generators can be reduced to practically nothing if the governors can be prevented from responding to slight quick changes in the speed, and this, of course, is a matter of suitable governor dash-pots. Each engine governor should be fitted with a dash-pot of such a nature that no alteration will be made in the engine cut-off, unless the force acting on the governor is continued. Obviously the worst dash-pot to use is an air dash-pot, and the best a modified form of grease dash-pot; on the other hand, if very thick grease is used, in order to prevent the governor taking notice of short, sudden speed variations, the governor may be rendered so very sluggish that it becomes insensitive to speed variations of a permanent nature, causing objectionable variations in the frequency. It would certainly appear that something more than an ordinary dash-pot is required, and that these necessary fittings for the governors of large slow-speed engines might be profitably designed in accordance with the requirements for perfect parallel running of the generators. It is a point that does not appear to be as well recognised as it should be. The fitting of special dash-pots to the engine governors reduces the swings of the generator magnet wheels to zero, or practically so, by

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preventing the admission of steam by the expansion valves during the periods of swing. It might happen, however, that the remedy in a particular case could not be applied for special reasons, and in this case the only remaining way of decreasing the amplitude of the oscillations would be to use damping coils between the field poles of the generators. The oscillations causing the phase differences between the E.M.F. waves of the various machines are accompanied by field distortion, just as described in connection with the sub-station machinery, and consequently they can be damped out in their early stages by the same means. On very large slow-speed generating sets it is quite certain that it will pay to use such damping coils on the generators; they should be applied as shown in Fig. 6 or in a similar way. On account of the bending of the shafts, it is of importance with machines of very large size to arrange the generators in such a manner that they are unaffected thereby. Experience with such machines shows that no matter what size the shaft is made, the arrangement of the generators outside the engines is not so good from the point of view of parallel running as that of putting the generators between the cranks, arranging the cylinders, if necessary, tandem fashion in order to allow of this being done. The two cranks should preferably be set at an angle of 180deg. to one another.

With regard to the governing of the engines driving the power station generators, in order to be able to distribute the load properly, this should not be too close. It is in general quite sufficient if the speed does not rise more than 2 per cent. when the load is decreased suddenly from full load to half load, or from half load to no load, and *vice versâ*. Of course, this change of speed must not be accompanied by the slightest hunting or irregularity, and the governors must control the engines perfectly when the latter are running at no load with stop-valves full open. The question of the permissible speed variation in one revolution or "cyclic irregularity" is an important one, for to a certain extent it determines the amount of metal that must be put in the rim of the generator magnet wheels. The whole question turns upon the frequency employed—at a given speed a far better engine is required for high-frequency generators than for those of low frequency, as is well known now. With a given type and speed of engine, the lower the frequency the better the parallel running, because a low frequency implies a smaller number of field poles, and consequently the speed variation in the revolution causes a smaller phase displacement between the E.M.F. waves of the different machines in parallel, meaning smaller synchronising currents and greater stability of running. The amount of "cyclic irregularity" permissible depends, then, upon the permissible phase displacement, and this depends, to a certain extent, upon the nature of the work. Thus for feeding rotary converters, which may be considered as being the most unfavourable case in practice, the phase displacement at any load should not exceed 2deg.; that is to say, a point on the rotating magnet wheel may not differ more than $\frac{2}{p}$ from the position it would have if the rotation was perfectly uniform, p being the number of pole pairs. Thus consider the case of a standard power generator of 2,000 kw. at 25 cycles and 83 revolutions per minute; the number of pole pairs (p) would be 18, the permissible "cyclic irregularity" must not exceed 1/9—that is to say, a point on the rotating magnet wheel of the generator must not be more than 0·11deg. in advance of or behind the point corresponding to absolute uniformity at the same speed. Thus the total "cyclic irregularity" or angular variation in this case would be 0·22deg.; had the frequency been 50 it would have been 0·11deg. for the same phase displacement of the E.M.F. waves, necessitating a much greater flywheel effect in this case. Of course, if the generators have a larger armature reaction than is usual, the permissible phase displacement can be greater for the same synchronising current. It must always be borne in mind that with generators running in parallel one may be ahead and another behind by the amount of the maximum "cyclic irregularity," so that the amount by which the two E.M.F. waves are out of phase depends upon twice this—that is, it depends upon the total amount of variation in this case; the synchronising current will be proportional naturally to the sine of this total angle of phase displacement—in the case taken above, to sine 4deg.

In accordance with what has been said before, the variation in angular velocity during a revolution should be kept within the permissible limits with the minimum weight of magnet wheel—that is to say, the desired result should be attained rather by careful design of the engines than by very large flywheel effects. If this point be attended to, if the governor dash-pots are suitably designed, and if the pressure regulation of the generators is not too close, there will be no trouble from hunting either in the power station or in the distant sub-stations. These remarks regarding the governing, speed variation, etc., of engines for power work can be concluded with the illustrations given in Fig. 9. The "tachograms," *a*, *b*, and *c*, are as nearly as possible exact reproductions of the records obtained by means of a Horn tachograph from one of the 1,000-h.p. engines referred to previously. The variations in the angular velocity during the revolution are quite clear; the three records represent three different adjustments of the engine governor after the engine and generators had been erected. It will be seen that after the governor had been properly adjusted, the total variation (up and down) in the speed does not exceed 0·3 of 1 per cent., or the "cyclic irregularity" of the engine does not exceed 0·15 to 1 per cent. up or down. The Horn tachograph does not appear to be so well known in this country as it should be. It is an accurate and extremely useful instrument, whose indications represent with sufficient accuracy what the engine is doing during the revolution. This is exactly what the electrical engineer wants to know in connection with the commercial problems of parallel running.

FIG. 9.—Tachograms of 1,000-h.h.p. Horizontal Engine. Triple Expansion; Two Cranks at 90 degrees, 90 revolutions per minute.

III.—Relative Comparison of the Different Types of Sub-Station Converters.

From what has already been said about the three classes of sub-station equipment, a good general idea can be formed of their relative advantages and disadvantages. From the point of view of simplicity and ease of operation asynchronous converters are far ahead of the two types of synchronous machines. But this advanaage is gained at the expense of plant efficiency, and consequently, simply on account of the lagging currents incidental to their use, this type of converter is unsuitable for work of any magnitude. It will continue to find its chief use in connection with schemes for the conversion of power for lighting and tramways, where the total amount of power to

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TABLE A.—Comparison of Sub-Station Machinery. Transmission: Three-Phase at 5,500 Volts between Lines and 40 Cycles. Distribution: Three-Wire at 510 Volts between Outers, Neutral Conductor Earthed.

Type of equipment.	Asynchronous motor-generator.		Synchronous motor-generator.		Rotary converters and step-down transformers.	
Output of sub-station converter	150 kw.	500 kw.	150 kw.	500 kw.	150 kw.	500 kw.
Speed of converter	480	300	480	300	480	300
Number of field poles (generator)	6	10	6	10	10	16
Peripheral speed of commutator	1,760	1,880	1,760	1,880	2,970	3,100
Number of commutator bars	162	270	162	270	400	560
Temperature rise, any part after 24 hours at full load	35deg. C.	35deg. C.	35deg. C.	35deg. C.	35deg. C.	35deg. C.
Rise of pressure when full load switched off, sub-station 'bus-bar pressure constant	15 %	12 %	14·5 %	11·5 %	9·5 %	8 %
Efficiency { Full load	83·5 %	86 %	84 %	87 %	90 %	92 %
Efficiency { Half load	75·5 %	80 %	76 %	79 %	85 %	87·5 %
Overload capacity for one hour with fixed brushes	25 %	25 %	25 %	25 %	50 %	75 %
Power factor { Full load	90 %	91 %	100·95 % (leading)	100·96 % (leading)	100·95 % (leading)	100·96 % (leading)
Power factor { Half load	87 %	88 %	—	—	—	—
Starting current from alternating-current side in terms of full-load current	80 % (rotor resistance)	50 % (rotor resistance)	100 % (starting motor)	100 % starting motor)	80 % (starting motor)	60 % (starting motor)
Full-load drop of speed	3·5 %	3 %	None	None	None	None
Relative cost per kilowatt, including regulating gear	20 kw.	15·6	19·1	13·2	12·4*	13·0*
Floor-space required per kilowatt (square feet)	0·8	0·5	0·75	0·5	0·55	0·45

* Including middle-wire booster.

be transmitted and distributed is relatively small, and where the sub-station converters do not exceed 150 kw. in size. Synchronous motor-generators, on the other hand, are ideal machines for the work in many respects. High power factors over the whole of the system are assured. There are no complications in working, and no parallel-running troubles need be feared provided a fair amount of care has been taken with the design of the plant in the first instance. Moreover, these machines possess (in common with the asynchronous converters) two very great advantages, the first being that they can be operated equally well from circuits of any reasonable frequency, there being no difference in the performance of the motors for frequencies between 25 and 60 cycles. The second great advantage is that the regulation of the direct-current pressure can be performed in well-known ways with the greatest ease, and not only this, but the direct-current pressure is independent of the pressure fluctuations at the ends of the long high-pressure feeders. Both asynchronous and synchronous motor-generators are efficient types, the efficiency of the asynchronous motor being generally about 1 per cent. less than the synchronous machine, while the efficiency of the latter will be about the same as that of the direct-current generator of equal size driven by it. Both classes of machine require simple switch gear, and very little of it, the advantage being with the asynchronous machine, on account of the simple starting arrangements. Rotary converters are on the same footing with regard to starting and power factor as synchronous motor-generators, and have two great advantages over either form of motor-generator—they are 4 to 5 per cent. more efficient at all loads, and possess a greater overload capacity. They are, on the other hand, extremely sensitive with regard to parallel running. With regard to fluctuations in the feeder pressure, moreover, their manner of operation is by no means simple, and the arrangements for regulating and running are in general somewhat complicated. This is on account of the special regulating arrangements and extra switch gear required for the step-down transformers and auxiliary devices.

With regard to the important points of floor space required and first cost, there is very little to choose between the different types of machines. Comparing the machines alone, there is, of course, a considerable advantage in favour of the rotary converter, but the additions to the latter equipment in the shape of transformers, air-blast outfits (when used), special regulators, and extra switch gear, bring up the cost of a rotary converter equipment to very nearly the same figure as that for the synchronous motor-generator equipment. The asynchronous converter equipment is somewhat dearer than the latter as a rule. Table A serves to illustrate the above-mentioned points in a practical way. Examples given are taken from practice, and the machines (built in the same works) are compared upon *exactly* the same basis with regard to conditions of operation—such as speed, frequency, voltage, etc. The case selected to illustrate what has been said is an actual combined lighting and power scheme, current for lighting purposes being taken from the high-pressure feeders *en route* to the sub-stations, as well as from the latter—hence the frequency. The case is somewhat unfavourable to the motor-generators, as these machines were arranged with a generator at each end of the motor shaft, having half its output; consequently the floor space required is greater and the cost more than would have been the case had each motor driven a single generator of equal output. It will be seen that with the larger machines the only substantial advantages of the rotary converter compared with the synchronous motor-generator are those of greater efficiency and overload capacity. These are, of course, of very great importance, but for many purposes the greatly superior performance of the synchronous motor-generator from the points of view of simplicity, parallel running, and pressure regulation must be carefully balanced against them.

Before concluding, a word or two must be said with regard to the performance of rotary converters of large size at different frequencies. It is not too much to say that the limit of successful operation of these machines is reached at 40 cycles. Above this frequency there is no doubt whatever in the author's mind that in all cases the best type of converter to employ in the sub-stations is the synchronous motor-generator, whatever the nature of the work. Above the frequency of 40 cycles there are two great difficulties in the way of successful working—good parallel running of the rotaries becomes extremely difficult, the machines hunting at the slightest provocation, and the question of commutation becomes a very difficult one to solve in a satisfactory manner. As already pointed out in connection with the generators, the lower the frequency the better the parallel running, for with a given angular displacement the phase difference between the E.M.F. waves of the various machines is smaller. The same argument applies equally to the case of the rotary converter, for in order to put the high-frequency machine on the same basis as the low-frequency machine in this respect it would be necessary to have the same number of poles in each machine, meaning that a machine operating at 50 cycles would have to run at double the speed of a machine of the same output operated at 25 cycles. This is, of course, impossible, on account of mechanical considerations, the principal difficulty being the commutator. If, on the one hand, the peripheral speed of the commutator is too great, the use of carbon brushes is rendered very difficult, and also the segments may buckle; while, on the other hand, as the number of segments required is practically fixed (by the permissible voltage per bar), these would become too thin if the diameter of the commutator is less than a certain amount. The higher the direct-current pressure the greater the difficulties in this respect. The net result is that with high frequency the number of field poles on the rotary has to be increased, the diameter of the armature has to be increased (which means increased momentum), and also the armature reaction of the machine has to be made larger in order to get a proper division of the current in the various branches of the armature. All these features, common more or less to the high-frequency rotary—namely, crowded poles, high peripheral speeds, high armature reaction, thin commutator segments, high voltage per bar, short distance between brush-holders, etc.—are wholly unfavourable to successful parallel running and good commutation, to say nothing of the increased wear and tear due to abnormally high speed. It is for this reason that a frequency of 25 cycles has been standardised for rotary converter work, and at this frequency the machines are undoubtedly satisfactory. Between 30 and 40 cycles their performance is still good under favourable conditions—that is, proportionately better engines, high speeds, and low voltages—while above 40 cycles the use of the rotary converter, in units of large size, would appear to be practically out of the question. Low frequency of operation, such as 25 cycles, while satisfactory, if the whole output of the power station is to be absorbed by the converter sub-stations, is undesirable if other work has to be done in addition. Generators, motors, and transformers become unduly heavy and expensive, and lighting work from the alternating-current

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mains is out of the question. But, on the other hand, all parallel running is better, and all inductive effects in generator, line, transformers, and motors diminish with low frequency, resulting in improved regulation over the whole system. Taking all these things into account, modern practice has shown that a frequency of 40 to 50 cycles is the best that can be employed for the work in question; a departure from this in order to suit the requirements of the rotary converters in the sub-stations constitutes in itself a disadvantage which is not present when motor-generators are used for the same work.

Concluding Remarks.

Given that it is required to convert polyphase current into direct current by means of converting sub-stations, it is possible, based upon the considerations noted in the paper, to draw the following general conclusions:

1. For power work and for those cases where the amount of lighting to be done is relatively small, rotary converter sub-stations operated at 20 to 30 cycles are preferable.

2. For lighting work the use of motor-generators, operated at 40 to 50 cycles in the sub-stations, will give the best results. This is also the case when the lighting load on the sub-station forms a considerable proportion of the total output of the latter.

3. Of the two classes of motor-generator sub-station that equipped with asynchronous machinery is on the whole unsuitable for work of any magnitude.

The above conclusions may perhaps form a basis for discussion, but they must not be considered as being perfectly definite, on account of the widely different conditions that are met with in modern practice. Finally, the author would like to suggest in this connection that the discussion might profitably include the broad question of the transformation and distribution of large amounts of polyphase current for supply over large areas, for it is one of the most important questions of modern electrical engineering. Although in many cases direct-current sub-stations are undoubtedly advisable, still in many cases the direct distribution of polyphase current from simple transformer sub-stations will undoubtedly be the best solution, not only from the technical, but also from the commercial point of view.

Discussion.

Mr. B. Field said that American engineers, who had had so much more experience with sub-station converters than they had had in this country, had now come to the conclusion that rotary converters were the right machines, provided the frequency was sufficiently low, say 25 cycles. Above 50 cycles, troubles were likely to ensue with rotary converters, although he believed the Westinghouse Company did not hesitate to build them up to 60 cycles. The full-load efficiency of a fair-sized rotary was 95 per cent., and including its transformer 93 per cent., which was much higher than with any other rotating converter, whether synchronous motor-generator or non-synchronous motor-generator. A rotary converter would run with 2½ times its full load without the least instability, and could be started up from the three-phase side with only about 30 per cent. above full-load current. He was told that some 60,000 h.p. was transformed by means of rotary converters in the Metropolitan Railway Company's system in New York, and no difficulties whatever were being experienced. In Glasgow they would have some 24 500 kw. of rotary converters in the various sub-stations, each rotary being direct-connected to a negative series booster. The rotaries were compound-wound, and the sole regulating device for varying the tension on the continuous-current side was the magnet winding. The transformers were specially designed with large self-induction—in fact, they would give a 12 per cent. drop with full-load current, if the load were a pure self-induction. The effect of varying the excitation was to vary the amount of lag or lead of the currents received from the transformers, with the effect that the self-induction of the latter increased or decreased the transformation ratio to the desired amount. In such sub-stations where the frequency could not be conveniently kept down to 25, he thought a very workable combination would be that of synchronous motor-generators together with non-synchronous motor-generators. The synchronous motor-generators could be so designed that they could be sufficiently over-excited to make up for the lagging current taken from the line by the non-synchronous motor-generators. With such a system the efficiency would be high, there would be no difficulties whatever in starting, since to start up a sub-station in the first instance a non-synchronous unit would be run up to speed, and then a synchronous motor-generator would be started up from the continuous-current side. Further, the sub-station, as a whole, would be receiving currents from the line which would be exactly in phase with the E.M.F. He did not agree with Mr. Eborall that the proper place for damping copper pieces was only between the pole-tips, and that they were useless elsewhere. Many makers surrounded the pole with a massive ring, which was thickened up at the pole-tips, the poles being often chamfered off at the tips, and the copper rings were arranged to enclose the tips so that part of the polar surface was, as it were, made of copper. Normally the whole pole flux passed through the ring, and in order for it to be blown out into the intervening space between the pole-tips it would have to cut across the ring. The induced currents in the latter would, of course, prevent that to any serious extent. The case sometimes arose where it was required to run a rotary reversed, that was to supply it with continuous current and take a three-phase current from it. Some regulating device was here essential to prevent the rotary from racing. For instance, if a lagging current were taken from the rotary it would tend to demagnetise the field magnets, and the rotary would speed up. Cases had been known where rotaries had flown to pieces owing to that cause. In any case the frequency was very variable, which was naturally objectionable. In Dublin, where on occasions a rotary was run reversed, the following ingenious device had been resorted to: Connected to the main rotary was an auxiliary one with no winding on its field poles. It was supplied on the three-phase side with alternating currents by means of series transformers inserted in the main three-phase line. The continuous-current brushes supplied merely current to the compound winding of the main rotary. The field-magnet system of the auxiliary rotary was rotatable, and its position was so adjusted that when the main current was in phase with the E.M.F. the auxiliary rotary back E.M.F. was at 90deg. to the current it received from the series transformers. It therefore received no power and could give out none—that was, no current circulates in the compound winding of the main rotary. If the current lagged or led, the auxiliary rotary received from the series transformers a correspondingly lagging or leading current, which magnetised the field magnets of the auxiliary rotary in the one direction or the other, so that its continuous-current brushes supplied to the compound winding of the main rotary a current which compounded or decompounded the machine according as it gave out a lagging or a leading current. The device was absolutely automatic, and the speed variation was never more than one or two revolutions. The auxiliary rotary must have an output of about 1 or 1½ per cent. of the main rotary.

Prof. S. P. Thompson referred to the advantages of the mesh connection of three-phase work set out by the author. Some of these, he thought, were known before, but he did not remember their having been noticed in any other scientific paper. With regard to the use of damping coils between the pole-pieces, he himself was shortly about to bring attention to this point. He agreed with Mr. Field that there was some advantage in putting thick copper coils around the poles. But he went further than this. You might have a reaction which tended to distort the magnetism of the poles by distorting the magnetism of one side of the poles, and an enclosing coil was quite insufficient to prevent hunting. Therefore, neither of these methods should be employed. The real remedy was to use an amortisseur having a number of enclosed copper circuits, so that the circuits passed through the pole-pieces. That this was of some advantage was shown by the way in which amortisseurs were coming into use. The question of the use of choking coils placed across the mains must be interesting to Mr. Mordey. It was particularly interesting to himself, as he specially pointed out the advantage of putting in three-phase choking coils at intervals according to the capacity in 1893. Coming to another point, he was discussing with Prof. Dolby the question of the amount of variation of speed in engines of different types some time ago. Prof. Dolby gave him some interesting data on the subject. He should like to put this most important point forward for the consideration of engineers: What kind of specification for an engine could be drawn up so as to ensure that the cyclic irregularity should not exceed the permissible limit? In conclusion, Prof. Thompson thought the author had made out a good case for the employment of motor-generators under the conditions of supply of large quantities of electric energy with a three-phase system at high voltage for sub-stations. But after all, whether you used rotary converters or motor-generators, you were only making the best of an imperfect job. You were putting down in the sub-stations a quantity of revolving machinery which required excessive attention, whereas if revolving machinery in these intermediate stations were got rid of, so much the better for the system, and so much the better in the long run for the industry. One way of getting rid of it was by not using continuous current at all, but to employ the polyphase currents direct. That was an old and often-discussed question.

Mr. S. Z. de Ferranti summed up the paper as doing a great deal of good in emphasising the extreme complication of the system which was required to convert alternating current into continuous. The only excuse for the continuous current was where you had two companies in competition, and where you had got to deal with the public who thought that the continuous current was so much better for the consumer than the alternating current. In his opinion the highest form of success, and also the most permanent good, was obtained from the most simple appliances and systems possible. In this paper all the author had shown was very largely a makeshift in order to suit the present demand. It was not a permanent thing, and before long they would see the alternating current taking its place. With regard to the hunting of these rotary converters or motor-generators, he agreed with Dr. Thompson that the true solution was that invented by M. Leblanc, whose results agreed very well with practice.

Mr. W. B. Esson thought this was a paper which required a great amount of study. The type of sub station apparatus in which he had had experience was that in which they had induction motors with two current generators forming a three-wire system. This was not a pure and simple case of transmission of power from a distance, but a case in which they had to distribute energy through a mixed area, the Board of Trade requiring them to supply alternating current in one part and continuous in another. On account of the length of the feeders, they had to generate an alternating two-phase current, and then the question arose as to

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how this was to be converted for a three-wire system. They discussed the synchronous motor, the induction motor, and the rotary converter. The rotary converter did not appear to find favour with engineers in this country, and it was rejected. The induction motors seemed to be by far the most simple to start and manage, and they were therefore adopted in this particular case. With regard to the air-gap of $\frac{1}{16}$in. in the inductor motor with a 3ft. 9in. diameter rotor, he thought this was too small to be safe. The American practice was to give a much larger air-gap. For a motor of the size mentioned the air-gap would be about $\frac{1}{32}$in. The striking thing about the machines supplied to the Metropolitan Railway Company of New York was that they seemed to be much lighter in weight than others, and he should like to know what was the drop in these motors. In England they were made with a drop of 2½ to 3 per cent., but on the Metropolitan Company's machines there was a drop of something like 9 or 10 per cent. on a non-inductive load. The fact was that the English engineers were making the machines too good, and in consequence had to diminish the drop. As to hunting, he had had a good deal of experience, and the trouble in one case was ultimately found to be simply due to the fact that the trip cams on the engines were not of the proper shape. They must be most carefully formed to agree with the position of the governor at any speed.

Prof. Carus-Wilson dealt with the question of the momentum of these converters or rotors. The author stated that in his opinion the momentum of the converters should be kept as low as possible, for it apparently assisted hunting. He should like to state that, as a matter of fact, momentum was the initial cause of the hunting, and, therefore, the problem assumed more importance than it was given in the paper. Taking the case of a converter used for traction work—in which the primary circuit was well regulated, and the irregularities were more particularly due to the very large variation of the load on the secondary side—what happened when an extremely heavy load was drawn from a sub-station was that there was a very large disproportion of torque on the two sides of the rotary. The inevitable result was a very large cross flux. He disagreed with the author's conclusion that you should reduce the momentum of the rotary as much as you possibly could in order to prevent hunting. The actual mechanical momentum was not the only thing which produced this. There were two other things having exactly the same effect. One was the ohmic resistance in the rotary and the other the strength of the magnetic field, because the stronger the magnetic field the less would be the disproportion of the torque between the two sides. A strong field counterbalanced the effect of a high momentum. Some time ago, when traction schemes were first talked about, much was said about subsidiary stations along the lines in the event of overloads. It seemed to him that they now had in the rotary converter, or in the motor-generator, the very thing which engineers at that time were aiming at. The object then seemed to be to make the momentum of the rotary act as a buffer to prevent the excessive overloads in the secondary being introduced into the primary. He would urge the consideration of the question that the damping effect could be counted upon as the best set-off to hunting, and whether it would not be advisable to increase the momentum of the rotating parts of the converter in such a way that the sudden overloads on the secondaries would not be reproduced in the primaries. It appeared to him that that type of sub-station for traction service would be most desirable where the greatest amount of momentum could be passed into the rotating art of the motor.

Mr. Cruse pointed out that Mr. Eborall did not touch at all upon the question of polyphase transformers as against three single transformers used in a sub-station. These kind of transformers were very much used abroad, and it was a question whether they could not be used in this country. So far as he could see, such types of transformers would be considerably more economical, would take up less floor space, and would be altogether better than the polyphase transformers. There was a certain amount of outcry against them in this country, because it was said that if one of the phases broke down the whole was put *hors de combat*, but the same occurred to the three-phase generator. He thought it was largely a question of manufacture. Another point was as regarded the statement of Mr. Eborall that there was no difficulty whatever in the regulation of the synchronous and asynchronous motor-generators. Did that statement assume that the line pressure was constant? In the number of power schemes which were now under consideration one of the difficulties would be to keep the line pressure constant. He did not believe it was financially possible to take a separate feeder to each sub-station, but he should like to know how far the author thought the pressure might vary not to interfere with the working of the synchronous motor.

Mr. W. M. Patchell referred to the work on which he had been engaged, in regard to which he was given so much diverse advice. In the end he decided not to have static transformers. Their generating plant was large enough to get 10,000 volts on it. Respecting sub-stations, if you were doing tramway work you were able to supply in very large units. In this particular case they had to supply in small units, and he decided that both the induction motors and the synchronous motors of 300 kw. should drive two 150-volt direct-current generators. In view of the pending visit of some of the members of the Institution to Frankfort, it might interest them to know that this plant would be ready for delivery very shortly, so that the members might have an opportunity of inspecting the same in the Lahmeyer Company's works.

Mr. C. P. Sparks thought that engineers in England were in agreement with the author as to his second conclusion—viz., that for lighting work the use of motor-generators operated at 40 to 50 cycles in the sub-stations will give the best results—that the simplicity derived from the use of motor-generators was more desirable than the extra efficiency obtained with rotaries. But there was another point—viz., the question of distribution of polyphase current from the sub-stations. In a scattered area, no doubt, the polyphase system could be continued, but when one came to the question of network, there appeared to him to be but little advantage to carry the polyphase network into very populous districts owing to the increased cost over that of laying the ordinary three-wire direct-current network. The only thing in favour of the polyphase network was the one question of electrolysis. This difficulty had been largely met by the introduction of triple and concentric cables, where the neutral conductor was earthed. Another point was that although motors were lighter, the fact remained that no polyphase motor could to-day be bought at the same speed to compete with the direct-current motor in price.

Mr. Eborall, in reply, said that this was one of the toughest questions they had yet had to consider. They had not to think of small units; the machines of to-day were of 2,000 kw. to 5,000 kw. He could not quite agree with Mr. Field with regard to the frequency of rotary converters. He thought that a frequency of 25 cycles, although very good for parallel running, was too low. The best frequency for polyphase working was undoubtedly between 40 and 50 cycles. On the question of damping coils he thought he had been somewhat misunderstood. As he stated in the paper, the poles of the motors or rotaries should be bridged from horn to horn by copper, but rods should also pass through the pole-pieces. In the majority of American machines this form of damper was used. The great objection to asynchronous motors was the heavy currents. That was one good reason why synchronous machines were preferable for nearly every class of sub-station work. His own idea was that if the work be small, and you want machines of 100 kw. or 200 kw. in the sub-stations, then it would pay to use asynchronous machines on account of greater simplicity in working; but in larger stations synchronous machines would give the best results. The effect of choking coils in feeders was not to annul the capacity, but to get rid of the pulsations which you always got with the use of long feeders. On the question of working with alternate currents throughout he thought he had been slightly misunderstood. The whole thing was a commercial question. In his opinion it was the greatest possible mistake to use transformers in the sub-stations except in traction work. For lighting work they were of no good use. Mr. Esson had said he preferred to use asynchronous motor-generators as a rule. He (the speaker) should like to know to what work he was referring; he believed it to be Greenwich. He (the speaker) was dealing with large works, and disagreed with Mr. Esson as regarded the drop in the machines. It was not true that English machines were too good, because if they were they would be bought in preference to Continental and American machines. As a matter of fact, the drop in the English machines was more like 5 or 6 per cent. rather than 2 or 2½ per cent. With regard to Prof. Wilson's remarks, all he could say was that the statements in the paper were based on experience. He found that the momentum in synchronous machines should be kept as low as possible. The limit of working with polyphase transformers was reached at about 100 kw., and it would pay better to have three single-phase transformers. With regard to Mr. Sparke's remarks, he said it was more expensive to lay a three-phase system than a direct-current. That was not so. Mr. Field and he had both come to the conclusion that the cost was practically the same.

The proceedings closed with a hearty vote of thanks to the author.

BRITISH THOMSON-HOUSTON COMPANY.

The British Thomson-Houston Company have just issued their pamphlets Nos. 91 and 92. The first of these deals with the magnetic blow-out controllers of the types manufactured for electric cranes and hoists, and also of the types which are specially adapted for small work, such as electric launches and automobiles. In all of these controllers the magnetic blow-out is employed. We notice from the illustrations of the various parts that great care has been taken in the insulation of these controllers, in order that under no condition should the operator receive a shock either from the handle or the case of the controller. Of course, for controlling large cranes special gears are required, and these have been carefully thought out by the company. Illustrations are given in the pamphlet of a 140-ton electric crane, which is provided with two independent lifting gears. In each case a single handle is arranged for both the forward and reverse motions. At the end of the list particulars are given of small controllers for use on industrial railways of narrow gauge, where the space available is exceedingly limited, as is the case in coalmines. The other pamphlet (No. 92) deals with automatic circuit breakers with capacities from 50 amperes up to 1,200. A good feature of the pamphlet is the list of dimensions, which will be found exceedingly handy when designing switchboards.

War Office Contracts.—It is reported that the War Office have placed orders for 120 searchlight wagons of a new type with various firms in London.

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LONDON'S ELECTRIC COMMUNICATIONS.

It is now so many years since electric tramcars were first used in the main streets of Greater London, that people have almost forgotten the early attempts which were made both in the West and East to work tramways by means of accumulator cars. The lines on which the experiments were made had to revert to horse traction, and it was not until Thursday in last week that a good system of electric tramways was again available in the Metropolis. We refer, of course, to the opening on that day of a small portion of the system of the London United Tramways Company. In consequence of this one is now able to go either from the Bank to Acton or to Kew Bridge by means of electrically-propelled vehicles. The first portion of the journey is made in the trains of the Central London Railway, and at Shepherd's Bush one changes over to the electric tramcars which run in the public streets. How far this will actually relieve congested areas will not be at once seen, but the reduction in fares now made by the London United Tramways Company tends in this direction. It is not only that one is able to get from Kew Bridge to the Bank for fourpence, or from Acton to the Bank for threepence, that is the consideration, although these figures show how cheaply electric communication can be made. The point which cannot be too strongly insisted on is the extreme frequency of the service. For instance, in the ordinary way there is only three minutes' interval between the tramcars on both the Acton and Kew Bridge routes; with the large cars used, holding seventy people, this alone is equivalent to one thousand four hundred passengers per hour on either route. On Easter Monday, the rush of Londoners to see the electric cars, combined with the attractions of Kew, put an enormous strain on the tramway system, which it was, however, quite able to bear. Each car as it arrived at the terminus was besieged by a crowd of people, and immediately loaded up until there was not even standing room. At the other end of the lines the same occurred, and in spite of this the managing director of the line, Mr. J. Clifton Robinson, was able to increase the service until there was only three-quarters of a minute interval between the cars. This is an illustration of how well a heavy demand for a short period, such as occurs every morning and evening on all London lines, can be met. One can also see by glancing at the map of the other lines owned by the London United Tramways, a good portion of which will be opened by July, that the company will have to run an extremely frequent service of cars, which will entirely save the large amount of time which is now lost annually by having to wait for trains on the ordinary railways. A speed of ten miles per hour is allowed on the lines in question, which make them a most convenient means of distributing the passengers by the Central London Electric Railway. Before leaving this subject we have again to refer to the long delay which has taken place in the opening up of the tramway company's system, owing to the opposition brought by the authorities at Kew. The fact that this delay actually took place is evident by the

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promptitude with which the lines were opened after due permission had been received. For example, it was only on Tuesday of last week that the matter was finally decided, the agreement was signed on Wednesday, and some twelve hours later the cars commenced running. The actual matters in dispute were referred by the Board of Trade to a committee of experts, and afterwards the Kew Observatory authorities carried out a large number of experiments on the spot. The fight was taken up by the Press with considerable vigour, and we believe that the consensus of opinion was in favour of having electric trams even if the expense of moving the observatory had to be incurred in consequence. It is a mark of the commercial spirit of the English nation that, while experts differed and interested parties disagreed, a decision was quickly come to as soon as the matter was taken up by the Treasury. A monetary consideration towards the expense of removing some of the magnetic instruments to other places, if necessary, was the final basis of agreement, and with this agreement we gather that the company are quite content. It, of course, saves them the inconvenience of using an insulated return, but we hope that the contribution was not an unduly heavy one, as it would be unfair for one section of the community to have to bear, as the passengers on the London United Tramways then would do, a large proportion of a cost which is necessitated by the growing needs of London as a whole. We look upon the lines opened on the 3rd inst. as being only the forerunners of many others which will give quick access to the heart of London. We may also add that the network of lines owned by the London United Tramways Company are an example of the advantage of leaving such work to private enterprise. Many of the districts through which these lines run are at loggerheads one with the other, and would never have constructed tramways on the comprehensive scale required.

THE ISLINGTON ELECTRIC LIGHTING REPORT.

We give elsewhere in this issue the report of the Lighting Committee of the Borough Council of Islington. The committee was, in December last, asked to report upon the machinery, plant, mains, and running of the electric lighting undertaking of the Council. The committee was authorised to employ, if thought necessary, a consulting electrical expert, but this they have not done. The report is one of the most unsatisfactory that we have seen, and the opinion of any eminent expert would, we are sure, have been different from that expressed by the committee. As will be seen in the report, full comparisons are made by the committee between the first cost and working charges of the Islington undertaking and that of four other county borough undertakings in London. From these figures it is seen that the cost per unit sold comes out higher at Islington than in any other instance, while the capital charge for interest and repayment of loans is also highest in the case of Islington. To quote the figures for Islington and Hammersmith, for instance, the costs per unit sold are respectively 2·76d. and 2·09d., while the capital charges average per unit sold for Islington 1·64d., and for Hammersmith 1·17d. We have selected Hammersmith because the system of supply is the same. These figures need considerably more explanation than is given by the committee, and, above all, they need to be radically changed. It will be seen that at the end of the report the committee advocate the suspension of all extensions to mains with the view of keeping down capital cost. This means that new consumers will not be so readily reached, and we do not share with the committee their opinion that the substantiality of the buildings and the quality of the machinery can be looked to as a solution of the present state of affairs. Electric undertakings in the hands of local authorities should not be run to make profit, but this is no reason why Islington should be content with an undertaking which barely pays its way, in spite of the fact that its average receipts per unit sold are over 1¼d. higher than obtains in another London district as a remunerative price.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE USE OF ELECTRICITY IN INDIA.

SIR,—I do not know whether the article in your number for April 5 by Mr. George Cecil is meant to be a skit on the use of electricity in India or not. If not, your correspondent has arrived at an erroneous conclusion with reference to the position of our profession on the Bengal side. I will take his remarks in order.

1. Telegrams. He writes that these may be sent anywhere except to villages. It all depends what his definition of a village is; if in his case a village means a collection of coolie huts, as in the tea-gardens, with a few Europeans stationed in charge, he is in error, as there are quite a number of places in the tea districts where telegrams can be sent to under the above conditions. Again, he gives the price of a telegram at two rupees. This gives one the impression that a telegram cannot be sent for any smaller sum. There are three prices—viz., eight annas = 8d.; one rupee = 1s. 4d.; and two rupees = 2s. 8d. The eight-anna telegram is called a deferred, and in outlying districts is generally delivered with the day's letters instead of being sent on by special carrier. This, however, may save a couple of days over the post in transmission to some places. The rupee telegram is equivalent to our ordinary, and the two-rupee is called an urgent, and takes precedence of the other two if the lines are being worked full. This is a great advantage. In all cases the address is included in the telegram without extra cost.

2. Electric lighting. From what I have been told by other electricians, most of the rajahs have the electric light in their palaces, which are made of *anything but mud*. The several jute and cotton mills run into a considerable number, and it is the rule, and not the exception, to have the light in the mills, because the spinners and weavers will not work in mills that are run by any other light as long as there are electrically-lighted mills in the same place. There are several mills that have installations of between 2,000 and 4,000 16-c.p. lamps. Not only do the sea-going steamers have the light, but also the river steamers (about 200 in number) and the steamers which tow the big cargo flats up country; these latter generally run through the narrow and tortuous streams of the Sunderbunds by searchlight. I do not quite understand what is meant by the term "latest and improved appliances." I think Mr. Cecil would find that the electrical firms try to keep everything that is required quite up to date, and although the Anglo-Indian electrician may "lack common-sense," he still has enough left to read

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up his work, and occasionally to take a trip to England or other countries to see how things are getting on. I would also remind him that one can get home now in three weeks. As far as arc lamps are concerned, without going outside the confines of Calcutta, there are four installations which aggregate 300 lamps; these installations are all run off private plant.

3. The electric fan, which "is rapidly becoming popular," has been in use for three years at least, and there must be at least 5,000 on the supply company's mains in Calcutta, a considerable number of which are on the day load.

4. Why on earth should we import standard lamps when nearly every house has three or four standard oil-lamps, and it does not require any very brilliant work to adapt them?

5. Batteries for telegraph work wherever possible are secondary, charged either from the office plant or off the town mains.

6. Mr. Cecil has evidently forgotten to visit Madras. This town was actually civilised enough to put in electric trams in 1895, and I have a distinct recollection of having ridden in them three years since.

7. I don't think there are many mills in the British Isles that are run by electricity, and I fancy the cause is very much the same as in India—there is too much capital sunk in steam to make any radical change at present.

8. I know several places where motors are in use for printing, tea bulking and stacking, pumps, organ blowing, lifts, and coal-cutting and boring.

In conclusion, if India is all that is horrid and uncivilised, why did your correspondent go out there? Besides, during the time he made his very extensive study of electrical work, he might have deteriorated to the level of the "Anglo-Indian" he seems to object to so much.—Yours, etc.,

A CALCUTTA ELECTRICIAN.

AMERICAN ENGINEERING COMPETITION—A NIGHTMARE.

SIR,—I think it is doubtful whether the above subject can be dismissed as lightly as has been done in your leader of April 5; at all events, when dealing with our own branch of engineering—electrical engineering. It appears that your leader has overlooked the fact that an increased turnover is supposed to help materially in the way of reducing manufacturing costs. Assuming that this is the case—and everything points in this direction—the following policy, which seems to have been adopted by our American competitors, appears on fairly sound lines. An American manufacturer has a yearly output of £500,000, which he disposes of chiefly in his own country. He believes that by increasing this output he can reduce his establishment and working cost per finished article. To dispose of an increased output in his own country would be difficult, whilst keeping prices up. He therefore decides to double his output, and to export £500,000, and sell it at any price that will cover the sales expenses and the actual cost of production, with a portion of the establishment charges. The original £500,000 output is sold at home at the original prices, but by virtue of the increased turnover the profit on this is an increased one, due, firstly, to the actual reduction in manufacturing costs, and, secondly, to a portion of the establishment charges being borne by the exported half of the output.

This policy is an old one, and has long been appreciated as the one adopted by many American manufacturers, and provided the business is well managed there seems no reason to doubt that it is sound policy. It will be apparent that, in addition to helping to increase the profits, there are secondary considerations not to be overlooked, such as the establishment of sales organisations for dealing with foreign business, which, at a time when business is quiet at home, may come to the rescue in disposing of the output.

Few of our own manufacturers have even thought at present of acquiring foreign business on properly organised lines. This is still to come, unless our manufacturers intend to remain in a small way and, so far as supplying the markets of the world, in the background.

"Bluff," as inferred from your article, no doubt plays an important part in the American policy, but at the same time the foundations of their policy seem sound, and if left alone may do a lot towards acquiring the lion's share of foreign trade.—Yours, etc.,

BRITISH MANUFACTURER.

FORTHCOMING EVENTS.

FRIDAY, APRIL 12.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper on "Iron-Lined Tunnelling Construction," by Mr. A. Woodroffe Manton.

SATURDAY, APRIL 13.

Institution of Junior Engineers.—At 3.30 p.m., visit the Great Northern and City Railway works to inspect the plant described in Mr. Manton's paper.

North of England Institute of Mining and Mechanical Engineers (Newcastle-on-Tyne).—At 1.30 p.m., council meeting; at 2 p.m., general meeting.

SATURDAY, APRIL 16.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. "Modern Practice in the Manufacture and Distribution of Gas," by Mr. H. E. Jones.

WEDNESDAY, APRIL 17.

Society of Arts.—At 8 p.m., "The Synthesis of Indigo," by Prof. Raphael Meldola.

Institution of Electrical Engineers (Birmingham Section).—Ordinary meeting. Adjourned discussion on "Polyphase Equipment in Factories," by Mr. W. Wyld; and, if time permit, Mr. A. C. Eborall's paper (read before the Institution on the 14th ult.), entitled "Some Notes on Polyphase Sub-Station Machinery," will be read in brief abstract for discussion.

THURSDAY, APRIL 18.

Rontgen Society.—At 8 p.m., ordinary meeting. Discussion on "X-Ray Therapeutics."

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Replies of Mr. H. Ravenshaw and Mr. S. F. Walker to the discussion on their paper read at the last meeting. Papers to be read: "Test-Room Methods of Alternate-Current Measurements," by Mr. A. Campbell; and "Note on the Use of the 'Differential Galvanometer,'" by Mr. C. W. S. Crawley.

FRIDAY, APRIL 19.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Mr. Wm. H. Maw will deliver his presidential address.

Royal Institution.—At 9 p.m., Prof. J. J. Thomson on "The Existence of Bodies Smaller than Atoms."

Institution of Civil Engineers.—At 8 p.m., students' meeting. "The Theory of Cast-Iron Beams," by Mr. E. V. Clark.

YORKSHIRE POWER COMPANIES.

At a recent conference, convened by the Yorkshire Electric Power Syndicate, representatives of Heckmondwike, Liversedge, Ravensthorpe, Batley, Dewsbury, Thornhill, Ossett, Birstall, Earlsheaton, Mirfield, Ravensthorpe, and Staincliffe districts listened to a statement by Mr. A. G. Lupton, one of the directors of the company. He said the company was formed of 60 shareholders, who proposed to have four generating stations—viz., at Methley, Wath-upon-Dearne, Thornhill, and at Bingley. A radius of 16 miles from each of the four centres practically covered the whole of the area of supply, and they would overlap each other so that they could help each other when required. The Bill asked for power to go along high roads with through cables, and the West Riding County Council had no objection except with reference to a few bridges, which he (the speaker) thought was being amicably arranged. The Leeds Chamber of Commerce was helping the company, and also that of Huddersfield, while Bradford and Halifax had decided to remain neutral. Of course, their scheme was in opposition to the South Yorkshire Company. They had modified one clause in the Bill so that they undertook not to go into the radius of a local authority without its consent, unless that consent was unreasonably withheld, to supply individuals, and they had also arranged that in the case of a local authority being the distributing factors the company should not enter that area at all, and in that way, he thought, a great difficulty had been met.

The South Yorkshire Company's district covers nearly the same area. Three generating stations are proposed—viz., at Thornhill, at Ferry Fryston, near Knottingley, and at Wombwell.

The prices of both companies are about the same. Roughly speaking, electrical energy is to be delivered in bulk at from four-fifths of a penny per unit for quantities of, say, 5,000 h.p., up to about 3d. per unit for small quantities.

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COMBINED TROLLEY AND CONDUIT TRAMWAY SYSTEMS.*

BY A. N. CONNETT.

In many cities where the overhead trolley is or will be admitted on surface tramways, there often exists a street or a central zone where it is or will be expressly prohibited. Again, other cities prohibit absolutely the trolley within their limits, but penetrating lines from the suburbs come to the limits with the trolley, and from there a change of cars must be made to enter the city, or the cars must be equipped so as to be able to use another system of traction. The general engineering problem in these two cases is about the same. Broadly speaking, it is that the electric motors, with which the car is equipped, must be furnished with current from a source other than the overhead wire along a part of its route. There is no one well-defined system or method of solving the difficulty upon which engineers are agreed as being the best. It is natural that this should be so, local conditions being such an important factor that each individual case must be carefully studied by itself, so that what would be a correct solution in one place might not be justified in another. The three means of solving the problems are by (1) accumulators; (2) surface contact; (3) open-slot conduit.

It is not the purpose of the author to discuss the first two systems. As the result of his experience with accumulators, he would advise that, if in a given case their installation should seem to be advisable, the contract should be drawn in the form of a rental for the batteries, on the terms of paying a fixed sum per automobile car mile for their use; this sum should include the entire cost of maintenance and renewal of the batteries for a fixed period. Penalties should be inserted in the agreement for each trip lost, due to failure in working of the batteries; and their electrical efficiency should be guaranteed up to a certain standard, below which the excess waste of energy should be paid for at an agreed rate per ampere-hour. This method has been employed in France and in Germany with good results. It seems the best devised to protect the user from a poor form of battery for a given work, and at the same time to ensure the upkeep of the batteries in the best possible conditions; this last is to the evident advantage of both buyer and seller. The batteries should be placed under the car body if possible; if this is not done, the acid fumes are disagreeable to passengers, and the effect will be a diminution of receipts and numerous complaints.

If a surface-contact system should be decided upon, the choice of one of the many systems will require careful study. If the number of cars using the portion of track to be equipped with this system is large, and the comparative length of such portion of track is small, it will be found that the cost of the car equipments for a system where the cars carry the magnets is relatively excessive, and that a system employing a magnetic switch for each contact point will be much cheaper. With the condition of a relatively great importance to the surface-contact portion of a line this conclusion as to first cost might easily be reversed. The vital questions of working, maintenance, and safety have to be given the most careful consideration, with the disadvantage that there is at present very little to be learned from experience on actual working lines, which are either too few or too recently installed. There should be no hesitation about adopting the conduit where financial and constructional conditions make it possible, for this system has proved itself to be workable. It has passed entirely beyond the experimental and uncertain period, and can now be adopted without hesitation as an electric tramway system for the propulsion of cars. It can fail completely, but even partial failure will be the fault either of design or of construction, or of both.

The problem of adapting the plough and track mechanism, to change from the overhead line to the conduit system or *vice versâ*, has been satisfactorily and carefully worked out on several different general principles. In America, where the conduit has been generally adopted in the cities of New York and Washington, the problem of a mixed line has received very little attention. In Washington, on two unimportant trolley lines, the cars run directly into the city on the conduit tracks, but the manner of making the change is crude and not worthy of attention. On the Continent there are a number of cases of this kind, and they are all worthy of attention, the problem having received in each case careful study. This, in the author's opinion, is only one instance in several where European tramways offer now a much more fruitful field for study than American tramways, especially so to the engineer called upon to instal a system in Europe under European conditions and requirements.

The subject will now be considered in the following order: (1) the general type of conduit to be adopted; (2) the mechanical and electrical bases on which to construct conduit; (3) the special apparatus necessary for a mixed conduit and trolley line.

General Type of Conduit.—The first question to be solved in a conduit construction is the conductor system, to which is intimately connected the manner of making contact. With the limited clearances in a conduit, there can be no other practical method than the one of installing rigid conductor bars, to which the original Budapest conduit owes its success. Apart from that, it had no special feature which was of enough importance to make this line a success where others had failed. The conservatism, not unnatural under the circumstances, shown in the construction of this road may be judged by the fact that 300 volts distribution was adopted, while now engineers have no hesitation in using 550 volts under similar conditions. The next question is whether the conduit shall be side-slot or centre-slot construction. If the engineer has his choice, he will undoubtedly adopt the latter type of conduit. On the Continent there is an objection in some of the cities on the part of the municipal authorities to the centre slot. Therefore in Budapest, Berlin, and Brussels only the side slot is allowed, while in the cities of Lyons, Nice, and Bordeaux the centre slot has been or is being installed. There are some short stretches of centre slot in Paris, but the reasons for this were exceptional, and in general this city may be classed in the first category also, 95 per cent. of the conduit mileage there being side slot. Of the 45 miles of conduit electric railway constructed in four European cities and one American city with which the author has been associated as chief engineer, 30½ miles are of the centre-slot and the remaining 14½ miles are of the side-slot type. His original opinion of the greater advantages of the centre-slot construction has been somewhat modified by experience, but he still believes that from an operating standpoint the centre slot is the better construction.

The inherent difficulty with the side slot is the switch at the junction of two slots. Figs. 1 and 2 show the two cases With the centre slot a comparatively light movable tongue can be hung or pivoted to the fixed tongue, its use being simply to guide the plough. With the side slot the tongue is much stiffer and heavier, because it must also guide the wheels of the car and support them in one position—that is, the entire tongue is movable, and its upper surface from point to heel must be level with the wheel rail. At its point it should have a certain thickness to give mechanical strength. This should be not less than ½in., which, added to the 1in. minimum width of slot, gives an opening of 1½in., which is gradually reduced to 1in. in a length of about 3ft. In the centre-slot construction the normal slot width of, say, ¾in. is increased in a length of about 8in., and the maximum increase is about ¼in. Another objection to the side slot is that the flanges of the wheels throw water and mud into the conduit and on to the plough. Another is that the slot rail, being also a wheel rail, should have a vertical web, which diminishes the distance across from rail to rail on the line of their base level, thus limiting the plough construction, and also making the conductor bars invisible from above, which renders the finding of faults more difficult. The principal trouble with the side-slot conduit is that connected with the switch, and it can be avoided by a special construction, which will be explained later. The advantages of the side-slot conduit are that the additional band of iron

* Paper read before the Institution of Mechanical Engineers.

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in the street required by the centre-slot rails is avoided, and that the maintenance of the paving is thereby simplified, every joint of a rail with the paving being a source of weakness in the life of the latter.

Mechanical and Electrical Details to be considered in the Construction of a Conduit.—With the broad question of type of conductors and of position of the conduit settled, the design in detail of a conduit can be undertaken. The first matter is that of insulators and their mode of fastening. In the present state of the art there can be no question about adopting a porcelain insulator, or at least a material which has the same general characteristics. The first line equipped in New York City used a built-up insulator, a bolt being covered with an insulating compound; it failed, and the type of insulator which had proved so successful at Washington was adopted. In Brussels the type of insulator used is a bolt surrounded by a rubber compound. This is subjected to a severe piercing test with a Ruhmkorff coil before being accepted. These insulators have been fairly successful, but they are expensive, and they may also deteriorate by exposure to the atmosphere. The iron-clad porcelain insulator is strong, durable, and cheap. There can be no hesitation about its use. The insulators should be vertical, so that they may not offer the chance for the accumulation of dirt, which can easily happen with one horizontally placed. The first Budapest road had its fault, but it was rectified in the later construction in that city. Assuming a vertical iron-clad porcelain insulator, the method of attaching it to the conduit construction becomes important, the depth of the tube being somewhat dependent upon this. For the sake of simplicity they should be fastened to the metallic structure, which has the further advantage of keeping the conductor bars at the same distance from the wheel rails, except in the special case of a centre-slot conduit, where the yoke construction does not permit the carrying of the wheel rails. The extreme positions of the insulator are: first, with the upper surface of the insulator as near the street surface as it can be for mechanical protection, or, say, 2in.; secondly, with the upper surface of the cast-iron insulator cover bolted directly to the bottom flange of the slot rail. Fig. 3 is an example of the former case. The insulator could have been reduced in vertical height so as to have carried the conductor bars higher, but this height is limited by the safe insulation distance required between these bars and the slot rail. Assuming this distance 3½in.—the depth of yoke seat diminishes it by about 1½in., leaving 2in. of air-gap—the top of the conductor bars will be 10½in. from top of a 7in. high slot rail. Fig. 4 is an example of the second case with the same slot rail. The insulator has been reduced in vertical height to the safe limit of mechanical strength. The corresponding distance to top of conductor bar is 14in., or a gain of 3½in. in the conduit depth for the first method of construction. If the insulators are carried close to the street level they must be protected by metallic covers, which in Europe are considered objectionable, and in some cases they are absolutely forbidden by the authorities, as in Paris. Therefore, the second method is the only one that can be used in such cases. Perhaps it should be said that the insulators are protected by metallic covers in the second case, but these are paved over so that the street surface is in no way altered in appearance by their use.

The limiting conduit depth being often a vitally important matter for the crossing of immovable sub surface constructions, it will not be amiss to take up this question more in detail. As just explained, the conductor bar carrying height is arrived at by adding the depth of yoke seat and the air-gap to the height of slot rail. It is possible that the height so arrived at will not give the necessary distance for a vertically-hung insulator and its mechanical protection. In this case the insulator determines the conductor bar carrying height. When this distance is determined, the height of bar itself, with the necessary clearance to the bottom of the tube, is added. The distance so determined gives the conduit depth. The

Fig. 1. *Side-Slot Switch.*

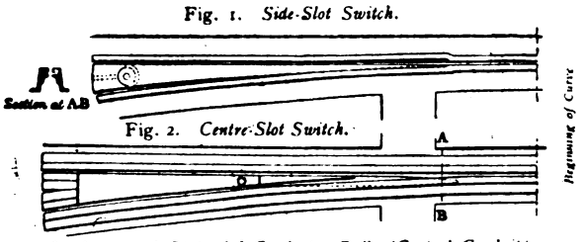


Fig. 2. *Centre-Slot Switch.*

Insulators and Suspended Conductor Rails (Central Conduit).

Fig. 3. *In Washington.*

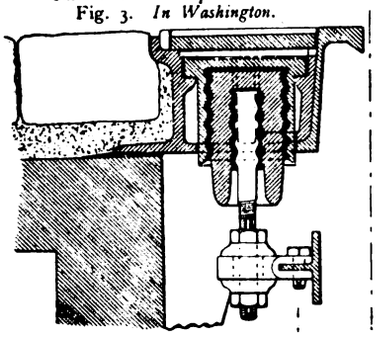


Fig. 4. *In Paris.*

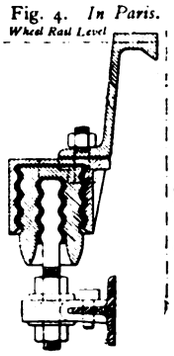
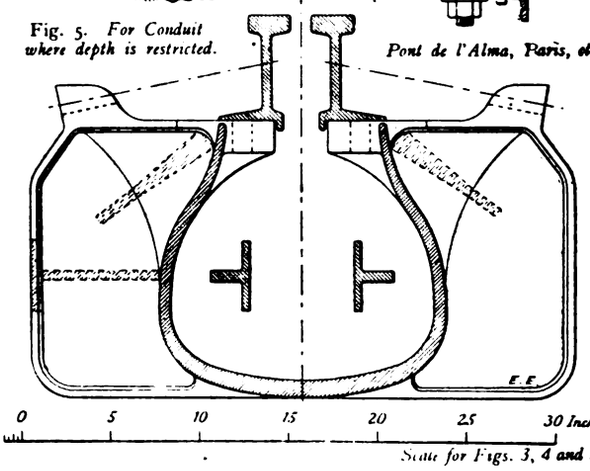


Fig. 5. *For Conduit where depth is restricted.*

Pont de l'Alma, Paris, etc.



Scale for Figs. 3, 4 and 5.

Special Shallow Conduit, Pont de l'Alma, Paris.

Fig. 6. *Section at Casting.*

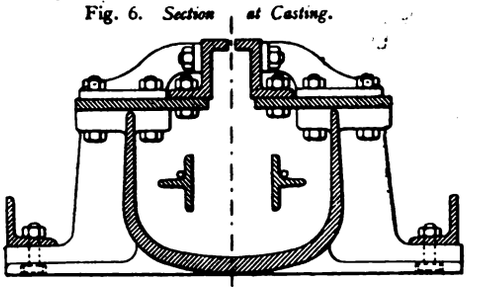


Fig. 7. *Section of Insulator.*

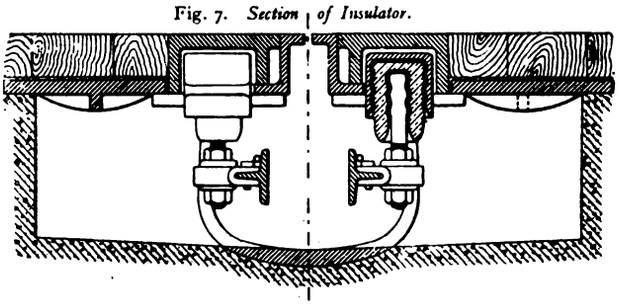
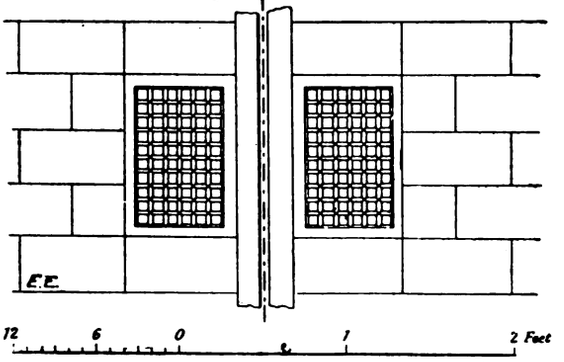


Fig. 8. *Plan.*



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clearance should be from 9in. to 10in. to allow considerable room for water and dirt accumulation, which might otherwise endanger the operation of the road. But for relatively short distances the clearance can be reduced to 4in., where the conduit must be reduced in height from any cause. The author has used this distance in a number of instances, and knows from experience that it is practically acceptable. Such lengths of conduits need cleaning often. Fig. 6 is an example of a shallow conduit which was designed for use on the Pont de l'Alma in Paris. The depth to top of conductor bars is 8in., the height of bars 4in., the clearance 4in., and the thickness of the cast-iron continuous tube $1\frac{3}{16}$in., or a total height of about 17in. Fig. 7 shows a section of the insulator at the same construction, and Fig. 8, a plan view, gives the appearance of insulator cover in the street. This construction, while entirely practicable, had the inconvenience in this particular instance of a different carrying height of conductor bars from the regular construction of the conduit. Special means would have been necessary to raise the plough on this stretch of the road. A careful examination showed that the construction given in Fig. 5 was practicable by slightly cutting the masonry arches, which was adopted. The conduit construction in this last case has a total depth of about 22in., with a 6in. slot rail and insulators bolted to their bottom flanges. The conduit shown is in actual operation, and it can be safely recommended for special cases where the depth available is restricted.

(To be continued.)

CATALOGUES.

The Simplex Steel Conduit Company, Limited, of London, Birmingham, and Manchester, have forwarded to us their new price-list for 1901. This we find is continually extending, as it occupies considerably more pages than the catalogue for last year. It is not so much in the bulk of their catalogue, however, as in the details of their apparatus that the Simplex Steel Conduit Company have made improvements. Certain of these improved details we are able to illustrate herewith. For

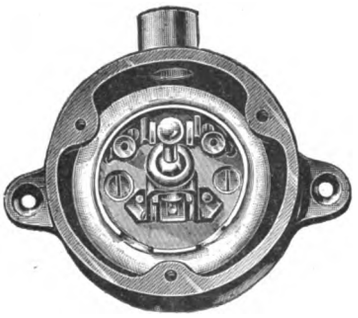

FIG. 1.

instance, in Fig. 1 is given a view of a watertight switch, which is designed for use with the screw Simplex conduit in position where the whole system is apt to be flooded in with water. In this figure the switch is shown with the cover off, while Fig. 2 shows the same switch with the

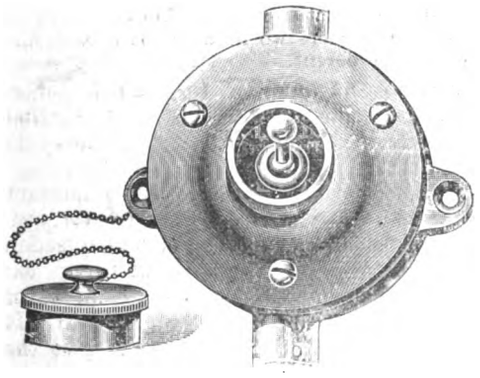

FIG. 2

cover on, but with the cap which protects the switch knob unscrewed. When the knob has been screwed on, the whole switch is absolutely waterproof. Another feature in which considerable extensions have been made, is the split connections for joining up lengths of tube. Thus Figs. 3 and 4 show respectively a tee and split bend designed on this principle. These are so arranged that the tubes are gripped tightly when the screws securing the two halves of the coupling are driven home. We also notice in glancing through the catalogue many improvements in the connecting boxes for use with the Simplex conduits, and also in the accessories, such as the connecting

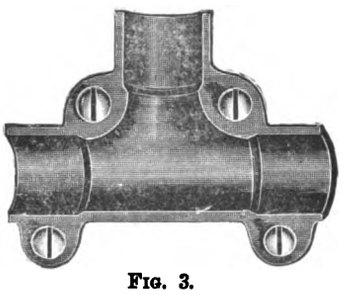

FIG. 3.

boxes for ceiling roses, etc. One great advantage of the company's system is the careful way in which they have standardised all their various parts, which greatly facilitates the erection of an installation, and also aids the company in giving prompt delivery.

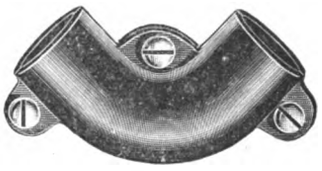

FIG. 4.

We have received a catalogue of the "Cupron-Element" primary battery, of which the Accumulator Industries, Limited, of 14, Silver-street, W.C., are the licensees. The cathode of this element consists of zinc, which is practically unattacked by the electrolyte when the element is not in use. The electrolyte consists of commercial caustic soda. The plates are not removed from the solution until the cell is completely exhausted, and this, according to the work for which it is used, may represent months, during which time the element is always ready to furnish a powerful and constant current. The consumption of material is low—about 1·25 grm. to 1·5 grm. of zinc only are consumed per ampere-hour furnished, and about 4 grm. of caustic soda. Although so low a voltage as ·85 may be considered somewhat of a disadvantage, this is counterbalanced by its low internal resistance. The main advantage of the "Cupron-Element," as against compressed copper oxide or any other forms of Laland element, is that after exhaustion it regenerates its anode, which may be used over and over again.

The Improved Electric Glow Lamp Company, which has its showrooms at 103, Queen Victoria-street, E.C., have forwarded to us an interesting little pamphlet on street-lighting, in which the subject of illuminating the public streets is dealt with in a way which will commend itself to all interested in such work. In the first place it is pointed out that in side streets the use of arc lamps is impossible owing to great cost, and that with incandescent gas the distribution of light leaves much to be desired, apart altogether from the cost of upkeep of the mantles. In order to secure a more uniform distribution of light between any two adjacent lamps, the use of reflectors is an absolute necessity. The pamphlet then deals with the best means of constructing these reflectors, with the not unnatural conclusion that they can well be made on the system designed by the Improved Electric Glow Lamp Company. We also gather from the pamphlet that Mr. Haydn T. Harrison has taken up the management of the street-lighting department of the company, which is worked from his office at 11, Victoria-street, Westminster, to which address communications on the subject should be sent.

APPOINTMENTS VACANT.

Clerk of Works.—The Colne Town Council will shortly advertise for a clerk of works, £2 per week.

Clerk and Canvasser, Bermondsey Borough Electricity Department, £140 per annum, April 15. Details in our advertisement columns.

Resident Engineer.—The Sutton Coldfield Town Council will shortly advertise for a resident engineer to superintend works, £200 per annum.

Electrical Engineer as Clerk of Works, Salford Corporation, to superintend the laying of cables, £150 per annum, April 19. Details in our advertisement columns.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

367. Wanted instructions for making a resistance at a moderate cost to break down from 220 to 55 volts for use with an arc lamp and capable of carrying a current of 70 amperes if required. It must be light, portable, and not liable to get out of order in travelling.—L. W. G.

368. A compound-wound traction generator, 200 amperes 500 volts, with six poles and carbon brushes, is run in parallel with a battery on the line. At regular intervals of six bars, black patches, covering from two to three bars, appear on the commutator. The battery has not been known to back on to the machine. Another machine of exactly the same size and make, which runs alternately with the machine in question, does not exhibit the above complaint. Give full explanation of cause.—J. C. P.

ANSWERS.

Question No. 361.—What percentage losses are in modern machines usually allowed (*a*) in the armature, (*b*) in the field windings; and to what extent are these allowances dependent upon the purpose of the generator?

Best Answer to No. 361 *(awarded* 10*s.).*—The losses in modern dynamos are invariably determined by the permissible heating and not by efficiency considerations, so that the loss stated as a percentage of the output of the machine is a somewhat indefinite quantity, and depends largely on the extent to which the machine is ventilated and on the speed. For the same reason the loss is practically independent of the purpose for which the dynamo is intended, except in the case of machines intended for intermittent work at considerable overloads, such as traction generators, traction motors, and crane motors. In this latter class of machine it is quite permissible to let the C^2R loss in both armature and field, at the maximum load, reach a value two or three times as great as that usual for a machine of the same size and intended to work continuously at normal load. The following table gives approximately the usual losses occurring in modern dynamos of various sizes running at usual speeds and intended to have a moderate temperature rise not exceeding, say, 70deg. F. after six hours' run at the load stated:

Full-load outputs in kilowatts.	Revs. per min.	Losses as a percentage of the full-load output. Armature. C^2R loss.	Armature. Iron loss.	Field. C^2R loss.
1	1,500	5 %	5 %	10 %
10	1,000	3½ %	3½ %	5 %
50	700	2½ %	2½ %	2½ %
100	500	2 %	2 %	2 %
500	250	1 %	1 %	1 %

The ratio of armature C^2R loss to iron loss varies somewhat with the number of poles used on the machine, but the total armature loss is not appreciably affected by this. When, for a given output, the speed is lower than that shown in the table, the machine is, of course, larger; and consequently for the same heating the losses will be a greater percentage of the output—*e.g.*, if the above 100-kw. machine is run at half speed (250 revolutions) to give 50 kw., the actual C^2R losses will remain unaltered, whilst the iron loss will go down to about half its previous value. The percentages will, therefore, be:

C^2R loss in armature.....	4 per cent. of 50 kw.
Iron loss in armature.....	2 per cent. of 50 kw. (approx.)
C^2R loss in field.....	4 per cent. of 50 kw.

—Q.

Answer to No. 361 *(awarded* 5*s.).*—When mechanical power is applied to a well-designed modern dynamo, by far the larger part will be delivered as electrical power at the terminals; the smaller part, which may be anything between 20 per cent. and 4 per cent., according to the size of the machine, will be absorbed in the dynamo in various ways, which may be stated as follows: (1) loss due to heating of armature winding; (2) loss due to field excitation; (3) loss due to hysteresis; (4) loss due to eddy currents; (5) loss due to air resistance and friction of the brushes; (6) loss due to friction of the journals. Now, if the generator be of large size, the total efficiency should be 96 per cent., and if the friction losses be put down as 1 per cent., the losses in the armature and fields will be 3 per cent., and this amount may be said to be equally divided between them.

The losses in the armature are three-fold, as shown above—viz.: (*a*) heating of armature winding; (*b*) hysteresis; (*c*) eddy currents in armature inductors. (*a*) and (*c*) can be to a very great extent minimised by a proper selection of the gauge and type of the armature inductors, and in large generators should not exceed 1 per cent. (*b*) is due to the rapid reversals in the magnetisation of the iron core, and has three functions—viz.: the number of reversals per second—*i.e.*, the speed of the armature; the mass of the core; and, thirdly, the extent of its magnetic induction. Now, while the hysteresis loss varies directly as the speed and as the mass, it increases very rapidly as the induction is pushed up nearer and nearer to the point of saturation; but this also affects the shunt, as a stronger field is required in order to obtain the high induction—that is, a greater magnetic force is necessary—and therefore more loss will result in the field coils.

If the generator is only of small size, say 1 kw., an efficiency of 80 per cent. will be fair; if of 10-kw. size, 88 per cent. efficiency at least should be obtained, so that it is evident that the size of the dynamo affects the value of the loss more than the purpose for which it is to be used. The fundamental rule of the conservation of energy applies equally in electrical as well as in mechanical engineering problems, and as lost energy cannot be annihilated, it must be dissipated in some degraded form, probably as heat. Now, a practical rough-and-ready rule is to allow 1·6 square inches for every watt dissipated in the fields, and 1·4 square inches for every watt dissipated in the armature, the smaller amount being used owing to its motion, and hence greater contact with cooling air. If, then, the cooling areas of the fields and armature are, as will often be found to be practically the case, in the ratio of 1·6 to 1·4, it may be taken that the efficiency of each is equal.

Providing the load of the generator is kept constant, it does not matter much for what purpose the dynamo is used; but if the machine is built to withstand occasional large overloads, as is the case with dynamos used for electro-metallurgical work, the losses in the armature under normal conditions must be kept very low, so as to permit of the overload being thrown on without the armature unduly heating.—M.

Question No. 362.—What is the practical method of calculating the air-gap reluctance of dynamos having slotted armatures? This little calculation is avoided in most text-books, and even in the one or two in which it does occur the results are widely different.

Best Answer to No. 362 *(awarded* 10*s.).*—This point has never been definitely settled, and probably few designers use exactly the same method. All are, however, agreed that some considerable addition must be made to the air-gap ampere-turns, calculated in the ordinary way, as for smooth-cored armatures—viz., using the whole pole-face area as the area of the air-gap and the radial distance from magnet iron to armature iron as the length of air-gap. The actual addition depends on the relative widths of the teeth and the slots, and the relation of width of slot to length of air-gap, but is independent of the depth of slot within the range of depths occurring in practice.

The commonest rule is to use an area for the air-gap equal to the average of the area of the pole-face and the area of the tops of the teeth under a pole-face, whilst the length of air-gap is taken as the actual radial distance from

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the tops of the teeth to the magnet iron. Thus, if A (Fig. 1) is the peripheral width of pole-face in inches; L the length of pole-piece or armature core parallel to the shaft in inches; a the peripheral width of a tooth; and t = the number of teeth under a pole-face + two teeth extra to allow for fringing of the magnetic lines at the edges of the pole-pieces, the effective area of air-gap would be

$$\frac{(A+[t\times a])\,L}{2} \text{ square inches} \quad . \quad . \quad . \quad (1)$$

and the number of ampere-turns required for the single air-gap, whose length is δ, would be

$$\cdot 313 \times \delta \times \frac{N}{(A+t\,a)\,\frac{L}{2}}$$

where N is the total flux per pole in C G.S. lines.

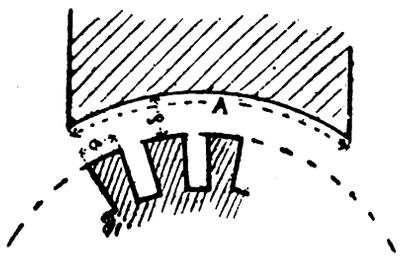

Fig. 1.

The above method gives fairly satisfactory results on the whole, but cannot be relied on in all cases, as it makes no allowance for changes in the relation of the width of slot to the length of air-gap, δ, though this ratio has a decided effect on the way in which the magnetic lines fringe out over the top of each tooth and into the sides of the slots.

A more accurate, though rather less simple, rule is as follows: Assume, what is more or less the fact, that the lines leaving the pole-face are divided up into alternate strips at a high density (opposite the tooth tops) and a low density (opposite the slot openings). The area of the whole of the high-density strips will be $t\times a\times L$ (Fig. 2), and the length of the gap will be δ. Assume, further, that the lines leaving the low-density strips enter the armature iron by a portion of the sides of the slots equal to $\frac{b}{2}$ inches (b being the width of a slot, as shown in Fig. 2), thus retaining a uniform area of air path from the point where they leave the magnet iron, up to the point where

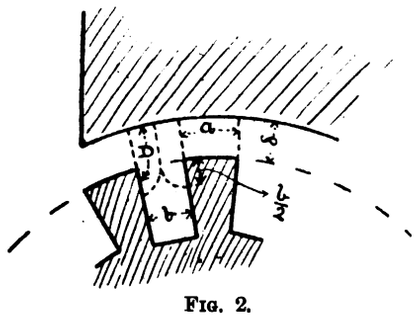

Fig. 2.

they enter the armature. The area of the whole of these low-density paths will be $t\times b\times L$, and the average length of such a path will be D (Fig. 2), and $D=\left(\delta+\frac{\pi\times b}{8}\right)$ We can now combine the high and low density areas into a single equivalent area with an average air-gap length = δ inches thus:

$$\left.\begin{array}{l}\text{Equivalent area of gap}\\ \text{reduced to a single air-gap}\\ \text{length of } \delta \text{ inches}\end{array}\right\} = (t\times a\times L)+\left(t\times b\times L\times\frac{\delta}{D}\right)$$

$$=t\,L\left(a+b\frac{\delta}{\left(\delta+\frac{\pi}{8}b\right)}\right) \quad . \quad . \quad . \quad . \quad (2)$$

The above assumptions are, of course, not absolutely correct, for the lines entering a slot, instead of confining themselves to a small portion of the sides of the teeth, enter at practically all points of the sides and bottom of the slot, thus increasing the average area of this path. At the same time the average length of the gap is increased by this distribution, and the two effects practically neutralise one another, and permit an accurate result to be obtained by the above method.

As an example of the different results given by methods (1) and (2), assume a machine with a pole-face A = 12in. peripherally and L = 12in. wide. Let the single air-gap $\delta=\frac{1}{4}$in., and let the width of a slot = the width of a tooth = ·4in. Then the number of teeth under a pole = $^{12}/_{\cdot 8}=15$, and allowing for fringing we get $t=17$. Then by (1) the effective air-gap area will be:

$$\frac{(12+17\times\cdot 4)\times 12}{2}=113 \text{ square inches};$$

whilst by (2) it will be:

$$17\times 12\left(\cdot 4+\cdot 4\,\frac{\cdot 25}{\cdot 25+\frac{\pi}{8}\times\cdot 4}\right)=132 \text{ square inches.}$$

—Q.

Answer to No. 362 (*awarded* 5*s.*).—Text-book methods of calculating the area of the air-gap with toothed armature vary considerably, as the questioner remarks, and most of them give a reluctance which is too high. The following method has never been published, but is based on well-known facts, and is very simple. When calculating the area of a gap with a smooth-core armature, it is necessary to allow for a "fringe" all round the pole-face of width equal to four-fifths of the iron-to-iron space. This figure was arrived at experimentally by Dr. Hopkinson, and is universally adopted. In the case of a toothed armature each tooth must be surrounded by a fringe of the same width. If the slots are not wider than 1·6 times the length of the gap, the fringes round two adjacent teeth will meet, and the area of the gap can be taken as if the core was smooth. It is interesting to note that this is about the limit of width of slot that can be used without producing serious eddy currents in unlaminated pole-pieces. This shows that with slots of this width the density in the air-gap is uniform, and therefore that the method of calculation is correct. In all properly-designed machines, then, unless provided with laminated pole-pieces, the armature may be considered as smooth for air-gap calculation. The correctness of the assumption has been proved by experiments on numerous machines. If a saturation curve be taken, and the calculated ampere-turns for the air-gap be plotted on the same diagram, the saturation curve should, at about one-third normal excitation, approach very near to the straight line showing the ampere-turns for the air-gap, as the ampere-turns for the iron part of the circuit then become almost negligible. This will show an inaccuracy of 2 or 3 per cent. in the calculated reluctance of the air-gap, and all the tests made showed the calculated values to be correct. This is the usual method of calculation. In the articles by H. F. Parshall on "Electric Generators," which appeared in *Engineering*, the area of gap is in all cases taken as for a smooth armature, and calculations by Mr. W. B. Sayers show the same assumption. The solution for any case is as follows:

Let l_g = length of gap;
" w_t = width of tooth at circumference;
" w_s = width of slot;
" p = pitch of teeth at circumference;

then $$p = w_t + w_s .$$

First calculate the area of the gap under the pole-face midway between the pole-face and armature surface, then add a fringe all round pole-face of width equal to $\cdot 8\,l_g$. This gives the area of gap for smooth core. Let this = A_s. If l_g is equal to or greater than $\frac{w_s}{1\cdot 6}$, A_s is the required area; but if l_g is less than $\frac{w_s}{1\cdot 6}$, then width of tooth plus fringe

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on either side equals $w_t + 1{\cdot}6\ l_g$, and area required $= A_g \times \frac{w_t + 1{\cdot}6\ l_g}{p}$.—J. W.

Answer to No. 362 (*awarded* 5*s.*).—The reluctance of any path is given by the equation

$$R = \frac{l}{\mu A},$$

where R = reluctance;
l = length;
A = area;
μ = coefficient of permeability.

Now, the coefficient of permeability being unity for air the only two unknown quantities are l and A; l is length of the path from the iron of the pole-shoe to the iron of the teeth of the armature core; but what will be the value of A? Messrs. Hawkins and Wallis give the following rule for the area of the air-gap for a smooth-core armature. If D be the diameter of the core, and l_g the length of one air-gap, the length of the arc subtending the polar angle at the mean radius of the air-gap is:

$$\lambda = \pi\ (D + l_g) \times \frac{\text{polar angle}}{360\text{deg.}},$$

and the effective area of the air-gap is

$$(\lambda + {\cdot}8 + 2\ l_g)\ (w + {\cdot}8 \times 2\ l_g);$$

where w is the width of the pole-piece parallel to the armature shaft. The quantity $\cdot 8 \times 2\ l_g$ is introduced in order to account for the magnetic fringe. Now, with a slotted armature the iron of the core is brought considerably nearer the iron of the pole, and hence the lines of force will flow almost perpendicularly from one to the other, so that the effective area will be $\lambda \times w = A$.

It might be assumed that if the slots are the same width as the top of the teeth, the effective area should be only half this; but this is not so, as the lines of force will not flow in tufts from the polar face, but equally all over this area, although they will tend to all congregate in the teeth of the armature core, and as the armature revolves they will be dragged round in the direction of rotation, and then snap across the slot. This dragging round will lengthen their path to a certain slight extent, but, on the other hand, there will be a certain amount of fringe which we have neglected, and one will counterbalance the other, so that we may write the reluctance of one air-gap as $R = \frac{l_g}{A} = \frac{l_g}{\lambda \times w}$. If the figures of any dynamo of which particulars have been published are carefully examined, it will be found that the above is the correct formula for the reluctance of the air-gap.—M.

ISLINGTON ELECTRIC LIGHTING.

The following is the report from the Lighting Committee of the Islington Borough Council, dated March 13, 1901, which comes up for discussion to-day:

We have considered your reference of Dec. 7, 1900, instructing us to report upon the machinery, plant, mains, and running of the electric lighting undertaking of the Council, and to employ, if in our opinion necessary, a consulting electrical expert for the purpose. We have not up to the present deemed it necessary to consult an electrical expert upon the points referred to us. We have viewed the electrical works belonging to the boroughs of St. Pancras, Shoreditch, Hampstead, and Hammersmith, and without wishing to in any way depreciate them, we have arrived at the conclusion that none of them will bear comparison with the works in Islington either as regards the durability of the buildings or the quality of the machinery. The system, capital expenditure, cost of working, receipts, and other important details of the undertakings ing these boroughs are compared with similar particulars in Islington in Table A, having been extracted from the several published accounts for the year 1899 by the borough treasurer for the purpose. It is apparent from this table that the reasons why the undertaking in Islington has hitherto failed to prove as remunerative as the undertakings in St. Pancras, Hampstead, and Shoreditch are mainly a small output and a relatively large expenditure in capital and wages. By "output" we mean the number of units actually sold, and while calling attention to the fact that this item is less in Islington than in either of the boroughs we have named, we deem it right to point out also that a much larger proportion of it is devoted to street-lighting, a mode of disposing of electrical energy highly advantageous from the public point of view, but owing to the difference in the price realised as between public and private lighting, and also to the extra cost the former entails in repairs, wages, cleaning, carbons, etc., one the least likely to yield pecuniary profit. In Islington, out of the total units sold in the year 1899, practically 50 per cent. was applied to street-lighting, while in Hampstead 8 per cent., in St. Pancras 14½ per cent., and in Shoreditch 22 per cent. only was used in this direction. The explanation of the relatively small output in Islington is that up to very recently the object of the undertaking has been to supply the more important business centres of the borough, and that not only are these scattered and at wide intervals, but their hours of consumption are limited during the winter months to an average of four or five hours per night, and in the summer to probably one or two hours. The result is that during the greater part of every 24 hours much valuable machinery and plant is lying idle and producing no return, while the remainder, devoted to street-lighting, is for the reasons previously mentioned, notwithstanding the fact that the demand for this purpose is fairly continuous, incapable of being supplied at the price the Council is at present paying so as to show a pecuniary profit. In both St. Pancras and Shoreditch there are, we were informed, considerable day loads, electricity being fairly in demand in both boroughs for driving machinery, while in St. Pancras and Hampstead, and especially in the latter borough, the consumption is largely by private householders, and spread consequently over many more hours than in Islington.

With regard to capital expenditure, a reference to the table will show that the Islington site was more costly than that in any other borough except Shoreditch, and very largely in excess of those in Hampstead and Hammersmith. Its area is 4,691 square yards, and in extending it it has been found necessary to purchase and remove a number of houses. The original advisers of the late Vestry were of opinion (wisely, we think) that, having regard to convenience and economy in the delivery of machinery, coal, and other materials, it was necessary to obtain a central station in immediate juxtaposition to a railway. The capital cost of the site, although it appears high, was, we submit, justified. The buildings consist of a double engine-house, having a total area of 1,519 square yards, and two boiler-houses, each having a total area of 943 square yards. There are also a full suite of offices, fitting shops, testing and switch rooms, converter and other stores, smithy, carpenters' shop, messrooms, etc. The buildings contain machinery and plant of a total capacity of 5,500 h.p. completed or in course of erection, and there is room for a further 5,000 h.p. without extension. There are two chimney stacks of sufficient capacity to take all the power required for many years. The principle which has been acted upon throughout has been to have regard to future requirements, so that in years to come, as additional machinery is required, the buildings can be further extended without interfering with the original structure. This and the fact that they are constructed throughout of the best selected brickwork and steel and cement concrete, so as to be practically fireproof, accounts for their costliness as compared with those in other boroughs. The machinery and plant include eight Lancashire and ten water-tube boilers, four engines and alternators of 250 h.p. each, three engines and alternators of 500 h.p. each, and three engines and alternators of 1,000 h.p. each; also pumps, water heaters, softeners, and other accessories, with switch-gear regulating appliances, instruments, and machine and other tools. Everything is of the highest quality and constructed of the best materials, with a view not only to durability and limitation of breakdown, but so as to facilitate repairs in the event of accident. The mains consist of cast-iron conduits, through which are drawn heavy double steel-armoured high-tension cables, which act as feeders to a series of transformers laid in boxes in the streets. The low-tension distributors, also steel-armoured, are laid in earthenware pipes. All the high-tension feeders are laid in the form of loops, each starting from the works and running thereto, while at intervals along the route switchboxes are fixed, enabling any portion of a main to be isolated should a fault occur, thereby limiting the interruption of current to a minimum number of consumers. This looping back of feeders is no doubt costly. The services into premises are connected from boxes in the street, instead of being soldered directly to the mains. This latter method, which is largely adopted in other districts, is much cheaper, but is a frequent cause of breakdown. The whole system of mains has been designed to specially meet the requirements of the Board of Trade.

Whether or not the extreme precautions which have been taken to ensure that the buildings, machinery, and plant shall be of the very best material, and perfectly sound, are justified will depend upon the point of view from which they are looked at—viz., that of immediate profit, or that of durability and the avoidance of accident—but of this we have no doubt, that in the latter respect they will bear comparison with any station in the kingdom. In working expenses we have included interest and repayment of loans, an item which has been

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TABLE A.

Borough.	System.	Number of consumers.	Number of units sold.	Receipts for the year.			Capital expenditure.			Working expenses for the year.					Net profit for the year.	Cost per unit sold.						Average receipts per unit sold.
				Private consumers.	Public lamps.	Total, including small additional receipts.	Site.	Buildings.	Machinery, mains, and plant, and all other expenditure.	Total.	Wages.	Coal, oil, water, and engine-room stores.	Repairs and maintenance of mains, building, engines, machinery, etc., including expenses of distribution.	Establishment charges, including rates and taxes.	Interest on and repayment of loans.	Total.	Wages.	Coal, oil, water, etc., and engine-room stores.	Repairs and maintenance of mains, building, engines, machinery, etc., including expenses of distribution.	Establishment charges.	Total costs.	Interest on and repayment of loans.	Total.	
				£	£	£	£	£	£	£	£	£	£	£	£	£	£	d.	d.	d.	d.	d.	d.	d.
Islington	Alternating current. High tension.	497	1,346 437	15,636	9,628	25,401	18,077	61,383	180,102	259,562	4,062	7,038	1,743	2,989	9,188	25,020	0·72	1·25	0·31	0·53	2·76	1·64	4·4	4·53
St. Pancras	Continuous current. Low tension.	1 184	2,477 508	37,790	6 640	44,726	16,085	43,464	228,598	288,147	4 397	10,475	7,523	4,682	10,807	37,884	0·42	1·01	0·73	0·46	2·62	1·05	3·67	4·33
Shoreditch	Continuous current. High tension.	595	1,630,426	16,771	5 144	22 036	31,205	15,041	124 137	170,383	2 746	8 363	2,623	2,166	5 575	21,473	0·40	1·23	0·39	0·32	2·34	0·82	3·16	3·24
Hampstead	Alternating current. High tension.	1,671	1 418,442	28,884	1,734	30,740	1,160	32,506	128,546	162 212	1,898	8 212	1,721	2,504	7 048	21,383	0·32	1·39	0·28	0·42	2·41	1·20	3·61	5·20
Hammersmith	Alternating current. High tension.	464	891,451	10 347	3,375	13,739	1,671	22,695	80,132	104 498	2 017	3 393	649	1,706	4,359	12,124	0·54	0·91	0·18	0·46	2·09	1·17	3·26	3·70

to some extent dealt with in our previous remarks, but as to which we think it right to add that but for the difficulty the late Vestry had in obtaining the consent of the London County Council to certain small loans for machinery necessary for the completion of extensions, those extensions would have been in working order and the £30,000 they cost would have proved remunerative during the year dealt with by Table A, instead of showing a dead charge of approximately £1,200. The result would have been to considerably reduce the cost for this item per unit sold. The question of wages is one that presents many difficulties. The expenditure under this head in Islington is, from any standpoint, high as compared with either St. Pancras, Hampstead, or Shoreditch. This is not the result of the "system," as will be apparent from a comparison with Hampstead, which, with a similar system and a larger output, expends less than half the amount in wages that Islington does. Neither is it to be attributed to any peculiarity of the machinery in use, which, as we have already intimated, is simple as well as effective in its working. Nor do we think that more men are employed than are necessary to the efficient working of the station if accidents and intermissions of supply are to be avoided. The real distinction between Islington and the boroughs we have named in the matter of wages is that the former pays a higher rate for labour than any other undertaking in London, and at the same time, contrary to the practice obtaining elsewhere, employs no apprentices or improvers. As regards the other working expenses, such as "coal, oil, water, and stores," "repairs," and "establishment charges," we submit that Islington compares favourably with other boroughs. We nevertheless hope to considerably reduce the cost of the first-named item when the new condensing plant is in full working order. The comparison is particularly favourable in the matter of repairs, and to emphasise it we submit particulars of the number of years each of the undertakings we have dealt with has been in existence, together with the average annual cost of repairs per unit sold in each. This is, we submit, the best confirmation that could be afforded of the wisdom of the policy adopted by the late Vestry with regard to the construction of the station and the class of machinery, plant, and mains employed.

In dealing with the working or running of the Islington undertaking, we refer first to the system. No doubt different systems find their different advocates, and while certain advantages may be claimed for one, others are admitted to belong to its rivals. It is, therefore, interesting to know that of 80 municipal electric undertakings in Great Britain 48 are high-tension similar to Islington, and 32 low-tension similar to St. Pancras, while, as appears from Table A, two other metropolitan boroughs (Hampstead and Hammersmith) have adopted the same high-tension system as Islington (as has Fulham, the most recently designed station in London). Shoreditch has adopted a continuous-current high-tension and St. Pancras alone a low-tension system. Apart from this testimony, we think that the alternating high-tension system is the best and most economical that could have been adopted for Islington, having regard to the size and conditions of the borough. The mode of laying the mains is peculiar to Islington, and, as we have already intimated, enables the mains so to be divided up as to limit the effects of an accident and to facilitate repairs, and we think it right to add that since the station was opened in March, 1896, only on four or five occasions have more than an individual consumer at a time been deprived of light, and that when these exceptional interruptions have occurred, they have been limited to at most eight or ten consumers. Further, no explosions or accidents of any kind have occurred since the installation.

We believe that we have now complied with the Council reference, but we venture to sum up this report by the following remarks: We are of opinion that as regards some of the recent extensions of mains made by the late Vestry it is doubtful whether for a considerable period they will prove remunerative, but having regard to the majority, we think that the Council may reasonably expect in the course of a year or two, when these shall have had time to get into working order and attract customers, to make a moderate profit upon their existing capital outlay, provided that for some time further extension of mains (especially in the direction of street-lighting *at its present price*) is avoided. We have no doubt that in the course of a few years the substantial character of the buildings and the quality of the machinery and plant employed in Islington will tell more to its advantage in the matter of profit as compared with the undertakings in neighbouring boroughs. We would not, however, have it go forth as the view of the committee that the object of the electric light installation belonging to Islington should be mainly one of profit. We believe that the sanitary, and even the moral effect, of securing a brilliant, wholesome, and cleanly illuminant for the streets and for the private use of the residents in the borough is worthy of consideration by a public body altogether apart from profit, and it is on these considerations we think the Council must base their justification as electric light undertakers.

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NEW COMPANIES.

The following companies have been registered since our last issue:

Kenworthy and Co., Limited.—Capital, £2,000. Object: to carry on the business of mechanical, electrical, and general engineers, etc.

Fairford and Cirencester Railway Company, Limited.—Capital, £3,000. Object: to construct, equip, acquire, own, and work railways, tramways, roads, tunnels, harbours, docks, and other works.

Derbyshire and Nottinghamshire Electric Power Syndicate, Limited.—Capital, £10,030. Object: to carry on in the counties of Nottingham and Derby (except those parts of the county of Derby which lie to the south of the River Trent, and to the north-west of the boundary between the unions of Bakewell and Chapel-en-le-Frith) and elsewhere the business of an electric power supply company.

Lahmeyer Electrical Company, Limited.—Capital, £100,000. Object: to carry on in all or any of their respective branches the businesses of electricians, electrical and mechanical engineers, contractors for the erection of electrical and other works and plant; also as manufacturers of and dealers in all kinds of machinery, plant, equipment, apparatus, and appliances used in connection with the generation, distribution, accumulation, and employment of electricity for the purposes of light, heat, or power.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Piatra Neamts (Roumania).—The Municipality invite tenders for the electric lighting of the town for 30 years. Tenders by April 25.

Tavistock (Devon).—The Urban District Council invite tenders for lighting the town from one to three years. Tenders by April 15. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for engines and dynamos, storage battery, and overhead travelling crane. Tenders by April 15. Details in our advertisement columns.

Motherwell.—The Electric Light Committee invite tenders for steam dynamo and switches, and steam, feed, and exhaust pipes, etc. Tenders by April 29. Details in our advertisement columns.

Colwyn Bay.—The Urban District Council invite tenders for a water-tube boiler, feed pump, injector, steam, exhaust, and feed pipes, etc. Tenders by April 13. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for six water-tube boilers and accessories. Preference will be given to straight-tube boilers. Tenders by April 27. Details in our advertisement columns.

Zagazig (Egypt).—The Local Commission invite tenders for the electric lighting of the town. Specifications, etc., may be obtained from the Public Works Department, Cairo, where tenders may be addressed until April 15.

Partick.—The Corporation invite tenders for the construction, supply, and erection of main switchboard and instruments and battery of accumulators and accessories. Tenders by April 29. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply and erection of main steam, feed, suction, and exhaust pipes, etc., and additional panels to traction switchboard. Tenders by April 26. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for poles, bases, refuge pillars, etc., brackets, feeder and section pillars, etc., trolley and other wire, and insulators and line suspensions. Tenders by April 30. Details in our advertisement columns.

Alloa.—The Electric Lighting Committee invite tenders for insulated cables, joint-boxes, etc., public arc lamps, lamp pillars, etc., and sub-station equipment and sundry connections. Tenders by April 30. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane, and workshop equipment. Tenders by April 22. Details in our advertisement columns.

Poole.—The Town Council invite tenders for connecting the Parkstone section of the borough fire brigade with electric calls. Specification, etc., may be seen at the office of Mr. John Elford, borough surveyor, King-street. Tenders by April 16.

Edinburgh.—The Corporation invite tenders for arc lamp carbons, cast-iron pipes, pavement and road box frames, and covers, etc., for their electricity supply stations for the year from May 15. Tenders by April 20. Details in our advertisement columns.

Poplar.—The Guardians invite tenders for the provision and carrying out of the necessary steam, exhaust, hot and cold water piping, valves, water-meters, etc., at their new works adjoining the union buildings in High-street, Poplar. Tenders by May 1. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, economiser, steam, feed, and other pipes, chequer plating, and sundry ironwork. Tenders by April 16. Details in our advertisement columns.

Croydon.—The Town Council invite tenders for the excavation and making foundations for an engine and generator at the Corporation electricity works, Factory-lane, Croydon. Specification, etc., may be obtained at the Borough Electrical Engineer's Office, Factory-lane, Croydon. Tenders by 18th inst.

Metropolitan Asylums Board.—The Board invite tenders for the supply and erection of a complete electrical generating plant and a complete boiler plant for heating at the asylum now in course of construction at Tooting Bec., S.W. Tenders by April 24. Details in our advertisement columns.

Southwark.—The Borough Council invite tenders for the supply, delivery, and erection of incandescent lamp brackets, switches, and fittings to 168 gas lamp-posts. Specifications, etc., can be obtained at the offices of Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S.W. Tenders by April 19.

Leeds.—The Lighting Committee invite tenders for steam, feed-water, exhaust, overflow, blow-off and other pipes, valves, hot-wells, feed-water pumps, economiser, etc., in connection with engines of 4,000 i.h.p. Specifications, etc., may be obtained from Mr. H. Dickinson, manager of the department, Whitehall-road, Leeds. Tenders by April 15.

Farnworth (Lancs.).—The Urban District Council invite tenders for taking up and removing existing pavement, excavation, concreting, and paving (labour) in connection with the laying of about four miles of tramway, single track. Quantities may be obtained from the engineer, Mr. W. J. Lomax, A.M.I.C.E., 11, Fold-street, Bolton. Tenders by April 15.

Middlesbrough.—The Electric Lighting Committee invite tenders for boiler-house plant—one 30ft. by 8ft. 6in. Lancashire boiler and accessories; engine-house plant—one 300-kw. high-speed steam dynamo and accessories, together with steam, exhaust, and feed pipes, etc.; condensing apparatus—ejector condenser, with circulating pumps. Tenders by April 30. Details in our advertisement columns.

Barrow-in-Furness.—The Corporation invite tenders for the supply of (A) paper-insulated, lead-covered concentric cables; (B) disconnecting and joint boxes, pavement covers; (C) cast-iron pipes, etc.; (D) earthenware conduits and pipes; (E) balancing transformer and switchboards. Specifications, etc., may be obtained upon application to Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness. Tenders by April 24.

Palencia (Spain).—Tenders are invited for the installation and working of a telephone system for not more than 20 years; 10 per cent. of the annual receipts will have to be paid to the Government. Tenders may be addressed to the General Post and Telegraph Department by April 21. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Battersea.—The Borough Council invite tenders for the carrying out of work in connection with the supply of water for condensing purposes to their central electric generating station, Lombard-road, adjacent to the River Thames, as follows: electric pumps, pipework, etc., for condensing water; river work, pipes, and pits for condensing water supply. Specifications, etc., may be obtained on application to the Town Clerk, Municipal Buildings, Lavender-hill, S.W. Tenders by April 30.

Portsmouth.—The Corporation invite tenders for supplying and laying telephone conduits and cables, copper wire, iron and steel stay wire, insulated wires, lightning and high-tension guards, arm bolts, nuts, and washers, miscellaneous ironwork, insulators, switchboards, batteries, telephone instruments, fixing subscribers' instruments, creosoted poles, oak arms, erecting poles, arms, stays, insulators, wires, etc., and silicium bronze wire. Tenders by April 30. Details in our advertisement columns.

Plymouth.—The Plymouth, Stonehouse, and Devonport Tramways Company invite tenders for the reconstruction of the existing tramway lines in Plymouth, Stonehouse, and Devonport, and the reduction of the gauge from 4ft. 8½in. to 3ft. 6in., and the bonding of the rails for electric traction. The rails, points, crossings, tie-bars, fishplates, fishbolts, copper bonds, and any granite setts that may be required will be supplied by the tramways company. Particulars can be obtained on application to Mr. John Glen, C.E., engineer, 11, Queen Victoria-street, London, E.C.

RESULTS OF TENDERS.

Halifax.—The Town Council have accepted the tender of the Chloride Electrical Storage Syndicate, Limited, Manchester, for supplying a battery of accumulators and regulation switch at £1,340.

Wolverhampton.—The Tramways Committee have accepted the tender of Callender and Co. for the supply and laying of feeders, conduits, and switch pillars for about five miles of tramway route at £6 710.

Colne.—The Electrical Committee have accepted the following tenders: J. Hawley, mason's work, £2,330. 2s. 3d.; Horsfield and Jackson, joiner's work, £351. 9s. 9d.; Greenwood and Batley, Leeds, 150-kw. steam dynamo, £1,562.

Burnley.—The Corporation have accepted the tender of the Barrow Hematite Steel Company, Limited, Barrow-in-Furness, for supply and delivery of steel rails required in the construction of about seven miles of double tramway track, at £16,387. 10s.

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Rotherham.—The Corporation have accepted the following tenders: Morgan, Monday, and Co., Alpha Electric Works, Sheffield, wiring the baths, £89. 15s. 6d.; Lomax, Kendall, and Co., St. James's-square, Manchester, wiring the free library, £54. 8s. 6d.

Fakenham.—The following tenders have been accepted: Messrs. Fryer, of London, supplying and laying cables and for conversion of lamp-posts, £592. 10s.; J. Needs, trench work, £379. 19s.; Messrs. Miller, Son, and Co., various works, £167. 10s. 2d.

Ayr.—The Town Council have accepted the following tenders for electric plant in connection with the electric tramways: Messrs. Cowans, Manchester, switchboard, £1,600. 7s.; Stirling Boiler Company, boilers, £2,471; Electric Power Storage Company, accumulators, £1,527; General Electric Company, Manchester, balancers and boosters, £525; Messrs. Alley and Maclellan, condensers, £1,220.

Hastings.—A tender of the British Westinghouse Electric and Manufacturing Company, Limited, has been accepted for the supply of 100 electricity meters immediately required, and of any additional meters which might be required during the ensuing 12 months. The company will supply the Westinghouse integrating wattmeter at the following prices—viz.: 5-ampere meters, £4. 9s. 8d. each; 10-ampere meters, £5. 4s.; 20-ampere meters, £6; 40-ampere meters, £7; and the Shallenberger integrating wattmeter at: 10-ampere meters, £5. 4s. each; 20-ampere meters, £6; 40-ampere meters, £6. 8s.

Southampton.—The Corporation have received the following tenders for supply and laying of insulated electric cables, frames, and covers, including excavation and reinstating of roadways, and also for three motor omnibuses:

St. Helens Cable Company, Limited, Warrington (accepted)	£868	9	4
Callender's Cable, etc., Company, Limited, London	891	13	4
W. T. Glover and Co., Limited, Manchester	917	17	5
Siemens Bros. and Co., Limited, Westminster	949	15	6
British Insulated Wire Company, Limited, Lancashire	951	8	10
Johnson and Phillips, Electric Cable Works, Old Charlton, Kent	1,034	5	1
Western Electric Company, North Woolwich	1,055	15	8
Telegraph Manufacturing Company, Helsby	1,508	5	0
Electrical and General Contracting Company, Limited	1,236	14	5
Motor omnibuses (each).			
Daimler Motor Company, Limited (to seat 12 persons and driver)	490	0	0
Motor Manufacturing Company, Limited (to seat 12 persons, excluding driver)	565	0	0
Motor Manufacturing Company, Limited (to seat 11 persons, including driver)	468	0	0
T. Coulthard and Co., Limited	600	0	0
Wolverhampton Cycle and Steam Motor Company (steam)	365	0	0
J. Harvey and Co. (steam)	650	0	0
Simpson and Bibby (steam)	600	0	0

BUSINESS NOTES.

TRACTION.

Plymouth.—The electric tramway to Compton is now in public use.

Colne.—It is anticipated that the Corporation light railway order will be signed forthwith.

Rovidge.—A report is being prepared on the question of providing a tramway for the town.

Swindon.—Colonel Yorke, Board of Trade inspector, has inspected the proposed tramway routes.

Blackburn.—The work of extending the electric tramways in the Audley district is to be commenced at once.

Yarmouth.—The Town Council have decided to proceed with the work of constructing the electric tramways.

Finchley.—The Urban District Council have sealed their consent to the Finchley and Hendon Tramways Bill, 1901.

Workington.—A meeting of burgesses has approved the decision of the Town Council to oppose the West Cumberland Tramways Bill.

Coatbridge (Scotland).—The only opposition which has been offered to the proposed burgh tramway as yet comes from Clarkston.

Batley.—The Town Council have approved the engineer's estimate for the construction of the tramways authorised by the Tramways Order, 1900.

Worcester.—The Corporation have signed the agreement with the tramway company as to the conversion to electric traction and the extension of the tramway system.

Rochdale.—The work of laying the tramways comprised in the authorised extensions is to be proceeded with forthwith, the work to be carried out by "direct labour."

Southend-on-Sea.—The Board of Trade have sanctioned the construction of tramways by the Corporation in the Leigh district, and the work will be proceeded with without delay.

Ayr.—It has been decided to lay a double tramway track from Elmbank-street to Bellersley-hill, subject to the consent of the proprietors on both sides of the road being obtained.

Carlisle.—At the last meeting of the Town Council a resolution was passed delegating to the Electricity Committee the control of the electrical equipment of the tramways of the city.

Houghton-le-Spring.—The Urban District Council have decided to insist upon their surveyor's advice in connection with the proposed new tramways being carried out by the company.

Penge.—The Urban District Council have decided against the scheme for an electric tramway in the district. The Croydon-road residents have petitioned against the traction proposals.

Wallasey.—The District Council have entered into formal possession of the tramway company's undertaking, the purchase price being £21,240. Major R. R. Greene is the new tramways manager.

Kinver.—The new electric tramways were opened to the public for the first time on Good Friday. The through fare from Coalbourn Brook to Kinver is 3d., but for intermediate stages there are four 1d. fares.

London United Tramways.—The trams have been running from Hammersmith to Kew and Shepherd's Bush to Ealing since Thursday week, and the extensions to Hounslow and Southall will be opened on July 1.

Southport—Altogether some 31,300 passengers were carried on the electric tramways on Good Friday, representing a total return of £145. On Easter Monday the passengers numbered 22,700, the total receipts amounting to £124.

Burnley.—The Tramways Committee have given instructions for steps to be taken for the sale of the cars, engines, rails, and accessories of the old company preparatory to the reconstruction and electrical equipment of the line.

Halifax—The Tramways Committee of the Halifax Corporation, having made an inspection of the tram routes to Queensbury and Shelf, have fixed the various stopping-places and the fares to be charged. The two routes are divided into three 1d. stages.

Automobiles.—The Local Government Board will be recommended by certain county councils at an early date to limit the speed of motor vehicles to 10 miles an hour. The Automobile Club is now organising an appeal against the suggested alteration.

Folkestone.—It is reported that the Board of Trade have intimated that the provisional order to construct tramways from the harbour to the boundary of the borough will be recommended to be approved. The order has, however, to be confirmed by Parliament in the autumn.

Barcelona.—The contract of the Barcelona Electric Railway Company, to which we have referred in various issues during the last few months, has been given to Messrs. Corady y Cia., and we learn that they are open to receive offers from manufacturers for engines, accumulators, and cars.

Cardiff.—A deputation, consisting of the Mayor, the electrical engineer, and other members of the Cardiff Corporation, has visited Portsmouth and inspected the tramways which have just been taken over by the Corporation of Portsmouth, and are being reconstructed for electric traction.

Sunderland.—The Town Council have sealed a memorial to the Board of Trade for leave to borrow a further sum of £31,000 for tramway purposes. It has been decided to run workmen's cars morning and evening upon all sections except the Christchurch section, at a fare of 1d. for any distance.

Dundee.—A tramcar accident occurred in Lochee-road on Saturday last which serves to illustrate the efficacy of the life-guard on the electric cars. A woman fell in front of a car, and being caught by the life guard was rolled along the ground for a short distance. Although stunned she was not otherwise hurt.

Salford.—Another branch of the work in connection with the electric tramways in addition to the laying of the new bonded rails has just been commenced—viz., the erection of the poles for the overhead equipment, which has been placed in the hands of Messrs. George Hill and Co., Trafford Electric Works, Manchester.

Drighlington.—The District Council have sealed their agreement with the British Electric Traction Company with regard to the tramway scheme. We learn that the company are now promoting a supplementary order with a view to getting powers to extend the scheme by running trams down Whitehall-road to join the Leeds tramways.

Bath.—A conference has taken place on the question of the proposed electric tramways between the Electric Traction Committee of the Urban Sanitary Authority and the promoters of the scheme. The latter have promised to use their best endeavours to get embodied in the order every one of the conditions agreed upon with the Council.

Barnsley.—The subject of the tramways which the British Electric Traction Company have guaranteed to construct within two years was raised at the Town Council meeting on Wednesday, when it was stated that there yet remained 18 months in which to complete them. Until that time expired the Council were powerless to do anything in the matter.

Huddersfield.—Major Druitt, of the Board of Trade, has inspected an extension of tramway from Fartown to Sheepbridge. The Corporation telephone wire at Westgate snapped on Friday last, and falling came into contact with the electric trolley wire and touched a horse in a trap. The horse plunged, and the people in the trap were thrown out, and one of them sustained a broken arm.

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Wigan.—We understand that the tramline to Martland Mill Bridge still maintains its average takings, and that there is not the slightest falling off in the weekly returns. With regard to the line in Wigan-lane, it is progressing very favourably, and should the weather allow of continuous work its opening before Whitweek may be anticipated. The work at the station also is within a very short period of actual completion.

Soothill Upper.—The British Electric Traction Company have approached the District Council with a view to ascertaining if the Council are willing to purchase that portion of the Dewsbury, Batley, and Birstall tramways as lies within the district of Soothill Upper, on condition that the traction company find the purchase money, and then for the Council to lease such line to the company for 35 years at £1 per annum.

Wednesfield.—A deputation from the Urban District Council has met the Tramway Committee of the Wolverhampton Corporation on the subject of extending the present tramlines in Wolverhampton beyond the confines of the borough to the village of Wednesfield. An arrangement has been come to by which the committee will apply for powers in an extension order to lay down a line from the Wolverhampton boundary to the bottom of New-street at Wednesfield, with further power to extend the line in future if so desired.

Shoreham.—At the last meeting of the Urban District Council, the Chairman referred to the meeting of delegates to consider the proposition of the tramway company to run the trams by electricity. He mentioned the decision to municipalise the undertaking and let the concern to a company for a period of years. It was the general opinion of the delegates, he said, that they could borrow the money and secure the control of the company and let it out at a profit. It had been decided at the meeting of delegates that each authority interested should appoint two delegates to go thoroughly into the whole matter.

Glasgow.—Lieut.-Colonel Yorke and Mr. A. P. Trotter, of the Board of Trade, accompanied by Messrs. Noble and Stewart, Post Office electricians, and Mr. Ballantyne, of the National Telephone Company, have inspected those sections of the Corporation tramways which have been converted from horse to electric traction, and on which cars will be running electrically before the opening of the exhibition. Little now remains to be done to complete the conversion of the whole of the system from horse to electric traction. So soon as the Pinkston power station is ready all the cars will be running by electricity.

Croyden.—The conversion of the tramway track for electric traction has now been carried out from the borough boundary at Purley to the south end of the town, and the work of constructing the lines at Norbury is being proceeded with. Progress is also being made in the matter of setting the poles for the overhead system, but we understand that some 12 or 15 months must elapse before the conversion of the old and the construction of the new lines for electric traction can be effected. When completed, the tramway will be something like six miles in length, and will serve a district long in need of such a means of communication.

Rotherham.—The Electricity Committee are negotiating with the tramways company on the question of entering into a working agreement with them for the supply of electric energy from the Corporation electric power generating station, and for a system of through traffic for tramway cars between the College yard and Rawmarsh. It will be recollected that the company recently agreed with the Rawmarsh Urban District Council to lease their tramways, and they are applying to the Light Railway Commissioners for an order extending the Rotherham and Rawmarsh tramway systems as far as Mexborough.

Blackpool.—The work of constructing the tramway along Central-drive is expected to be completed in three weeks' time, and the trams running by Whitsuntide. At the monthly meeting of the Town Council last week it was stated that the receipts for the year totalled to £30,658, against £22,590 for the previous year, an increase of £8,068, or 36 per cent. The committee had estimated that they would be able to hand over £10,700 to the relief of the rates, but so far as could be seen at present the profits would not exceed £8,000 or £9,000. The deficiency was attributable mainly to the adoption of the penny stage system and the bad weather.

Ilkeston.—At the last monthly meeting of the Town Council a letter was read from the North Ward Liberal Association requesting that tramways should be at once laid down from Park road to Bridge-street, Cotmanhay. It was resolved that the first section of lines should be laid along Bath street, South-street, and Nottingham-road, to the end of Thurman-street, and that electric mains should be laid for lighting purposes from the north end of Bath-street to the east end of White Lion-square. The engineer was instructed to prepare the necessary plans and specifications for these works immediately, and meet the committee with them.

Rickmansworth.—At the last meeting of the Urban District Council it was reported that those parts of the Tramway Bill affecting the Watford and Rickmansworth urban districts had passed second reading in the House of Lords. The part in the Watford rural district had been dropped because the Council had not given their consent to it. The promoters would, however, in May be able to apply under the Light Railway Act for powers to construct a light railway to connect the two districts. By taking this course it would not be necessary to get the Rural District Council's consent. The County Council had given such consent as was necessary to enable the promoters to do this.

Musselburgh.—Correspondence was read at the meeting of the Town Council on Tuesday which showed that the Council, on noticing the purpose of Edinburgh Town Council to apply for a provisional order for an extension of time for the construction of the projected tramway between Musselburgh and Portobello, had signified their willingness to support the promoting company. The Musselburgh Town Council had been advised to oppose the Edinburgh Corporation in the matter by petitioning against the order, but the Council had decided that more could be got by friendly negotiation than by such a course. The Provost and Land Committee were empowered to negotiate with Edinburgh Town Council.

Manchester.—We understand that the first of the Corporation electric trams will be running on the Cheetham-hill route about a month hence. The districts that will be next in order for an electric tramway service are the Rochdale-road and Bury New-road. Most of the cars will accommodate a total of 43 passengers inside and out, as against 41 in the present horse cars, but for seasons of extra pressure others of a larger size will be put on, with space for 67 persons. It is not intended to use trailers except in special emergencies. The Board of Trade regulations fix eight miles an hour as the maximum speed of electric trams; but for a time, until drivers become familiar with their duties, a much slower rate than this will be adopted.

Birmingham.—The Bristol-road tramway will be completed and ready for use in about three weeks. The first consignment of the new cars has arrived in the city. They are wider and loftier than the cars now in use, and are handsomely appointed. At night they will be lighted both inside and out by electric lamps. When the system is in full working order the company promise to give a three-minute service. The danger incidental to the breakdown of the crossing telegraph and telephone wires, and their contact with the live trolley wires, has been provided against. At the expense of the company the telephone wires have been insulated, and in all places of crossing there will be the additional protection of a guard wire. Crossing telegraph wires will be guarded against the possibility of contact by similar means.

Sheffield.—The Tramways Committee have resolved that the city surveyor be authorised, if the resolution of the Improvement Committee as to the widening and improvement of Weedon-street be confirmed by the Council, to proceed with the laying of the tramways between Tinsley and Brightside, in conjunction with the improvement and highway work in Weedon-street. The work of extension on the Intake route was commenced at the end of last month. The committee have expressed their willingness to transfer the sum of £5,000 out of the profits on the tramway undertaking to the Finance Committee to be applied in relief of the rates. The Tramways Committee have accepted Barrow steel for 1,500 tons of rails and fishplates. At the last meeting of the Town Council it was stated that the price of £7. 10s. a ton is a reduction of 5s., representing a total saving of £400.

Merthyr Tydvil.—Passenger traffic was commenced on Saturday morning last on the new electric tramways, which have been constructed for the subsidiary local company by the British Electric Traction Company, to connect the town with Dowlais and Cefn Bridge, in which district it will come within easy reach of an immediate population of 50,000 inhabitants. The Dowlais section is very steep, the gradient rising 341ft. in one mile two furlongs, and in one part there is a steep up-grade of 1 in 11. The capital of the Merthyr company has been fixed at £100,000, and the purchase price to be paid the British Electric Traction Company is £66 000. The service is being largely patronised. From figures to hand we gather that on Easter Monday over 12,000 passengers were carried, and on the two previous days the total number carried was over 16,000.

Railway Contracts.—The Westinghouse Electric Company of Pittsburg has been awarded the contract for the complete motor and control equipment of all the elevated lines of the Brooklyn Rapid Transit Company of New York. This system comprises over 30 miles of double-track railway, which is one of the largest elevated rapid transit systems in America. This contract was awarded to the Westinghouse Company after a long series of trials and tests, each competitor furnishing a number of sample trains. These trials and tests extended over a period of nearly three years. The other competing firms were the General Electric and the Sprague Electric Companies of America, each of which offered an electric system of multiple-unit control in competition with the electro-pneumatic system proposed by the Westinghouse Company. The above result is of direct importance to English railways, as the Westinghouse system which has been adopted by the Brooklyn Rapid Transit Company is the same as that which the British Westinghouse Electric and Manufacturing Company, Limited, has proposed for operating the trains of the Metropolitan and the Metropolitan District and other underground railways in this country.

LIGHTING AND GENERAL.

Durham.—The Council have commenced to put in the concrete foundations at their electricity works.

Wheatley.—The Urban District Council will offer no opposition to the Yorkshire Electrical Power Bill.

Warrington.—Mr. Mathias has been appointed chief assistant. Notice of a vacancy will be found in another column.

St. Peter's, Rome.—St. Peter's was illuminated for the first time with the new electric light installation at Easter.

Penge.—We understand that the Urban District Council have come to an agreement with a company for the electric lighting of the district.

Ilkley.—The District Council have obtained from Mr. Gibbings and others the total rights of their electric lighting order for the district for £150.

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Lewes.—A sub-committee of the Town Council has been appointed to ascertain the cost and other particulars of lighting the town with electricity.

Burnley.—The Rural District Council offer no objection to any of the ratepayers in Reedley coming to terms with the Corporation with respect to electric lighting.

Swindon.—The Town Council have accepted plans prepared by Messrs. Lacey, Clirehugh, and Sillar for buildings in connection with the electric generating station.

Rotherham.—It is expected that the electric light will be switched on to the various buildings prepared to take it in the last week in April or the first in May.

Limerick.—The No. 1 Rural District Council have agreed to support the resolution as adopted at the conference held *re* Shannon Power Bill, noted in a previous issue.

Ilfracombe.—The District Council have decided to transfer their provisional order for the electric lighting of the town to Messrs. Edmundsons' Electricity Corporation.

Manchester.—We are informed that all communications for the Corporation's electricity works are in future to be addressed to Mr. G. F. Metzger, the chief engineer.

Dewsbury.—The Chamber of Commerce have agreed to support the Yorkshire Electric Power Company on condition that the Dewsbury Corporation came to terms with them.

Motherwell.—The Town Council have decided to erect 30 additional arc lamps on the principal streets of the town, and to reduce the price of electricity for motive power.

Heckmondwike.—The District Council are engaged upon the building of an electric lighting station, and in all probability the township will be lighted with electricity next season.

Lytham.—The Electric Lighting Committee of the Urban District Council have decided that the question of proceeding with the lighting scheme should be left to the new Council.

Direct Spanish Telegraph Co.—The cable between Marseilles and Barcelona is now restored. Telegrams for Barcelona, etc., can again be sent by the rapid route "*vid* Marseilles."

Newmarket.—The District Council have refused to grant an application from the General Post Office for permission to erect telegraph poles and wires on Exeter-road and Moulton-road.

Wallasey.—Colonel J. T. Marsh has held an enquiry into the application of the Urban District Council for permission to borrow £12,300 for the purpose of extending the electric lighting system of the district.

Glasgow.—The Glasgow and South-Western Railway Company have completed their arrangements for taking their electricity supply for their St. Enoch Station and head offices and hotel there from the Corporation.

Arbroath.—At a meeting of the Town Council on Tuesday it was resolved to guarantee one-third of the sum required for seven years for the establishing of telegraphic communication between Arbroath and Auchmithie.

Exmouth.—A letter from a firm of electric lighting engineers, asking if the Council would take the electric current from a station about to be erected in the neighbourhood of Exmouth, is before the Electric Light Committee.

Fakenham.—A sum not exceeding £1,200 is to be expended in laying the necessary cables and erecting the necessary fittings for the purpose of lighting the town by electricity. The accepted tenders will be found in another column.

Brighton.—The Town Council have decided that the present electric lighting poles around the end of the Victoria Gardens shall be moved to the opposite side of the road, as it would be inconvenient to use the tramway poles for lighting purposes.

Yarmouth.—The Town Council have consented to the erection of a line of telephone poles to the golf-house on condition that they are made hollow, to be used as sewer ventilation shafts. The telephone company is to pay a yearly rental of 1s. a year for each pole.

Edinburgh.—The equivalent of 8-c.p. lamps applied for from March 14 to April 4 was 7,078 for lighting and 2,174 for motor power, making a total of 9,252 of 8-c.p. This demand constitutes a record, the applications for a similar period being usually about 4,000.

Longton.—A deputation of the Town Council is conferring with Mr. Menzies, the agent of the Duke of Sutherland, who has made a suggestion as to supplying the Corporation with electrical energy in bulk, they to undertake the distribution throughout the town.

Isle of Dogs.—The report mentioned in our last issue has now been considered by the Borough Council, who are becoming alarmed at the rapid increase of their lighting bill. As the result, the Council have referred the report back for further consideration.

Heywood.—The Electricity Committee have received 117 applications for the position of clerk of works for the electricity station. The following leet has been made: Messrs. W. S. Johnston, Sheffield; W. J. Baker, Bolton; and H. B. James, Manchester.

London Gazette.—At a recent general meeting of the Electrical Vehicle Syndicate, Limited, Mr. A. Holmes, Portland-road, Newcastle-on-Tyne, was appointed liquidator; and a receiving order has been made out *re* J. Brown, 28, Silksworth-row, Sunderland, on debtor's petition.

Bromsgrove.—The National Telephone Company's appeal against their assessments in North Bromsgrove and Stoke Prior has been settled. The Assessment Committee raised the telephone assessment in North Bromsgrove from £5 to £100, and the amount at which a settlement had been arrived at is £95.

Battersea.—The Lighting Committee have appointed Mr. J. E. Livsey to be chairman of the committee for the ensuing three months. Subject to a consumer's guarantee to take a supply of electricity for a period of two years, the mains will be extended to 1, Thurleigh-road at an estimated cost of £66.

Alfreton.—The Urban District Council last week, after discussing a communication showing that the Board of Trade would not grant an electric lighting provisional order applicable to the whole parish unless it was intended to light the whole parish, nevertheless resolved to restrict the area to the Alfreton Ward.

Carnarvon.—The Board of Trade have declined to grant a provisional order to a syndicate to construct electric lighting works in the town, in connection with which there was also a proposal to make a light railway along the shore to Dinas Dinlle. The application was opposed at the recent enquiry by the Corporation.

Keighley.—The electricity works erected by the Corporation are fast approaching completion, and it is expected that the formal ceremony of switching on will take place about the end of the present month. The electric lighting station and the town hall are already lighted by electricity generated by the Corporation plant.

Malvern.—At a special meeting of the Urban District Council last week a report by the surveyor upon the question of electric lighting and the erection of a refuse destructor was adopted. Mr. Maybury advised the Council to combine the two schemes, his estimate being £14,000 for electric lighting and £3,000 for the destructor.

Sheffield.—During the last six months there have been 29 cases in which the light has been cut off or had become defective. These defects were caused by water, which obtained access to the street boxes. The Electric Light Committee are now substituting overground for underground chambers in order to remove such interference.

Kirkcaldy.—The authorities are now pushing ahead with the various preliminaries concerning the carrying out of the electric lighting and tramway schemes. As for the former undertaking, the consent of the Secretary for Scotland has just been obtained for the borrowing of £50,000. Both schemes will be advanced simultaneously.

Spalding.—The Postmaster-General will extend the telephone system to Spalding and establish an exchange there if not less than 20 local subscribers are forthcoming. It is proposed to obtain communication with the trunk system by way of Boston. It is anticipated that there will be no difficulty in getting the number of local subscribers required.

St. Annes.—The electric lighting installation is now in use. The battery is not yet fitted, but this will be finished in a fortnight. Some 50 or 60 premises are at present wired ready for connecting up. It is anticipated that before Christmas the works will be fully loaded up so as to require extensions. The charge is 7d. and 4d. per unit on the maximum demand system.

Grimsby.—The Council have adopted a report of the Public Lighting Committee recommending that the charge to be made for the street arc lighting should be £20 per annum per arc lamp, each lamp to be lighted for 3,650 hours in the year. The gas lamps affected thereby will be discontinued. The Highways Committee is to be asked to make the road in the front of the electricity works.

New Publication.—The first number of *Traction and Transmission*, a monthly supplement to *Engineering*, published at 2s. net, promises well. Its pages, as one might expect, are largely devoted to the interests of electric traction, both home and Continental practice receiving attention. Several prominent questions relating to electric traction work generally are discussed in signed articles.

Oriental Telephone and Electric Co.—The directors have resolved to recommend to the shareholders, subject to final audit of the accounts, the payment of a further dividend of 8·40d. per share, free of income tax, making, with the interim dividend paid on Nov. 1 last, a total of 6 per cent. for the year ended Dec. 31, 1900. The transfer books will be closed from 15th to 26th inst., both days inclusive.

Gomersal.—At the last meeting of the District Council Mr. Knowles reported upon the result of the conference recently held at Leeds *re* the South Yorkshire Electric Power Company's Bill, and said he considered it would be advisable for the Gomersal authority before they took any action in the matter to ascertain what the Yorkshire Electric Company were prepared to do. This suggestion was accepted.

Glasgow Telephones.—The Glasgow Corporation telephone exchange has been opened. Only a small number of the subscribers were put in communication at first, but the numbers will be increased rapidly each day till the 4,500 who have subscribed are all connected. The sum sanctioned to be spent on the telephone installation was £121,000. Of this amount about one-fourth has already been expended.

Swansea.—The Electrical Committee are again endeavouring to solve the question of supplying the Harbour Trust with electric light at the cost which it is at present proposed by the Harbour Trust themselves—which they state at slightly under 1d. per unit. A sub-committee has been appointed to discuss the question with the Harbour Trust, with power to call to their assistance a third party to ascertain the present actual cost to the trustees.

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Trowbridge.—At the last meeting of the Urban District Council the Clerk read a letter from Messrs. Baker, Lees, and Co., dated March 19, stating that the Board of Trade had that day forwarded the order made by them with a request that they would lose no time in making the necessary deposits of the order in compliance with the rules, and publishing the notice in the local papers in which the original advertisement of the order was published.

Colchester.—The Council have decided to purchase from Mr. A. T. Osborne for £3,900 two properties adjoining the present electric lighting station, the total area being 797 square yards, for the purpose of erecting water coolers with condensing tanks, and to provide for the extension of the station, which will be necessitated at no very distant date by the growth of the undertaking and the intended construction of municipal tramways.

Barrow.—The County Council have decided to allow the incandescent street lamps to remain alight a quarter of an hour longer in the mornings of November, December, January, and February, without additional cost to the Highways and Lighting Committee. Applications having been received for supply to five houses in Ainslie-street and Oxford-street, an extension of mains of about a quarter of a mile in length will be made at an estimated cost of about £210.

Bath.—During the quarter ended March 25, 882 8 c.p. lamps were connected and 67 arc lamps. The total number of 8-c.p. lamps now connected to the mains is 28,573. In his last report, Mr. Metzger said that he had not the slightest doubt that the large increase of private lighting during the past six months and the doubling of the number of street arc lamps would give the long-desired credit balance on the working of the new financial year just entered on.

Stalybridge.—The question of providing a suitable site for a generating station in connection with the joint scheme of electric traction and lighting for Stalybridge, Mossley, Dukinfield, and Hyde was discussed at the monthly meeting of the Town Council. Application is to be made to the Board of Trade to nominate an engineer or inspector to decide the point, the different authorities having failed to agree to the Flatts site at Stalybridge, which was included in the original scheme.

St. Andrews.—At the last meeting of the Town Council a letter was submitted on behalf of Messrs. Crompton and Co., Limited, London, as to providing electric light for the burgh. The Provost thought it was high time they made up their minds on the subject. They should themselves apply for a provisional order and then make the best bargain they could with regard to the introduction of the electric light. The matter was remitted to the special committee for consideration and report.

Cardiff.—At a meeting of the Electric Lighting Committee on Thursday week a long discussion took place with reference to the proceedings pending against a Queen-street tradesman, who was charged with having illegally taken electric current from the Corporation supply. The committee had recommended that as the man had apologised the proceedings should be withdrawn, but the Council declined to adopt this view, and referred the matter back for reconsideration. The case is to be proceeded with.

Brandon.—The Urban District Council have under consideration a letter from Messrs. Pease and Partners, Limited, stating that the proposals of the Council had been submitted to the meeting of directors, together with the suggested terms by which Messrs. Pease and Partners were to provide and maintain the generating plant, and the latter had decided that, subject to suitable terms being arranged and a proper agreement signed, they were prepared to provide the necessary plant for lighting the district.

Middlesbrough.—At a meeting of the Electric Lighting Committee last week Mr. Clayden electrical engineer, reported on the probable revenue and expenditure for the incoming year up to March 31, 1902. The income was estimated to reach £3,600 and the expenditure on works, etc., £1,750. There would be a profit, leaving aside interest and redemption on £45 000, of £1,850. There would be a deficit after meeting all the payments for interest and redemption, etc., of £850. The chairman thought that was very satisfactory.

Darlington.—The last report of the borough electrical engineer states: "The number of consumers connected during the month is 11, making a total of 64. The number of 8 c.p. lamps connected during the month is 1,633 making a total of 5 510. I have applications from 24 intending consumers, who will require 1,404 8 c.p. lamps. The number of units generated during the month is 8,048, and 44½ tons of coal have been consumed, the cost of coal per unit being ·82d.; 150 yards of distributing cable has been laid in Langholm crescent."

Barry.—In accordance with the intention expressed by the District Council during the proceedings in Parliament in connection with the South Wales Electrical Distribution Bill, the Board of Trade were applied to for a provisional order granting the necessary power to supply electrical energy in their own district for private and public purposes to the Council. The order has just been granted with a view to its inclusion in a Confirmation Bill about to be introduced into Parliament and sought by the Council, which will embrace other matters of minor importance.

West Bromwich.—The Electric Lighting Committee have decided to lay a main along the Beeches road. They have obtained about 50 applications for electricity in that locality, and the estimated cost of putting down the main is £700, which will be defrayed out of the loan already sanctioned. It is stated, in connection with the expenditure in respect of the electrical undertaking, that probably considerably less than the £30,000 for which sanction was obtained will be required. So far as the work has proceeded, the committee are about £1,000 under their estimate.

Halifax.—The Town Council have confirmed the following minute of the Electricity Committee: "That from April 1 the charge for the supply of electricity for lighting purposes be at the rate of 4d. per Board of Trade unit to all consumers of under 7 500 units per quarter, and to all consumers of 7,500 units and upwards per quarter the charge be at the rate of 3d. per Board of Trade unit, with a discount of 5 per cent. on all accounts if paid within the prescribed time. That the charge for the supply of electricity for power purposes be at the rate of 2d. per Board of Trade unit."

Sutton Coldfield.—The Electric Lighting Committee reported at the last meeting of the Town Council that the contractors would shortly commence the laying of the cables, and as it was desirable that intending consumers should at the same time be in a position to have their house service connections made, it was, on the committee's recommendation, decided to make such house service connections free of cost to consumers where applications for a supply of current were made before a date to be fixed by the committee. It was also decided to appoint a resident engineer to superintend the works at £200 a year.

Brighton.—It has been decided to borrow £455 upon substituting electric light for 304 gaslights in the Pavilion. The undermentioned electricity mains are to be laid: 180 yards in Hartington road, at an estimated cost of £90; 80 yards in Bath-street, at £41; 140 yards in Park-street, at £59. 10s.; and 270 yards in Wellington-road, at £122. With regard to the lighting of the workhouse, which has given cause to so many angry debates it has now been decided to take independent expert opinion on the figures given by the Welsbach Company. Therefore the chance of the electric lighting scheme does not appear to be lost entirely.

James Keith and Blackman Company, Limited.—We are informed that the Blackman Ventilating Company have now acquired from Mr. James Keith, C.E., his business as heating engineer (with departments in gas and hydraulic work), carried on at 27, Farringdon-avenue, and at his foundries and engineering works in Arbroath. This union of two of the largest businesses in ventilating and heating respectively in this country rests largely on the essential dependence of these two branches upon each other for perfect development and successful use. The name of the new firm will be James Keith and Blackman Company, Limited.

Barnsley.—The Town Council on Wednesday decided to advance the salary of the borough electrical engineer by three yearly instalments of £50 each. The salaries of his assistants were advanced to £130 and £104 respectively. The output of the works during the first year has been 200,112 units or half as much again as it was expected that there would be at the end of three years' working. The department has met all charges, including two years' sinking fund charges of £685 a year, only one of which was really chargeable to the past year, and has a balance of £8 0s 11d. to carry forward. Nothing was drawn from the rates, and the charges for lighting have been reduced. Hitherto the charge had been 7d. per unit the first hour, 3d. per unit afterwards. It is now proposed to adopt alternative systems of charging 4½d. per unit, and 7d. per unit the first hour and 2d. per unit after the first hour.

Ambleside.—The Urban District Council have decided to transfer the provisional order to the Windermere and District Electric Supply Company, subject to the following clauses: (1) that the Council should have the right to purchase at the end of 15 years, the purchase price to be 33 per cent. above the value under Section 2 of the Act, and that they shall have the right to purchase at quinquennial periods afterwards, the 33 per cent. being reduced proportionately so as to expire altogether at the end of 42 years; (2) that the Council shall have the right to take over the company's works within their district at any time during the 42 years at a valuation, allowing nothing for goodwill, severance, or prospective profits, provided the company shall fail to give a satisfactory supply, or provided they shall charge more than they are charging to their ordinary consumers in Windermere or Bowness, the question of whether the right of purchase in this case has arisen to be decided by an arbitrator appointed by the Board of Trade.

Southend.—Lieutenant-Colonel A. C. Smith has held an enquiry into the application of the Town Council for sanction to borrow £40,030 for the purposes of electric lighting and £350 for the erection of shelters on the Lower Esplanade, Westcliff. The Town Clerk said there was a very great demand for electric lighting. The revenue account showed an estimated income over expenditure of £860, the total income being about £6,710. There was no opposition. An agreement has been arrived at with the telephone company, the chief clause of which is: "The company are not to be at liberty to place, fix, or maintain any pole or post in any street or public road or thoroughfare within the borough without the previous special written consent of the Corporation in each case." The company are to provide and maintain free separate telephonic communication with their Southend exchange from the town clerk's office, borough surveyor's office, accountant's office, medical officer's residence, piermaster's office, and the fire brigade station, with a right to communicate within the Southend area and outside that upon the ordinary terms.

Stockton.—A joint meeting of the representatives of the Corporations of Stockton, Middlesbrough, Darlington, Hartlepool, and West Hartlepool was held last week with regard to the opposition to the Cleveland and South Durham Electric Power Bill, which comes before the House of Commons Committee on the 24th inst.

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Mr. Balfour Browne, K.C., will lead for the promoters of the Bill, and the Hon. J. D. Fitzgerald, K.C., will appear for the Hartlepools and Darlington, with Prof. Kennedy as their electrical expert, and Mr. Bagley, K.C., for the Corporations of Middlesbrough and Stockton, for whom Mr. Hammond will give expert evidence.

Barnes.—The Consulting Engineer reported to the District Council last week that the chimney shaft was within 3ft. of the terra-cotta cap. The brickwork on all the boilers would be finished that week, plastering and plumbing work completed, and the painter and other trades all well in hand. Messrs. Siemens had delivered and fixed all the engines, and had also delivered the switchboard, which was in position. The fixing of the battery was being proceeded with, also the auxiliary plant and steam pipework. The cable work was nearly completed, and he had issued instructions for extending the distributing cable round Mortlake Green to the top of Guildford-place.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to City and South London Railway Company further issue of 10,000 ordinary shares of £10 each, fully paid, Nos. 60,001 to 70,000. The committee has been asked to allow Willans and Robinson, Limited, further issue of 10 000 ordinary shares of £5 each, fully paid, Nos. 80,001 to 90,000, to be quoted in the official list. The committee has appointed April 17 special day for Central London Company provisional scrip certificates, fully paid, for £698,201 4 per cent. debenture stock. The committee has also ordered the said securities to be quoted in the official list.

Electrical Trust.—The Montreal correspondent of the *Sheffield Daily Telegraph* on Friday wired that the Montreal Heat, Light, and Power Company is organising an immense trust for the purpose of monopolising all the electric power and gas business in and about Montreal. The capital of the trust is 25,000,000dol. The promoters say they can generate electrical power cheaper in Montreal than in any other place in the world. Immense new dams are being built at Chambly, and there will be an increase of from 8,000 h.p. to 30,000 h.p. in the power-houses within two months. Mr. James Ross, one of the directors of the company, has been attending to the financial part of the project in London during the past week.

Airdrie.—At the last meeting of the Town Council it was reported that the order for the electric lighting of the burgh had now been remitted to the Board of Trade. The Clerk reported that the 26 burghs who had petitioned Parliament against the electrical power companies' Bills had not been able to get any satisfactory arrangement of the clauses, and nearly all of them were arranging individually to oppose the Bill, not only on the clauses, but on the preamble. There were 15 burghs in exactly the same position as Airdrie and 11 who had installations of their own, and were opposing the preamble. The matter was remitted to the Road Committee with powers to take what steps may be necessary to protect the interests of the Council as to roads and pipes.

Worthing.—A plan has been approved showing the precise positions in which the arc lamps will be erected. The Council have agreed to the offers received from Messrs. Page and Miles, Limited, and Messrs. Bostel Bros., on the terms and conditions relating to electric wiring and fittings, and at the undermentioned rentals—viz.: Single lamps—9d. per quarter per lamp of 8 c.p., 16 c.p., 25 c p., or 30 c.p.; clusters of lamps—9d. per lamp per quarter for the first lamp, and 3d. per lamp per quarter for every other lamp in the cluster, where the cluster is controlled by one switch. If more than one switch is required for any cluster not exceeding three lamps, 9d. for each lamp per quarter; if more than two switches are required for any cluster above three lamps, the full charge of 9d. for each lamp.

Darwen.—Mr. Charles Garnett has been appointed as chief electrical engineer in succession to Mr. Stanley Clegg, who will leave Darwen shortly to take up duty as electrical engineer to the Lincoln Corporation. Mr. Garnett served his apprenticeship with Messrs. E. J. Dugdale and Co. in Manchester, and whilst with them he had considerable experience in central-station work, for, among other important work, he was engaged on extensions to the city of Manchester power station—work that eminently fitted him for the charge now devolving upon him. From Messrs. Dugdale's establishment he went to the private lighting station of a large shipping and wharfinger firm in Manchester as chief engineer, and after that he was appointed as an assistant to the engineer to the Oldham Corporation, whence he came to Darwen. We wish him every success in his new sphere.

New Issue.—The Charing Cross and Strand Electricity Supply Corporation are making an issue of £250,000 4 per cent. debenture stock at par. The Company has an authorised capital of £800,000, of which £500,000 has been issued, and has power to supply electric energy in the parish of St. Martin in-the-Fields, the area formerly under the authority of the Strand District Board of Works, part of the area recently included in the St. Giles' district, and in the city of London. That undertaking is being worked as a separate branch of the Company's business, and the necessary works are being constructed by the Charing Cross and City Electric Company, Limited, to whom the requisite capital is being supplied by this Corporation by way of loan. In addition contracts have been made with various local authorities who are to be supplied in bulk from a station at Bow. The Corporation proposes to use the proceeds of this issue for the following purposes: for the building and equipment of the sub-station at St. Martin's-lane; the erection of a larger general office; extension of mains; for the purpose of advance of capital to the Charing Cross and City Company; and for provision of additional working capital.

Belfast.—The Gas and Electric Committee having considered the reference to them regarding the supply of current to Messrs. Harland and Wolff, Limited, have resolved that the principal committee be recommended to offer to supply current to Messrs. Harland and Wolff on the following terms—viz.: the maximum demand to be not greater than 1 000 e.h.p. (746,000 watts), delivered at the Council's main terminals, at Messrs. Harland and Wolff's works, Queen's Island; the minimum quantity to be paid for to be 2 100,000 units per annum; the price for the first 1,000,000 units per annum to be 1½d. per unit; the price for the additional 1,100,000 units per annum to be ¾d. per unit; a contract to be entered into to take the above supply for seven years. Subsequently it was resolved that further consideration of the terms of supply current to Messrs. Harland and Wolff be postponed for the present. This resolution has been confirmed by the Council.

Seaford.—The Council have approved of the application for a telephone license by the Eastbourne Corporation for a local exchange area to be coterminous with the Eastbourne parliamentary division. The General Purposes Committee's last report acknowledges the receipt of a letter from the Board of Trade, stating that an extension of time to June 30 had been granted to the undertakers of the provisional order for the supply of electricity in the district of Seaford; and that if the provisional order were transferred to the local authority they could enter into a contract with any company or persons for the execution and maintenance of the work. A letter was received from Mr. Edward Bedford, stating that the syndicate accepted the terms offered by the Council for the transfer of the provisional order. The Board of Trade also wrote stating that any conditions for the transfer of the provisional order which might have been agreed upon in the draft deed of transfer must be submitted to the Board of Trade by the undertakers for approval. Letters were also received from F. J. Warden Stevens offering to introduce a company for carrying out and maintaining works for the supply of electricity in the district of Seaford.

Cheltenham.—Colonel Langton Coke has held an enquiry into an application for a further loan of £6 150 for electrical purposes. Up to the present sanction has been obtained to raise £122 000, and £110.000 of this has actually been spent. The present application is to provide additional plant (including two traction generators for the supply of traction power to the tramway company) and for main extensions. The borough electrical engineer stated that in 1896—the first year that the works had been in operation—the number of customers for the light was 101; now the number was 490. The units sold to private customers in the first year were 47,000; the number at present was about 300,000. Commencing with two arc lamps, the number of such lamps now in the streets was 260, and it was intended to bring the total up to 440. As to the working profits of the undertaking (exclusive of interest and sinking fund), there was a deficit of £620 on the first year, the next year a small profit was made, in the following year a profit of £1 250 was made, in the succeeding year the profit was £2,150, and in the next roughly £3,300. Details of the proposed expenditure having been given, the inspector closed the enquiry, no one being present to object to the outlay.

Hammersmith.—The last report states that 23 additional consumers have been connected, representing a maximum of 1,376 8 c.p. lamps; these added to the number previously reported, show a total of 847 consumers taking current from the mains. A report was also submitted relating to a letter from the Secretary of the General Post Office, stating that the Postmaster-General is unable to accept certain of the conditions attached by the Council to their consent to the opening of roads for laying telephone cables; that the Postmaster-General, whose works are for the benefit of the public, has a statutory right to the use of the streets, and cannot agree to restrict his right to such user by the acceptance of conditions which are not imposed by the Telegraph Acts; and that he was bound by statute to make good any damage done in the laying or maintenance of his telegraphs, and to pay all reasonable expenses of keeping the street or public road in good repair for six months after the same is restored, so far as such expense may be increased by the opening or breaking up of the street. It is not proposed to take any action upon this letter. Application is to be made to the London County Council for loans for carrying out the undermentioned works: condensing scheme, £10,000; new electric cable (Hammersmith-road, etc.), £900. A loan of £13,530, part of the loan of £15,500, is to be taken up at once; the term of payment is 42 years. We notice that the Council have been obliged to give instructions for three summonses to be taken out against consumers in respect of the non-payment of accounts for electric current supplied for the quarter ended Dec. 31 last.

North Shields.—The new electric works erected by the Tynemouth Corporation have been opened by the Mayoress of Tynemouth (Mrs. Jacob Daglish). The plant consists of three large Lancashire boilers, with superheaters and economisers, and three 300 h.p. engines and dynamos, and is sufficient to supply about 15,000 lamps and the tramways as at present worked. One of the principal features of the station is a Klein water-cooling tower, which obviates the necessity for large ponds, and was supplied by Mr. E. F. Jarvis, of Middlesbrough. The engines were made by Messrs. Belliss and Co., of Birmingham, and the dynamos by Messrs. Holmes and Co., of Newcastle, and the Westinghouse Company. The mains were laid by Messrs. Siemens Bros., of London. Messrs. Lacey, Clirehugh, and Sillar were the consulting engineers, and Mr. Charles Turnbull, the

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resident engineer, superintended the erection of the works. At the opening ceremony Councillor Irvin traced the history of the undertaking from 1891, when the provisional order for lighting the town by electricity was first obtained. In 1899 the matter came prominently before the Corporation, especially in reference to the tramways. Having described the works, he said the Corporation had ordered another engine of 1,000 h.p., which would practically duplicate the present power station. They were equipped for any demands that might be made in the town either for motor power or electric lighting purposes. The light was giving every satisfaction, and they expected the work for the first year would something like pay itself, if not absolutely leave a profit. The Mayoress was subsequently presented by Councillor Irvin with a handsome gold brooch set with diamonds and rubies, the centre cluster of diamonds representing an electric lamp.

COMPANIES' MEETINGS AND REPORTS.

BROMLEY ELECTRIC LIGHT.

The annual meeting of shareholders was held at Bromley last week, Mr. F. E. Gripper presiding.

The report stated that the progress made by the Company during the year had been satisfactory, the lamp connections in Bromley having increased from 7,337 to 13,395, whilst 4,987 were being supplied in Chislehurst. The sale of current had increased from £2,358 to £4,044. The result of the year's trading, including the balance of £1,020. 18s. 2½d. brought forward from last year, showed a profit of £3,029. 5s. 11d., and after payment of debenture and loan interest amounting to £1,945. 14s., and writing off the whole of the preliminary expenses amounting to £243. 15s. 8d., the amount available for dividend was £835. 6s. 3d. The directors recommended the payment of a dividend at the rate of 4 per cent. for the year, and that £400 be placed to a reserve fund for the renewal of plant, leaving a balance of £125. 13s. 2d. to be carried forward. Large extensions had been made to the works during the year, the buildings having been enlarged, and additional engine and boiler power added, and a large condensing plant put down, which would enable a considerable reduction to be made in the coal consumption.

The **Chairman**, in moving the adoption of the report and accounts, said the average price they had obtained for the light this year was only 4⅞d. per unit—4·7d.—while last year it was a little higher, being 4·81d., so that they had been selling the current at a slightly cheaper price than last year. The cost of the current was only 2·7d. this year, while it cost 3·1d. last year, so that they had made a considerable reduction in the cost of production, having produced a good deal more, and he hoped that next year they would find that the cost would be considerably less, because they would produce still more and coal would be cheaper.

Mr. D. Grinsted seconded the motion.

In reply to questions, the **Chairman** said that now they had about 20,000 lamps connected, and the present station, when fully equipped, would be sufficient to supply 60,000 lamps.

The report was ultimately adopted, and a dividend of 4 per cent. declared.

CITY OF LONDON ELECTRIC LIGHTING.

An extraordinary general meeting of the shareholders of this Company was held at Winchester House on Wednesday for the purpose of confirming resolutions for altering the Company's articles of association which were unanimously passed at a general meeting of the Company held on the 21st ult.

On the motion of **Mr. G. Herring** (the chairman), seconded by **Mr. F. W. Reynolds**, the resolutions were unanimously agreed to.

Sir David L. Salomons, Bart., having resigned his seat on the Board in consequence of ill-health, Mr. George Herring has been unanimously elected chairman.

BABCOCK AND WILCOX.

At the general meeting of the proprietors held on Wednesday at the Company's offices, Farringdon-street, E.C., **Mr. John Dewrance**, who presided, remarked that in the first balance-sheet issued since the reconstruction of the Company there were one or two changes in form. The reserve fund of £130,000, on which they prided themselves in the old company, had unfortunately been ruled out in the reconstruction of the Company, but it was now represented by certain assets which had been purchased by the new Company. They would now start a new reserve fund by placing the profit made in the interval of reconstruction, the 10s. premium on the new issue of £90,000 of shares. The year had been one of exceptionally hard work, and he hoped the shareholders would be satisfied with it. He moved the adoption of the report and accounts.

Sir Wm. Arrol, M.P., seconded the motion.

In reply to shareholders, the **Chairman** said there were not wanting a great many croakers who thought we were on the brink of a great depression in trade. Personally, he did not think so, and he was of opinion that when the political atmosphere cleared there would be an increase. But if there was to be a shrinkage the Company would be well able to bear it. As to their maritime boilers they had enormous hopes. They had had great encouragement by the fact that the Boilers Committee of the Admiralty had placed the Company's name at the head of the list. That recommendation had already borne fruit, and he hoped it would continue to do so. More than that he could not say at present.

The motion was agreed to.

FOLKESTONE ELECTRICITY SUPPLY.

In our last issue we gave an abstract of the report of the directors of the above Company for the year ended Dec. 31, 1900. Herewith we give abstracts of the revenue account and general balance sheet, and statement of electricity generated, sold, etc., for the same period.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£1,794	14	6			
Oil, waste, water, and stores	139	15	11			
Proportion of salaries	345	0	0			
Wages and gratuities	376	3	9			
Repairs and maintenance	292	11	8			
				2,948	5	10
Distribution of Electricity.						
Proportion of salaries	30	0	0			
Wages and gratuities	160	10	9			
Repairs, etc., of mains	1	18	8			
Repairs, etc., of transformers, etc.	13	17	5			
Repairs, etc., at distributing stations	5	3	8			
				211	10	6
Public Lamps.						
Attending and repairs	62	6	4			
Renewal of lamps	200	6	2			
				262	12	6
Rents, Rates, and Taxes.						
Rents payable	41	18	6			
Rates and taxes and insurance	261	7	9			
				303	6	3
Management Expenses.						
Directors' remuneration	375	0	0			
Salaries	415	11	5			
Salaries of collectors	15	18	0			
Stationery and printing	188	17	9			
General establishment charges	174	6	4			
Auditor of Company	5	5	0			
Auditor under the order	23	19	4			
				1,198	17	10
Special Charges.						
Preliminary expenses incurred				62	14	8
Balance carried to net revenue				2,930	5	2
				£7,917	12	9

Cr.	£	s.	d.
Sale of current, less discounts	5,828	19	3
Public lighting	1,550	1	5
	7,379	0	8
Rental of meters and other apparatus	120	8	6
Rents receivable	36	10	0
Transfer fees	5	0	0
Sundry fees for testing, etc.	3	13	6
Profits on installations	373	0	1
	£7,917	12	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	75 000	0	0
Sundry tradesmen and others	2 057	4	1
Sundry creditors on open accounts	950	18	6
Balance at credit of net revenue account	2,345	2	4
Reserve fund account	400	0	0
Temporary loans	2,000	0	0
Suspense account—balance of debenture premiums	99	9	7
	£82,852	14	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	75,150	2	6
Hire-purchase installations	1,963	4	6
Stores on hand	1 025	15	5
Sundry debtors for current supplied	3,294	13	9
Other debtors	74	13	10
Cash at bankers and in hand	1,344	4	6
	£82 852	14	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		515,566
Quantity sold { Public lamps	89,976	381,776
Quantity sold { Private consumers by meter	291,800	
Quantity used on works		133,790
Total quantity accounted for		515,566
Number of public lamps		66
Total maximum supply demanded (kilowatts)		322·6

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT.

The report of the directors to Dec. 31 last states that the Company commenced the supply of electricity from its own generating

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station on Feb. 14, 1900. This was much later than was originally intended, and the delay involved a serious loss of revenue. Part of this loss—to the extent of £1,200—has been recovered from the contractors as compensation for delay in the delivery of the machinery. The business is steadily increasing. The number of lamps connected on Feb. 14, 1900, was equivalent to 5,957 of 8 c.p., and on Dec. 31 was equivalent to 14,473. During the same period the number of consumers increased from 132 to 342. On March 31 the connections amounted to an equivalent of 16 520 8-c.p. lamps, and applications for a further 4,907 8-c.p. equivalents have been received, making a total of 21,427 8-c.p. connected and applied for. The issue of 4½ per cent. debenture stock, to the amount of £100,000, authorised in July last, was fully subscribed. The generating station having been in operation for less than a year the accounts show but a small profit, but the increasing demand justifies the directors to expect a profitable development of the Company's business in the immediate future.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The directors' report for 1900 states that the total receipts on revenue account amounted to £127,097 and the expenditure to £89,137, leaving a balance of £37,960. After providing for debenture interest and placing £3,000 to credit of renewals fund, there remains £16,911 at credit of net revenue account. An interim dividend of 3 per cent. on the "A" preference shares was paid in October last, absorbing £6,000, and the directors now recommend additional dividends on the "A" preference shares of 3 per cent., making 6 per cent. for the year, and on the "B" preference shares of 2½ per cent. These will take £9,437, leaving a balance of £1,474 to be carried forward to the next account. The arrears of the cumulative dividend on the "B" preference shares amounted on Dec. 31 last to 17 per cent. (17s. per share). Deducting the dividend now recommended, the arrears will amount to 14½ per cent. If the improvement in the traffic receipts experienced since the completion of the electric equipment of the line be continued, as there is reason to expect, the directors hope to be able to further reduce these arrears out of the working of the present year in addition to meeting the full "B" preference dividend for the year. Horse traction was not entirely superseded by electric traction until Sept. 10 last, so that the disadvantage of the concurrent working of both systems of traction prevailed for the greater part of the year. The average premium on gold in 1900 was 131 per cent., as compared with 125 in 1899. The above report will be submitted to the meeting to be held on the 19th inst.

PROVISIONAL PATENTS, 1901.

MARCH 27.

6383. Improvements in protectors for overhead electrical tramway wires. Leonard Cooper, jun., 55, Market-street, Manchester.

6393. New or improved means or apparatus to be employed in or for the covering in or fixing of roofs to the tops of electric tramcars. Charles Henry Wilkinson, Market-place, Huddersfield.

6396. Improvements in telegraph apparatus. Oscar August Berend, 2, Basinghall-avenue, London.

6403. Improvements in automatic electric circuit breakers. August Eckstein and David Barclay Mellis, Peel Works, Adelphi, Salford, Manchester.

6445. Improvements relating to switch mechanism more especially applicable for use in electric motors. Harry Lamm, 45, Southampton-buildings, Chancery-lane, London.

6454. A new or improved grid or electrode for retaining plumbic oxides in accumulators to prevent disintegration during charging and discharging. Edward James Clarke, 165, Queen Victoria-street, London.

6460. Improvements in electrical signalling appliances for steam, electrical, and other railways. Rudolf Bartelmus, 6, Bank-street, Manchester.

MARCH 28.

6531. Improvements in electric ignition devices for explosion motors. Bryson Milligan Turner and Richard Tilden Smith, 46, Lincoln's-inn-fields, London.

6554. A new or improved means of varying the current in electrometers. Charles Ashley Carus-Wilson and Edward Henry Tyler, Norfolk House, Norfolk-street, Strand, London.

MARCH 29.

6587. Improvements in watertight electric bells. August Eckstein and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

6594. A new or improved method of and apparatus for connecting electrical wires or conductors. Walter Henry Weguelin, 77, High-road, Willesden Green, London.

6597. Improvements in apparatus for use in wireless telegraphy. Sidney George Brown, 9, Putney-hill, London.

6615. Improvements in arc lamps. Hugo Bremmer, 18, Buckingham-street, Strand, London.

6617. Improvements in charging devices for electromobiles. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Caryl D. Haskins, United States.) (Complete specification.)

6620. Improvements in drying electric cables and other goods, and in apparatus therefor. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

6624. Improvements in and relating to automatic magnetic circuit breakers. William Robert Lake, Southampton-buildings, Chancery-lane, London. (William Maxwell Scott, United States.)

6635. Improvements in and relating to automatic magnetic circuit breakers. William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (William Maxwell Scott, United States.)

6645. Relay for telegraphic purposes. Christian Albrecht Theodor Jensen and Hermann Samuel Reimarus Sieveking, 77, Chancery-lane, London.

6648. Improvements in the process of electrically pulverising metals. William Longman, 16A, Tokenhouse-yard, London. (Paul Bary, France.)

6649. Improvements in heater cut-outs and holders for electrolytic incandescent lamps. John Robert Quain and Thomas Thomson Turnbull, 25, Gladsmuir-road, Whitehall Park, London.

MARCH 30.

6660. Improved double-action electric bell. Bertil Brander, The National Telephone Company's Factory, Nottingham.

6663. Improvements in electrical measuring instruments. Crompton and Co., Limited, and William Arthur Price, The Arc Works, Chelmsford.

6720. Improvements in means for driving dynamo-electric machines. Alfred Atkinson Jordan and Albert Charles Oakes, 6, Bream's-buildings, Chancery lane, London.

6728. Improvements in means for applying the active material to the plates of storage batteries. Theodore Pescatore, 322, High Holborn, London.

6739. Improvements in and connected with the distillation or utilisation of tar, pitch, petroleum, and other hydrocarbon mixtures, and the extraction of carbon suitable for the manufacture of electrodes, calcium carbide, and other industrial products. Leon Gaster, 37, Essex-street, Strand, London.

APRIL 1.

6757. An improved electric fire alarm, which might also be applied to notify overheated bearings in machinery. Ebenezer Barnard and Harold George Steadman, Stour Cottage, Christchurch.

6760. Improvements in electrical switches. Arthur Denby Smith, Sunbridge-chambers, Bradford.

6776. Improvements in alarm apparatus for engine-room telegraphs or the like. Alfred Ward Higgs and the Anti-Collision Alarm Telegraph Company, Limited, 34, Castle-street, Liverpool.

6786. Improvements in vessels for use with electrical liquid resistances. Hugo Hirst and Henry Bevis, 71, Queen Victoria-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on April 27.

1900.

146. Starting or controlling apparatus for electric motors. McGurty and McEwan.

2219. Measurement of electric power and energy. Arno. (Date applied for under International Convention, July 5, 1899.)

6244. Plates for secondary electric batteries and electrodes for electrolytical purposes. David.

6564. Reflectors for electric incandescence lamps. Gaertner.

6866. Electricity distribution on the multiple-voltage system. Spence.

7784. System of distribution and collection of current for electric traction. Davis.

8111. Parts of telephone instruments. British Electric Works Company, Limited, and Brander.

9061. Electric brakes for electrically-propelled vehicles. Newell.

9263. Electric heaters. Alexander Ritchie Leask and Percy Morgan Belliss.

9579. Telephonic apparatus. Veysey. (Date applied for under International Convention, Oct. 24, 1899.)

10361. Flexible electrical conductor from any point of which a current may be taken. Halford.

10363. Electric contacts. Halford.

13967. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Rice.)

22692. Electric ignition devices for explosion engines. Osborn and British Motor Traction Company, Limited.

1901.

2433. Apparatus for disinfecting the transmitters and receivers of telephones. Axtell.

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3047. Apparatus for regulating pressure in electric mains connected to storage batteries. Highfield.

3288. Dynamos and other electromagnetic machines. Howitt and P. R. Jackson and Co., Limited.

3313. Purifying beverages and liquids by means of manganates under influence of the electric current. Thompson. (Soc. Mangano Electrique pour la purification des eaux et des boissons.)

3388. Contact-makers for electric igniters. Thompson. (Boiron.)

3397. Commutator brushes. Siemens Bros. and Co., Limited, Dumas, and Palairet.

3576. Electric switches or couplings. Spies and Norden.

4768. Electric bell circuit for mechanically-driven ploughs. Meissner.

TRAFFIC RETURNS.

Line	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Apl. 6	589	593	- 4	—	—
Birmingham Trams.	,, 6	4,209	4,280	- 71	55,727	—
Blackburn Corp'rat'n	,, 5	533	417	+ 116	5,622	5,013*b*
Blackpool Corporatn.	,, 4	150	—	—	150	—
Blackpool-Fleetwood	,, 6	384	206	+ 178	2,268	2 279
Bolton Corporation..	,, 7	1,699	1,017	+ 682	18,442	—
Bradford City Trams	Mar. 24	800	350	+ 450	9,167	4,189
Bristol Tramways Co.	Apl. 5	4,027	2,738	+1,289	—	—
Carlisle Tr'mw'ys Co	,, 6	169	—	—	—	—
Central London Ry.	,, 6	5,654	—	—	84,889	—
City & South London	,, 7	1,793	1,380	+ 413	28,144	17,319
Cork E. T. and L. Co.	,, 4	380	322	+ 58	4,621	4 127
Dover Tramways ...	,, 6	221	160	+ 61	2,219	2,028
Dublin & Lucan E.R	Mar. 30	78	73	+ 5	923	763
Dublin U.T., elec. cars	Apl. 5	3,205	5,016	* - 1,809	—	—
Dublin S.D. Electric	,, 5	714	1,753	* - 1,039	—	—
Dundee Tram Co. ...	,, 3	532	369	+ 163	21,608	17,164
Glasgow Corporation	,, 1	8,347	8,985	- 438	—	—
Halifax Corporation	Mar. 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	,, 30	701	601	+ 100	36,050*b*	32,953
Hull Corporat'n E.S.	Apl. 6	1,724	—	—	1,600*b*	—
Liverpool Corporat'n	Mar. 30	8,079	7,173	+ 906	101,733	87,283
Liverpool Overhead	Apl. 7	1,607	1,317	+ 290	20,813	19,454
Portsmouth Corpn...	,, 6	575	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 7	3,316	—	—	—	—
Southampton Trams	,, 4	624	369	+ 255	—	—
Southport Corporat'n	Mar. 30	*a*405	—	—	7,416*d*	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. *b* Since April 1, 1900. *d* From July 18, 1900.
* Queen Victoria's Visit, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Barcelona, £170 increase.

Barcelona Ensanche y Gracia, £53 decrease.

Brisbane (Feb. 20), £107 increase.

Buenos Ayres and Belgrano Electric (month of March), £3,258 increase (?).

Calcutta (April 6), £38 increase.

Cape Town (month of February), receipts, £13,594; expenditure, £5,712.

Mexico Electric (month of March), receipts, £17,150; expenditure, £9,900.

Perth Electric (April 5), £460 increase.

Port Elizabeth (month of February), receipts, £3,043; expenditure, £1,803.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Railways.—		
Central London, Ordinary	10	9-9¼
—— Pref. Half-Shares	5	4¾-5¼
—— ,, ,, deferred	5	4-4¼
City and South London, Consolidated Ordinary	100	46-50
—— Ordinary	18	4-5 xd
—— 4 per cent. Debenture Stock	100	112-117
—— 5 per cent. Pref. Stock '91	100	132-137
—— ,, ,, '96	100	122-127
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
Waterloo and City, Ordinary	100	94-97
Telephones.—		
National Telephone, Ordinary	5	3¼-3⅜
—— 6 per cent. Cum. First Pref.	10	11-13
—— 6 per cent. Cum. Second Pref.	10	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-4⅝
—— 4 per cent. Deb. Stock, Red.	100	96-99
—— 3½ per cent. Deb. Stock, Red.	100	90-93
Oriental Telephone and Electric Company	1	¾-1¼
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-120,000	1	⅞-1 xd
British Electric Works, Ordinary, 50,001-95,000	1	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	100	85-90
British Insulated Wire, Ord., 1-70,000	5	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	100-105
British Westinghouse Elec. and Manf., 6 per cent. Pref.	5	4¼-5
Brush Electrical Engineering, Ordinary	2	1⅝-1⅞
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	103-106
—— 4½ per cent. 2nd Debenture Stock	100	101-103
Callender's Cable, Debentures	100	109-113
—— Ordinary	5	15-16
—— 5 per cent. Pref.	5	5⅛-6
Crompton and Co.	2	2¼-4
—— 5 per cent. Debentures	—	100-103
Edison and Swan United, Ordinary	2	1½-2
—— 5 per cent. Debentures	5	¾-4
—— 4 per cent. Deb. Stock, Red.	100	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	94-98 xd
Electric Construction, Limited, Nos. 1 to 112,100	2	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-120,000	1	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	15-16
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	101-104
Telegraph Construction and Maintenance	12	37-41
—— 5 per cent. Bonds	100	101-104
Telegraph Manufacturing, Ordinary	5	11-12
—— 5 per cent. Cum. Pref.	5	5¼-6 xd
Willans and Robinson, Ordinary, 1-80,000	5	11⅝-12⅛
—— 6 per cent. Cum. Pref., 80,001-90,000	5	6¾-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	70-75 xd
Bournemouth and Poole, Ordinary	10	11½-12½
—— 4½ per cent. Cum. Pref.	10	10-11
—— Debenture Stock, Red.	100	101-104
Brompton and Kensington, Ordinary	5	7⅜-8⅛
—— 7 per cent. Preference	5	8¼-8⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	6¾-7⅛
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5⅝
Chelsea Electricity Supply	5	5⅜-6⅛
—— 4½ per cent. Debentures	100	109-111
City of London, Ordinary	10	7-8
—— 6 per cent. Cumulative Pref.	10	12-13 xd
—— 5 per cent. Debenture Stock	100	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	101-103
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	106-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	4¾-5⅛
—— 6 per cent. Cum. Pref.	5	5½ 6
—— 4½ per cent. First Mort. Deb.	100	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4¾-5⅛
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-5⅝
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7¼-8¼
Kensington and Knightsbridge and Notting Hill	100	103-105 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10½
London Electric, Ordinary	3	1¾-1⅞
—— 6 per cent. Pref.	3	3¾-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	98-101
Metropolitan, Ordinary	10	11½-12¼
—— ,, 85,001-98,769	5	9-10
—— 4½ per cent. First Mortgage Debenture Stock	100	110-113
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Notting Hill Electric Lighting	10	15½-16½ xd
Oriental, 1879	1	1⅛-1⅜
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	5⅛-5⅝
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	8¾-9⅛
River Plate Electric Light and Traction, Deb.	100	65-75
Royal Electrical Company of Montreal	$100	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	102-104 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2-2½
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	13¼-14½
—— 7 per cent. Pref.	5	8¾-9¼
—— 3½ per cent. Deb.	100	93-101
Westminster, Ordinary	5	11½-12¾
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2¼-2½
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	4¼-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	100-102
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10	11½-12¼
—— 5 per cent. Perpetual Debenture Stock	100	119-122 xd
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¼-5
—— 5 per cent. Deb. Stock, Red.	100	104-107
—— Prov. Cert., all paid	100	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	1⅛-1⅜
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	98-102
Kidderminster and District Lighting and Traction, Pref.	5	3¾-4
London Street Tramways, Nos. 1-31,000	4	1-1⅛ xd
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	102-104
New General Traction, Ordinary	5	3-3¼
—— 6 per cent. Cum. Pref.	10	4¾-5⅛
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	107-109

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NOTES.

City and Guilds of London Institute.—We are pleased to note that his Majesty the King has graciously consented to become patron of this institute, of which, as Prince of Wales, he has occupied the position of president since 1881.

Society of Arts.—His Majesty King Edward, who, as Prince of Wales, has been president of this society since 1863, has now graciously consented to become patron of the institution. The King's profile will also continue to figure on the medals of the society.

Books Received.—We have received a copy of the second and revised edition of Mr. Stuart A. Russell's work, entitled "Electric Light Cables and the Distribution of Electricity," published by Messrs. Whittaker and Co., of Paternoster-square, E.C., at 10s. 6d.

Practical Engineering.—The award of certificates to successful students of the Crystal Palace Company's School of Practical Engineering for the Easter term took place yesterday in the lecture theatre of the school. Mr. R. E. Cooper, a member of the council of the Institution of Civil Engineers, occupied the chair. In the course of the afternoon a number of the visitors availed themselves of the opportunity to inspect the several departments of the school.

Arc Lighting for Sponge Fishing.—We learn from a note in the *Scientific American* that a submarine electric arc light will soon be experimented with to aid in the sponge fishery off the coast of Florida. At present the sponges are obtained only from a comparatively small depth, as the sponge fishers can only see to a limited distance by the aid of a water glass, and if this distance could be increased larger areas would immediately be opened up where sponges have been growing unmolested for years.

Franklin Institute Journal.—The April number of the *Journal* of the Franklin Institue, of which we have received a copy, contains the continuation of the interesting paper by Mr. George W. Colles on "The History, Theory, and Characteristics of Rotary Transformers." The paper on "Apparatus for Power Distribution from Central Stations," by Mr. Charles F. Scott, which was read before the institute just 12 months ago, is also printed in this issue, which also contains some notes on "How should Boiler Heating Surfaces be Calculated?"

Chemical Society.—A ballot has been taken on the proposal to change the day and hour of the ordinary meetings of this society to Wednesday at 5.30 p.m. In all, 1,900 cards were issued to Fellows, and 1,000 answers were returned. Of these, 581 were unreservedly in favour of the suggested change, while an analysis of the replies of those Fellows who have contributed papers to the society shows that 188 have voted for the change, and 78 against it. On the face of these figures, we may expect to hear that the meetings in future will be held on the day and hour given above, although it is not so stated in the *Proceedings* of the society which gives the report of the committee appointed to enquire into the matter.

Traction Accumulators.—According to the *New York Journal*, Mr. Edison has succeeded in making a new accumulator which is ever so much lighter than the older types, in which the active materials employed are lead oxides. According to the paper in question, Mr. Edison uses plates of copper and cadmium separated by asbestos sheets. Only a small quantity of liquid is said to be required, and it is also stated that for equal outputs the new accumulators only weigh half what lead accumulators do. The other advantages claimed are durability and cheapness, but all these are, of course, subject to trials under commercial conditions. We should have been more pleased if the news of Mr. Edison's success with a copper-cadmium accumulator had come through a technical paper.

Electricity in Building Work.—We are pleased to note that Messrs. Turner and Sons, who are erecting the new town hall in Cardiff, are introducing electrical plant to aid them in the construction of this large building. A 25-h.p. steam-engine is to drive a dynamo, from which the derricks, of which six will be required in various parts of the building, will be worked. We gather from the note in the local paper that this is the first time that the firm have tried electrical driving, but we see every reason to believe that they will save very largely by so doing. The use of one boiler instead of six is in itself a great saving, and there will also be no need to hoist coal and lower ashes. In this alone considerable economy will be effected, but for ease of control, and also speed of hoisting materials, we should expect still further advantages beyond the money actually saved.

Polytechnic Conversazione.—The annual conversazione and prize giving of the South-Western Polytechnic Chelsea, S.W., will take place to-morrow evening, when Sir Wm. H. Preece will distribute the prizes and certificates to the successful students of the evening classes and day colleges for men and women. This will also be made the occasion of the formal opening of the fine new buildings of the polytechnic. Amongst the attractions of the evening will be lectures on "Wireless Telegraphy," by Mr. W. H. Eccles; on "Modern X-Ray Photography," by Mr. Frank J. Addyman; and on "Great Achievements of Engineering," by Prof. Pullen; while two concerts are arranged for by the Polytechnic Choral Society and Orchestra respectively. The whole of the laboratories, engine-rooms, workshops, etc., of the polytechnic will be open to inspection during the evening, and "cooking by electricity" is among the subjects to be demonstrated. The chair will be taken at 7.30 p.m. by Mr. R. C. Antrobus.

Cost of Electrical Power on Railways.—With a view to showing how cheaply electrical power may be generated for electric railways, the *Street Railway Review* gives a very comprehensive table of figures from four stations in the States. In each case the output was measured by a wattmeter. The most favourable instance gives the total cost of electrical output per kilowatt-hour at ·289d., made up thus: ·168d. for fuel; ·64d., labour; ·016d., supplies, oil, etc.; ·015d., water; and 026d. for repairs. The monthly output (kilowatt-hours) is extremely large, the figure being 2,109,400. The quantity of water used is put at 5·50lb. per pound of coal, and the lubricating oil ·50 gallon per 10,000 kilowatt-hours. For the same output 1·35 gallons of cylinder oil are necessary. In all four cases bituminous fuel is used, taking 1·25lb. per kilowatt-hour, the cost of which is 6s. per ton of 2,000lb. In the other three instances given in this table the total cost per kilowatt-hour is stated to be ·292d., ·324d., and ·320d.

Trinidad Indiarubber.—On Tuesday last at the Colonial Institute, Sir H. E. H. Jerningham, K.C.M.G., read a paper on "Trinidad and its Future." Amongst the interesting experiments which are being tried in Trinidad is the growing of indiarubber on a large scale. We gather from the remarks in the paper that the indiarubber trees, which have been planted on an 8,000 acre estate, have not yet reached the stage at which they can be tapped for indiarubber. The company owning them, however, is in the meantime making profit out of cocoa and cocoanut

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trees, which on certain parts of the estate will be removed when the indiarubber trees are matured. The author quoted the opinion of Prof. Bovallius to the effect that the land in certain parts of Trinidad was quite as favourable to the growth of Heavea and Castillca as any ground he had seen on the Orinoco River. We trust that the experience of this company will induce others to plant up estates in order to supply the ever-increasing demand for indiarubber.

High-Voltage Transmission Lines.—A short note in the *Railway and Engineering Review* states that a company in California, which controls several power-houses, and is supplying electric current to towns and mining districts in Yuba and Nevada counties, has nearly completed a line to Oakland and San Francisco that will be 140 miles in length. On some of its existing lines the company is transmitting at 16,000 and 24,000 volts; but the transformers will be capable of giving 40,000, 50,000, or 60,000 on the Oakland route. Operations will begin at 40,000 volts, and the higher pressure will be resorted to as soon as the line losses exceed 10 per cent. The line is being constructed with a view to standing 60,000 volts regularly. A comparatively short line at Telluride, Colo., now carries at 40,000 volts, and an 83-mile line between San Bernardino and Los Angeles, Cal., carries 10,000 h.p. at 33,000 volts, though a test pressure of 50,000 volts has been carried.

Illumination of Niagara Falls.—There is a proposal in the States to illuminate Niagara Falls during the coming summer by electricity. The beauteous effect obtained from such an illumination has been well demonstrated for several years at the Falls of the Rhine at Neuhausen, where it is a widely advertised attraction of the place. The American scheme cannot therefore be termed novel, although it will no doubt be carried out on a grander scale than at Neuhausen, at which place the falls are only illuminated for a few minutes each evening. The Michigan Central Railroad Company is proposing to illuminate Niagara Falls, which it is anticipated will in consequence afford a view of unprecedented grandeur. Tests having convinced the officials of the marvellous effects which might be secured, arrangements are in progress for the erection of a number of coloured lights and searchlights on the high banks on the Canadian side overlooking the falls. The electric power will be derived from the rapids, according to a note in the *Railway and Engineering Review*, and the illumination will take place during the passage of all trains after dark, special stoppages being allowed for in order to permit of the passengers viewing the scene.

Tariff Disputes.—There is considerable evidence that the large and powerful trusts which are being organised in the States will in the long run become antagonistic one to the other. Amongst the largest of these is a trust which controls the sugar industry, and by its influence import duties were recently increased on all the beet sugar imported into the States from abroad. One of the nations which supplied a small amount of sugar to the States was Russia, and in that country the increase of import duties was resented in a prompt and effective manner by the raising at once of the import duties on all machinery received from the States. Thus we gather that the increase on electrical apparatus was over 30 per cent., which is practically equivalent to keeping American-made engines and dynamos out of Russia. The *Electrical World's* comment on this is that "having ourselves, in this country, inflicted heavy duties of corresponding amount on the poor foreigner, we begin to see how it feels when the tables are turned." Our interest lies in the fact that the poor American is the sufferer, even more than the foreigner whose goods are refused admission into the States. The question is how long the American people will be content to pay enhanced prices for most of their requirements, in order that the trusts shall be protected from competition by outside nations.

Instruction of Tramway Drivers.—Now that the introduction of the new system of electric tramways into the city of Manchester may be expected to take place very soon, the all-important matter of instructing the drivers in the handling of the electric cars has been promptly taken up by the Corporation. Arrangements have been made at the depôt of the tramway company, where daily a number of men are receiving a course of instruction which should amply prepare them for the intricacies of the road, under the able direction of Mr. Elsey, who has had some 11 years' experience in these matters. From a conversation which this gentleman had with a representative of the *Manchester Weekly Times*, we gather that the men are first initiated into the details of handling the vehicles on a stationary car. When they have thoroughly understood the controller, and can with certainty adjust the latter to its correct point, can make and break the connections properly, and generally have a grasp of the details necessary, they are permitted to try their hand on a "live" car, which is given a trial trip in the private yard of the company. Instructions are also given to the men as to how to act in all cases of emergency, and how to take home a car that might happen to break down in the streets. It may be added that each driver is furnished with a volume of instructions giving these details, with particulars as to the construction and handling of the cars.

The Metropolitan District Railway.—The *Globe* has recently been publishing certain information respecting the electrification of the Inner Circle, which appears, on the face of it, to have the evidence of truth. For instance, on Saturday of last week, its financial editor announced that an agreement had been come to between the Metropolitan and the Metropolitan District Railway Companies, in connection with which Mr. Yerkes's name is mentioned. It is said that, while he will not be again in this country until June, active steps for obtaining electric plant for the District Railway will be taken at once. It is also added in the note in the *Globe* of that day that it is proposed to adopt uniform fares for all distances, so that the line could compete with the Central London Railway. The latest news is to the effect that the resignation of Mr. James Staats-Forbes, who for so many years has been the chairman of the Metropolitan District Railway, is soon to take place, and that he will be succeeded by Mr. R. W. Perks, M.P. This recalls the first rumour to the effect that Mr. Yerkes had obtained the controlling interest as the largest shareholder in the Metropolitan District Railway, with which rumour Mr. Perks's name was associated. The whole difficulty in connection with the change over has been one of finance, and we trust that this will quickly be overcome. It is certainly to the interest of all shareholders in the undertaking that the line should be speedily put into a position to compete against the rivals which are springing up around it, and which in certain cases are already playing havoc with their traffic.

Franchises.—It is exceedingly difficult to persuade the American that he is not able to obtain concessions or franchises in this country to construct either railways or tramways without conforming with the Acts of Parliament which have been passed to govern such undertakings. An American engineer, for instance, is now said to be in England arranging for a franchise for a railway between London and Brighton. The first announcement we saw of

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his coming to this country added that he expected to make this railway entirely over private ground, and without crossing the public highways. We do not think his success so far as this is concerned is likely to be great. In the States, frequently it is the practice to construct the works and to get the necessary permission afterwards. In fact, it is done even by the corporations themselves when they are constructing such important undertakings as waterworks, in which serious interference with private rights is involved. In tramway undertakings it seems to be quite the usual practice in small towns for large companies to construct the lines, and have cars running, before those who would interfere with them are able to get injunctions to restrain the invaders. A case in point recently occurred in a New Jersey village, in which the local street railway company was extending its lines without the permission of the borough council. The council accordingly sent men to tear up the track, but this was prevented for the time by an enterprising lineman making connection between the trolley wires and the rails already laid. The resultant shocks to anyone handling the rails suspended the work until the police arrested the ingenious official and made him undo the connection.

The Institution's Calcutta Section. — *Indian Engineering* has the following paragraph in its issue for March 23: "The Calcutta Section of the Institution of Electrical Engineers was inaugurated recently by the chairman, Mr. F. G. Maclean, who delivered a very interesting address. We are glad to welcome this society to India, but would have been better pleased if the inauguration had been that of an independent Indian institution. India is a vast continent, and its interests are so vast as to demand the existence of an independent association. When many of the Colonies find it to their advantage to have home rule in this direction, surely India would also find salvation in managing her own affairs." We fail to see what advantages the Calcutta Section would gain from home rule in the sense advocated by our contemporary. Under the existing arrangement every member of the new section of the Institution of Electrical Engineers will receive annually the *Proceedings* not only of the London institution, but also the best of the papers read and discussed at the various branches of the institution in Great Britain and Ireland. In the same way the best of the papers read in Calcutta will be published in the *Journal* of the parent institution. The members in India will thus receive in single volumes the most up-to-date information as to the progress of electrical engineering in the British Empire. They also enjoy, from what we know, a very full amount of home rule, in that they arrange their local affairs without any interference by the parent institution. In fact, we think the plea for independence is a plea for isolation, which evidently has not been endorsed by the electrical engineers in India.

Ipswich Engineering Society.—On Monday last, at a meeting of the Ipswich Engineering Society, Mr. James Hall read a paper on the evolution of the modern dynamo. From the account we have before us of the lecture, the subject was treated in a masterly way, and we are also pleased to note that the author did not try to crowd the whole range of continuous-current dynamos, single-phase alternators, and polyphase machinery into the one lecture. Instead of that, he devoted himself to the first of the early machines, out of which the modern dynamos have been evolved, and he showed that in these earlier types alternating currents were generated Afterwards, the need for a commutator was found. The author proceeded to describe the various means of exciting continuous-current machines, and then referred briefly to alternators. It was hinted at the end of the paper that a further communication on polyphase machinery may be given to the society at a later date. In the discussion which followed, Mr. W. Reavell, the president of the society, complained of the low standard voltage adopted in the British and American navies. He thought that the 80-volt standard should at least be increased to 110, and that more electrically-driven auxiliaries should always be introduced, as a great number of the steam auxiliary engines used in big battleships were exceedingly wasteful of steam. We do not think, however, that Mr. Reavell's idea that a higher voltage would be of use for the powerful searchlights is correct, as 80 volts is quite sufficient for the largest searchlight. Any increased voltage means additional loss in existence, and this, we think, is why the 80-volt standard was adopted some years ago. The meeting closed with a vote of thanks.

The Cockerton School Board Judgment.—Certain members of the School Board have been publicly stating that the effect of this judgment would be to prevent the working classes from obtaining the instruction they need in science, art, and other subjects, ignoring entirely the good work which is being done by other educational authorities, particularly in our larger towns Some interesting figures are given in a letter in the *Times* of April 15 to show how the School Board continuation classes in London have interfered with the educational work being done by the polytechnics. For instance, since the introduction of free evening classes by the London School Board, at a particular polytechnic where the number of students prior to that event had been uniformly progressive, the numbers have now fallen from 9,116 to 7,574—*i.e.*, a loss of 1,542. At one of the School Board free evening schools conducted close to this polytechnic there was not long ago a certain technical class numbering 39 students. Of these 39, no less than 10 were former students of the polytechnic class on the same subject who had been tempted away by the free classes of the London School Board. It is interesting to note that the fee charged for this subject at the polytechnic in question only amounted to 1½d. per lesson. Again, a student who till recently attended this polytechnic in preparation for the London University matriculation examination, and who won one of the Society of Arts prizes for English literature, has left this polytechnic in order to attend a free evening School Board class in Latin, as, she says, she does not see why she should pay for instruction in that subject at a polytechnic when she can get it free from the London School Board. This is surely a striking case in point, fairly bearing out the writer's contention that the Board School continuation classes have had a detrimental effect on the work of the polytechnics.

Wireless Telegraphy.—In the early stages of the voyage of the "Ophir" with the Duke and Duchess of Cornwall and York on board, Marconi's system of wireless telegraphy was subjected to some severe trials. On one occasion, when the vessel was rapidly leaving the Rock of Gibraltar far behind, the Duke and Duchess were receiving final messages of thanks and congratulation from those on shore, and when the fortress was quite out of sight the "Andromeda," one of the accompanying men-of-war, was sent forward at full speed to open communications with the ship stationed in Bougie Bay, and thence with Malta. Another striking example of the capabilities of wireless telegraphy occurred when the "Ophir" and H.M.S. "Diana" were south of Crete, the "Andromeda" having gone ahead to open communications with Port Said. At this stage a message was received from the King of Greece, which had been received on board the "Vin-

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dictive," somewhere off the northern coast of Crete, and by her transmitted to the "Diana." The Duke of Cornwall immediately replied by the same means, the message being delivered to his Majesty in Athens *vid* Crete. Up to the present wireless telegraphy at sea has been practically confined to warships, but we understand that the Cunard Company contemplate utilising Marconi's system on their Atlantic steamers. It is said, however, that some improvements are necessary before all the possibilities of the system can be fully developed. While on this subject we notice that an important series of experiments in wireless telegraphy are now being carried out between France and Corsica by the Marconi Company in the presence of representatives of the French naval, military, and postal authorities. A mast 130ft. high has been erected at La Brague, near Antilles, on the French side, while the Corsican station is situate at Calvi. The distance between these two places is 125 miles, and most satisfactory results are said to have attended the first attempts at communication a few days ago.

Electricity v. Steam.—Mr. W. J. Stevens, writing under this heading in the *Railway Magazine*, throws more light on the effect which the competition of the Central London Railway has had on the two Metropolitan underground railways. In the first place, the Central London line offers a clear atmosphere and clean rolling-stock, and secondly, it adopts a uniform fare of 2d.—the one factor being, in the opinion of the writer, as important as the other. Having only one class to maintain instead of three, also, leads to a saving of time in training and detraining, and makes for economy in rolling-stock, clerkage at booking-offices, and the collection of tickets. Taking the case of the Central London Railway, there is apparently nothing to be gained as regards working expenses by the use of electric traction, the expenses per train-mile on that line being about 6d. more than those on the District Railway, and rather less than 4d. more than those on the Metropolitan. As Mr. Stevens points out, however, a reduction in the cost of electric traction may be looked for in the near future, whereas the two steam underground railways have already attained the irreducible minimum. From a considerable mass of statistics given by the author, we gather that the number of passengers carried on the District Railway during the six months ending Dec. 31, 1900, as compared with the corresponding period the previous year, showed a decrease of 1,229,382, which represented a loss in receipts of £14,747. Taking the same six months, the number of season-ticket holders fell off by 1,709, being a loss of £4,168 to the company. On the Metropolitan Railway the effect of the Central London competition is even more apparent. The number of passengers, including season-ticket holders, carried during the second half-year of 1900 showed a decrease of no less than 2,966,842 on the corresponding six months the previous year, the receipts accordingly showing a decrease of £26,246. In conclusion, the author says that the shrinkage in cab traffic, though very appreciable to the cabmen and proprietors, may be ignored in this competition.

Modified Induction Motor.—The digest of the *Electrical World* for March contains an abstract of an article by Grob, giving the theory of a three-phase induction motor, in which stator and rotor are connected in series. The two rotary fields must have the same speed in space; for that reason the rotor must have double the speed of the stator field and the rotor field must rotate in the opposite direction. The author gives briefly the theory of such a machine and shows that it exerts a torque. It is a synchronous motor and not self-starting. He compares the properties of the same motor, in the one case connected as an ordinary induction motor, in the second case as a synchronous motor, and assumes that the utilisation of the copper and iron are the same in both cases. This condition requires the double voltage for the synchronous motor; the speed is doubled for the synchronous motor; the no-load current is reduced to one-half; the maximum torque is doubled; the angle of phase is reduced to one-half; the efficiency is nearly the same. He also gives a comparison of both motors at equal speed. The voltage and the no-load current are the same; the overload capacity is about doubled with the new connections; the power factor has slightly increased; the efficiency is about the same. Rotor and stator may also be connected in parallel, but the two circuits must then be well balanced. A set of two such motors, coupled together, can be run at four different speeds; both motors in parallel, each with stator and motor in parallel; both motors in parallel, each used as ordinary induction motor; the rotor of the one motor, used as ordinary induction motor, supplies the current to the second motor, in which stator and rotor are in parallel; both motors run as ordinary induction motors, the secondary of one supplying current to the primary of the other. The four speeds have the proportion $2 : 1 : \frac{2}{3} : \frac{1}{2}$. The author remarks, in conclusion, that the same method can also be used for two-phase motors, but not for single-phase motors. He has not yet confirmed all of his theory experimentally, but a first experiment shows that a motor connected by his method runs and gives the maximum torque according to the theory.

Lighting of Artisans' Dwellings.—We give elsewhere in this issue a report by Mr. James K. Bock on the question of the electric lighting of artisans' dwellings in West Ham. It will be seen from the report that when the West Ham Council decided to instal the electric light in certain of their new tenements they fixed on a charge of 6d. per week to cover the cost of electric light, which could then be burned by the users of the tenements for as many hours as they liked. In order to ascertain how far this price was remunerative, Mr. Bock has carried out experiments on three blocks of tenements for the quarter ending September last, and for the 14 weeks ending Jan. 4 this year. The experiments were made by placing a single meter and maximum demand indicator in each tenement, the charge being estimated then at 7d. per unit for the first hour's average use per day of the maximum demand, and 2d. per unit for all over this quantity. In the summer quarter the average price per tenement per week required by the meter ought to have been respectively 7¼d., 7½d., and 7½d. for the three blocks of tenements in question, and in view of the saving in not having a meter in every tenement there is not much to choose between this and the price obtained of 6d. per tenement per week. In the winter quarter, however, the matter was very different. According to the meters the average charge per tenement should have been respectively 14¾d., 15½d., and 13d., which is more than double the revenue actually derived. In view of the great difference against the electric lighting undertaking, Mr. Bock has advocated the introduction of prepayment meters in each tenement with a charge of 4½d. per unit. We think he is right in so doing, as there is no doubt that with a fixed charge the consumer will keep his lamps burning when they are quite unneeded. The experience at West Ham is likely to be repeated elsewhere, and we should not be surprised to find that in the long run the installation of a meter for each artisan's dwelling will be found to answer best both in the interests of the electric light undertakers and of the

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consumers using the light. Any averaging of the cost only tends to waste, as there is no inducement offered to make the consumers economical with their lighting.

Government Telegraphs.—At a recent meeting of the Industrial Commission in Washington, Mr. T. F. Clark, a prominent telegraph expert in the United States, gave evidence on the question of Government control of the telegraph lines of that country. The major portion of Mr. Clark's evidence was concerning the wisdom of State ownership, and he reviewed the conditions that exist in Great Britain, in Switzerland, and in Belgium, where all the telegraph lines are owned by the Government. He pointed out that the conditions in the States were exceedingly different from those in Europe, stating, for example, that there are only 67 people for each mile of telegraph wire in the States, whereas in England there are 130 people to the mile. In Switzerland the number reaches 220 persons, and in Belgium 321. He also added that he had found from investigation that there are in the United States 1,100,000 miles of telegraph wire in use, whereas in the whole of Europe the mileage was only 1,580,000. Another comparison was made by Mr. Clark as to the number of telegraph stations, which, in the United States, total to about 29,000, whereas in Great Britain only 10,816 towns and villages are so connected. In our opinion the most essential feature of comparison was made at the end of his evidence, in which he expressed the view that unless the Government ownership were undertaken by a permanent civil service the result would be disastrous, and no good would come out of the matter. In other words, if in the States it be ultimately decided that the Government shall take over the whole of the telegraph lines, then the control of the system must be in the hands of a permanent staff, both in the central offices and also in various local offices. It is usually the case in the States that all Government officials are changed after every presidential election, provided that a change in party has taken place, and we quite agree with Mr. Clark that any such procedure would mean utter ruin to a telegraph undertaking.

Cape-to-Cairo Telegraph.—In a recent issue of the *Daily Telegraph* Mr. Lionel Decle has an article on Northern Rhodesia, in which he briefly sketches the progress that has been made with the trans-African telegraph line in that country. Everyone, he says, looks upon the accomplishment of the scheme now as a matter of course, but few people are aware of the advanced state of the work and of the difficulties which have had to be surmounted. When the line was first pushed north of Salisbury, before the Matabele rebellion, it ran towards the north as far as Mount Darwin and thence turned to the east towards Tete. When the Mashonas rebelled, this line was destroyed by them. Many of the iron poles were pulled down, and some of them were actually used as cannon by the rebels. When peace was restored the line had to be rebuilt, and a new and better road was selected, which starts from Umtali and goes almost due north. Experience having shown that wooden poles were soon attacked by white ants, it was decided to erect the line entirely on iron poles. So long as wagon transport could be used difficulties were but slight, but when the line reached Inyanga, 200 miles south of Tete, wagons had to be replaced by human porterage, the tsetse fly being prevalent there. In the spring of 1898 784 miles had already been laid from Umtali to Bandawe, on Lake Nyassa, with a branch line running to Chiroma, the Anglo-Portuguese frontier on the Shire River. Since then 500 miles have been added, and, as already stated in these columns, the southern extremity of Lake Tanganyika is already in telegraphic communication with the Cape, another link connecting Fort Jameson with the main wire. The writer states that there are few lines in the world which are so well and so permanently laid, and interruptions are of comparatively rare occurrence. The line from Lake Nyassa to Fort Jameson was erected at a cost of £31 per mile, including expenses of transport of plant from the coast, surveying, clearing, and erecting it, which shows how the cost of laying a line in the interior of Africa may be reduced under careful management to a very low figure. To this must, however, be added the original cost of the plant. In the opinion of Mr. Decle the prospects of the regions which the line crosses make its ultimate success a certainty.

Proposed Automobile Restrictions.—The decision of various county councils to recommend the Local Government Board to limit the speed of motorcars to 10 miles an hour has aroused the manufacturers of automobiles in this country to action. In a weighty appeal against the proposed recommendation, they point out that altogether capital to a total of £3,345,612 has been subscribed for the purpose of the motor industry, which would be most seriously damaged if any further restrictions of the use of such vehicles were imposed. The state of things in this country in regard to this matter is compared with the existing conditions in France, in which country the maximum speeds have now been fixed at 18½ miles an hour on country roads and 12½ miles where there is considerable traffic. Furthermore, the petitioners state that they have evidence that in cities and towns where electrically-propelled tramways are in use the speeds of these tramcars frequently exceed 15 miles per hour, and they often travel up to 20 miles per hour. As to this statement, we can only say that we do not know of any case where electric trams would be allowed to run at such a speed as suggested. Of course, the point which must be considered is whether the proposed restrictions would have a detrimental effect on the industry itself, and in this appeal the manufacturers state that they are convinced that unless the movement is hampered and practically destroyed by legislative restrictions there will very shortly be established in England an industry of vast proportions, giving employment at high wages to many thousands of persons and producing vehicles which will be of untold benefit to all classes in the United Kingdom. Yet, it must be admitted, the automobile industry in the land to which its origin can be traced as far back as the thirties, is considerably behind the progress made on the Continent. The export of automobiles from France in 1900 was at the rate of £333,000 per annum, and a good portion of this came to this country. The answer of the British manufacturers to this position is that it was not until the restriction imposed years ago on road locomotion were removed, to some extent, by the Light Locomotives Act of 1896 that they had a chance of competing on even terms with foreign manufacturers. In an interview with a *Daily News* representative, Mr. C. Johnson, the secretary of the Automobile Club, said that invitations for the automobile demonstration in May had been issued to no less than 4,400 members of county councils, and he expressed the firm opinion that when they realised how safely the machines could be used, and how instantaneously they could be stopped, these gentlemen would change their present opinions upon the subject. We think the petitioners have certainly a very strong case to urge, and trust that the Legislature will not, without earnest consideration, impose restrictions which cannot but tend at least to hinder an industry which gives at the present employment to such a large portion of the working community of the British Isles.

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ELECTRIC LIGHT FOR SMALL HOUSES.

BY R. D. SUMMERFIELD, A.M.I.M.E.

The question of electric illumination for the class of small dwelling-houses, occupying in point of size the position between the workman's five-roomed cottage and the detached villa, is one which it is earnestly to be hoped will soon have more attention paid to it, both on account of the enormous number of people who would be benefited by being able to light their houses by electricity as cheaply as by gas or oil, and also on account of the great impetus which would be given to the electric light industry if all such small houses now using gas were to adopt electricity instead. The class of houses mentioned above constitute a large proportion of the dwelling-houses proper in most towns, but as yet very little has been done in the way of supplying them with electric light. This is chiefly owing to the very limited demand for light from such houses, causing the electric lighting companies and corporations, as a rule, to pass them by with very little consideration, and to make small effort to develop business in this quarter; but if whole streets of such houses could be induced to make use of the light, they would become most profitable customers.

On the score of health, electric lighting is far more important for small houses than large ones, as small rooms so soon get hot, stuffy, and unhealthy when lighted by gas or oil; in a room 14ft. by 12ft. the writer recently noticed a difference of 5deg. F. in the temperature just below the ceiling and against the wall less than 4ft. lower down, after three hours of lamplight but with no fire in the room. This gives some idea of the overheated state into which small rooms soon get when using the ordinary artificial lights; but those who are obliged to sit for several hours in such rooms during winter evenings will need no telling that gas or oil are not the proper illuminants to use in such confined spaces, while the blackened ceilings and dingy curtains prove that the bad effects of the light are not confined to human beings only. Yet the small householder puts up with these disadvantages, considering that electric light is quite beyond him; he may earn his living in an electrically-lighted office, may be able to afford more for light than he is paying, and may even have an electric light cable laid in the street before his door, yet he seldom seems to think of taking up the question of electric lighting seriously. This may be because he considers it dangerous, as even now a great number of people imagine that they might be killed or seriously injured by touching any kind of electric wire; but the objection which probably weighs heaviest with most people is the trouble and expense involved in wiring and fitting-up their houses for the electric light; and as they have very little data to go upon, they are apt to form very exaggerated estimates of the cost, besides imagining that the house will have to be partially pulled down to run the wires.

Now, a small seven-roomed house—such as are rented in the suburbs of London at about £30 per annum—could be fitted up with an installation to give a quite sufficient degree of illumination at a cost of £1 per 16-c.p. lamp, this sum including lamps, plain but sound fittings, switches and accessories, wires, and labour in wiring and fixing. Such an installation would consist of two 16-c.p. lamps each in the front and back sitting-rooms, one in the hall, one in the kitchen, one each in the first and second bedrooms, one 8-c.p. lamp in the third bedroom, and one 8-c.p. lamp in the bathroom—or 10 lamps in all, equivalent to 18 8-c.p. lamps. Now, a central supply station, charging, say, 6d. per B.T.U., will receive an average revenue of about 6s. per 8 c.p. lamp per annum; but as this average includes shops and business premises as well as private houses, we may take the cost to the small householder at 6s. 6d. per 8-c.p. lamp per annum, as he burns his lamps for longer hours than a shopkeeper or the tenant of an office. In the case under consideration, with an equivalent of 18 8-c.p. lamps fixed, the annual cost of current would come to £5. 17s. at 6d. per B.T.U.; and if we add 10s. for meter rent, the annual cost would be £6. 7s. The cost of gas at 3s. 6d. per 1,000 cubic feet for the same number of burners as electric lamps, and to burn for the same number of hours, would come to about £2. 5s. per annum, including rent of meter. The difference in cost, therefore, between gas and electric light would be £4. 2s.; and although this seems large, yet when the longer life of curtains, pictures, and furniture, and the less frequent necessity for painting and whitewashing is taken into account, not to speak of the very great benefit to health the difference becomes very small—in fact, the advantages gained by using electricity more than counterbalance the increased cost. Of course, with current at 3d. or 4d. per B.T.U., the difference between the cost of electricity and gas is decreased, or the cost becomes equal. In Brighton, for instance, electric light is cheaper than gas, and is therefore used in the smallest shops, while small dwelling-houses, at rents of £20 and £25 per annum, are wired for electric light instead of having gas-pipes put in while building.

The first cost of an installation, however, sometimes prevents the householder from putting one in, although he might be quite willing to pay the extra annual cost for light, as against gas. The installation of 10 lamps mentioned above would cost £10, and the tenant might hesitate to spend this lump sum, especially as he would have to leave, at any rate, part of the installation behind him in case of removal. This difficulty is, however, overcome by such concerns as the National Free Wiring Company, who will put in a complete installation free of cost in the first instance, and charge for the use of the same a rent of about 1d. for each B.T.U. consumed, as registered by the meter. Several corporations have also commenced to hire out fittings to their customers at a nominal rent. Electric wires in private houses should be run in steel conduits, as the risk of fire is much less when the wires are carried in this manner than when run in wood casings; besides which, the cost of labour in wiring is from 30 to 40 per cent. less. In some cases it might be possible to draw the wires into existing gas-pipes, by altering the sharp bends and introducing junction boxes at intervals; but the insulation of the wires would probably be damaged by the burrs on the ends of pipes unless the greatest care was exercised.

If by using the electric light the occupiers of small houses benefited in health and comfort, the suppliers of the light would also benefit from a pecuniary point of view, as such customers would be very profitable ones. The maximum demand for current from the class of houses in question would not occur until most business places were closing, and would continue until 11 or 12 at night, thus flattening the peak of the load curve at the lighting station and increasing the load efficiency of the plant. Of course it would not pay to lay cables down a street to supply one or two small customers only, and electric light companies and corporations should therefore canvass thoroughly all the streets of smaller houses in their districts, leaving at each house little pamphlets setting forth in the plainest manner the advantages of the electric light, together with the approximate cost of installing same or hiring fittings, and the actual average annual cost of current per 16-c.p. and 8-c.p. lamps, etc.

To charge by meter for the small quantity of current required in the cases we are considering would be expensive for the lighting company, and might result in a dead loss to them, as sometimes the meters will not record very small currents. One system of charging which has been tried is to charge a fixed price per annum for each lamp fixed; this gives satisfaction to the customer, as he always knows how much he has to pay, and can burn his lamps as long he likes; it affords means, however, for unscrupulous persons to cheat the supply company. Another system, especially applicable to new houses, is for the landlord to put in a complete installation, including lamps and fittings, and to charge a slightly higher rent to cover cost of current and hire of fittings, so that the tenant has no need to trouble about the light at all. This system is giving great satisfaction in many blocks of flats in London; large blocks sometimes have their own generating station in the basement, in which case the current can be produced very cheaply.

The value of the small customers mentioned at the beginning of this article to the supply company or corporation depends upon the number of them in a given length of street; if the number who now use gas were to use electricity instead, they would probably be the most

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valuable class of customers. But it does not pay to take a main down a long street to supply only one or two such customers, and supply companies, therefore, generally demand a guarantee that a certain number of units will be consumed before they will lay a main in a new district. In one large London suburb the corporation require a guarantee that they shall receive a return of at least 15 per cent. per annum on their outlay before they will make an extension of mains. Where a main is already laid in a street, the supply company can afford to connect almost any customer, as the average cost of such connection varies from 50s. or 60s. for shops, where the pavement only has to be crossed, to £5 or £6 for private houses with gardens in front. In the case of the small houses under consideration, the total cost of a connection from the street main to the house meter would come to about £4; and if the revenue per 8-c.p. lamp per annum from such houses is taken at 6s. 6d., one lamp would cover the interest on this outlay and the proportion of the meter inspector's time.

For some of the latter figures in this article the writer is indebted to the officials of the Croydon Corporation electric light department.

COMBINED TROLLEY AND CONDUIT TRAMWAY SYSTEMS.*

BY A. N. CONNETT.

(Concluded from page 527.)

Fig. 9 is a view of this conduit during construction. One side of the cast-iron tubes is here shown specially curved to fit the centre longitudinal arch so as to avoid excessive cutting of the masonry. Fig. 10 is a view of another special construction over the steel railway bridge of the new line from the Gare St. Lazare to the Invalides. This conduit construction rests directly on the steel beams of the bridge, and spans from one to another of them; it, therefore, had to be in the form of a bridge itself, and a built-up beam construction was adopted. Where the regular yoke construction is used these project from 6in. to 8in. below the tube depth, which is normally from 24in. to 28in., depending upon method of insulator suspension, as already explained, giving, roughly speaking, extreme depths of metallic structures between the limits of 17in. (Fig. 6) and 36in. A careful examination of a proposed route should be made to see if the sub-surface constructions would permit the building a safe practicable conduit. With this broad question settled in the affirmative, there is no good reason why the expense and annoyance due to the removal and lowering of many sub-surface obstructions should not be avoided by taking advantage of the possibility of varying the depth required for the conduit. This only becomes a grave matter where the question may involve the complications due to changing the carrying height of the conductor bars to get the minimum depth of conduit. It may be suggested that the conductor bars could be carried at this minimum height for the entire construction, but an examination of Fig. 6 will show that it is only possible with a slot rail of about 4in. high, which is only practicable with asphalte paving.

It may not be amiss to say a few words about the switches, because in practice they are responsible for most of the interruptions in service. A misplaced switch has the result of guiding the car in one direction and the plough in another. The latter can become twisted in the conduit in a variety of ways, but with the too sure result of interrupting the traffic for a time, which, in the author's experience, may vary from 15 minutes to two hours. This bare statement is sufficient to demonstrate the necessity of so designing the switches as to reduce to the strictest minimum the possibility of such accidents. There are two distinct cases to be considered. The first is where the track is alone switched, the slot being continuous. Fig. 11 is a photographic view of such a switch for a centre-slot construction. Fig. 12 is a sectional view of a counterweight mechanism which can be adjusted to close the switches automatically, so that the track should be always open for the passage of the cars using the conduit track. Fig. 13 is a section of the same mechanism for the case of a side-slot conduit. This precaution should always be taken, but it may fail. When this happens it is usually due to something solid having fallen into the switch, and in consequence the tongues fail to return to their normal position. In the case of the centre-slot construction, the danger of an accident

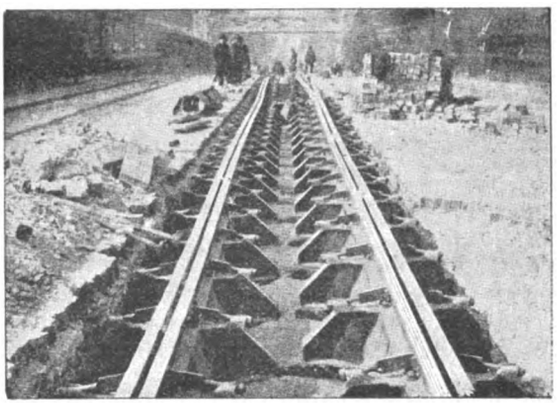

FIG. 9.—Special Shallow Conduit; Pont de l'Alma, Paris (under construction).

can be avoided if the ploughs are hung on slides, which permit their travelling completely across the car. If the ends of these slides are left free of all obstruction from the truck or otherwise, the plough will drop off when the car has reached a certain distance on the wrong track. But the motorman generally perceives his error before that

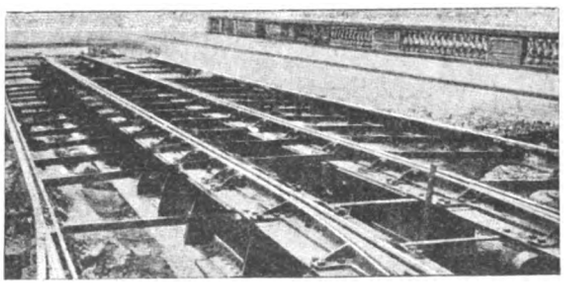

FIG. 10.—Special Construction Over Steel Railway Bridge, Paris.

occurs, and simply stops and reverses the car, with the result of no interruption worthy of mention. Even in the worst case of losing the plough the car is simply "dead," and can be pushed in by the succeeding one. A trap should be placed conveniently at each such switch, so that the plough can be taken out with no loss of

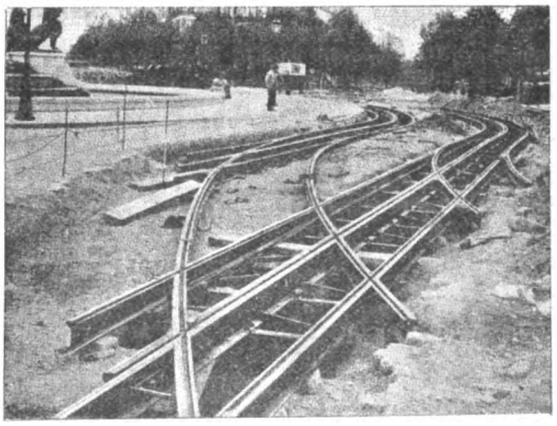

FIG. 11.—Siding Without Conduit, Paris.

time. If the accidents are only of this nature, they are not worthy of any serious attention. But in the case of the ordinary side-slot conduit, this result cannot be attained. The tongue there in one position covers the slot. In case of a false position of the switch, an accident will happen which almost surely must result in a serious interruption of the car service. To avoid this difficulty, the author suggests that before the switches are reached

* Paper read before the Institution of Mechanical Engineers.

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the slots should be deflected to the central position. Figs. 14 and 15 show how it may be accomplished.

In the second case, with a slot switch, the slot tongue is a necessity. The author recommends for the side-slot conduit the same deflection of the slot to the central

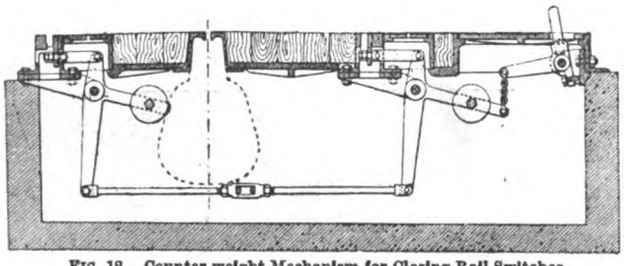


FIG. 12.—Counter-weight Mechanism for Closing Rail Switches Automatically, Paris.—For Centre Slot.

position. This serves the purpose of being able to avoid the side-slot slot switch, the constructional difficulties of which were enlarged upon in the first part of the paper. The danger of an accident with this switch is limited to the case where the point of the slot tongue is directly in

With one movement of the handle the three tongues are thrown in unison. For a dense traffic, it is advisable to put a switchman at such slot-switch points, to reduce to a minimum the danger of accidents and of interruptions of service. The author feels confident that the accidents at

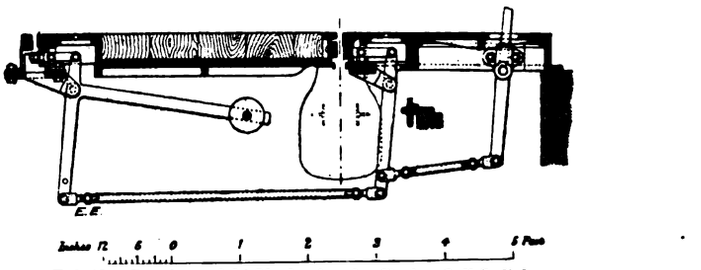


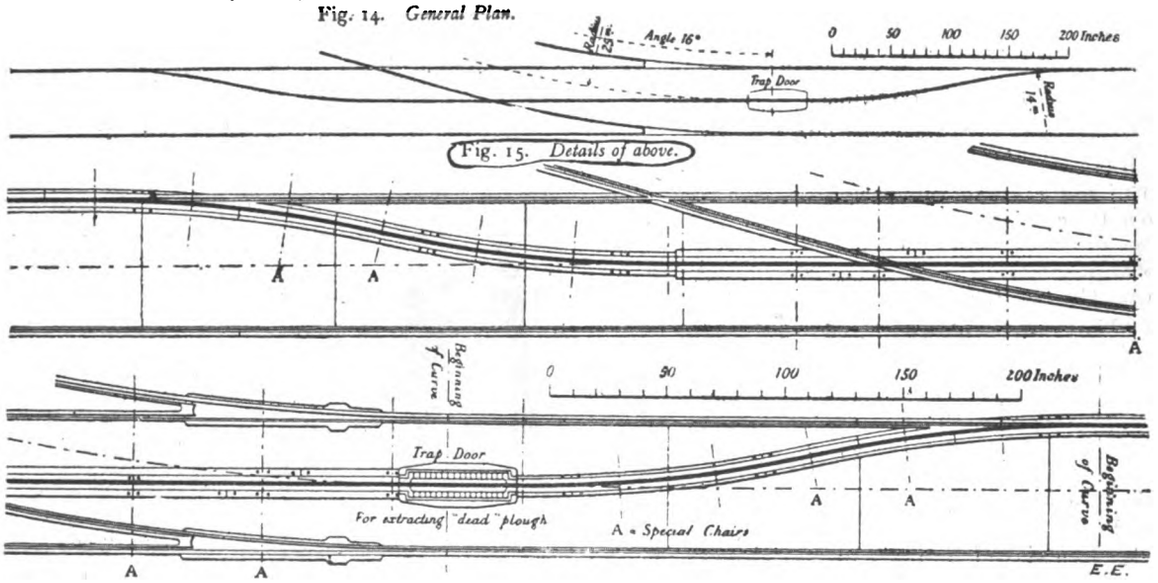
FIG. 13.—Counter-weight Mechanism for Closing Rail Switches Automatically, Paris.—For Side Slot.

switching points will be almost negligible if the construction above indicated is followed.

Special Considerations for a "Mixed" Line.—The first decision to be made for a line partly conduit and partly overhead is whether the plough shall be carried continually

Deflection of Side-Slot to Centre-Slot at Switch, Paris.

Fig. 14. *General Plan.*



the slot. A "head-on" collision can then take place. But if the tongue is not thrown in the same direction as the track tongues, the same slight interruption may happen as above explained—providing, of course, that the system of plough slides there mentioned is in use. Fig. 16 shows

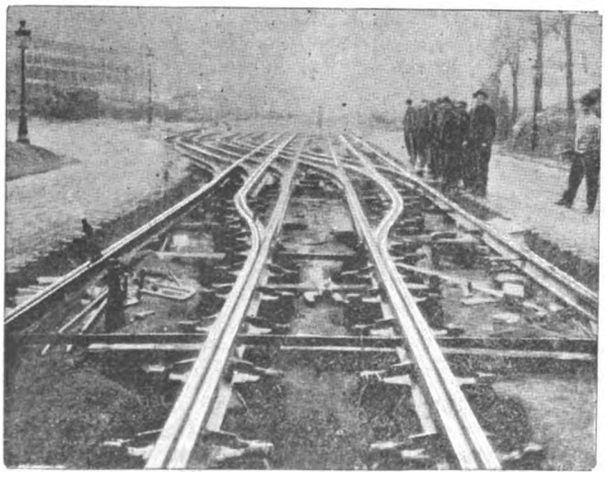


FIG. 16.—Deflection of Side Slot to Centre Slot, Paris.

the case of a side-slot conduit deflected to the centre of the track at a slot switch. There are no mechanical or electrical difficulties in this case, the results of actual operation in Paris having demonstrated this statement Fig. 17 is a view of a slot-switch operating mechanism.

on the car, or removed and replaced at each junction point of the two systems. The latter is the simpler method. A roomy manhole containing a man to do this work is all that is needed; but it needs no argument to prove that it is an undesirable and expensive method to adopt. One is then impelled to a method whereby the plough is always carried on the car, as the trolley is, to effect which the plough must be raised or lowered at the

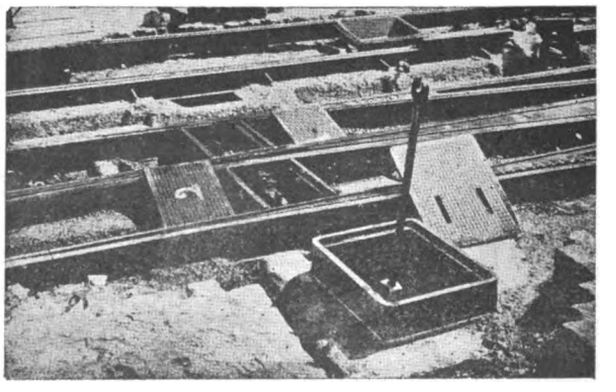


FIG. 17.—Tramway and Conduit Switch, Paris.

junction points of the two systems. The most natural and the neatest solution is to raise the plough through the slot with no special arrangement in the latter. This has been successfully done in Berlin and Brussels. In the former city the plough is equipped with a wheel at its

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lower extremity, which runs up an inclined plane; and the contact shoes working on horizontal axes pass through the slot by being depressed to a vertical position. The wheel then runs in the groove of the wheel rail, and it is raised clear of the track by the turn on a crank given by the flappers press against the conductor bars. The contact may be made on the vertical or the upper face of the bars, according to the way the road is designed. The flappers are not thick—in fact, the whole construction of the plough is very much cramped, for it must pass

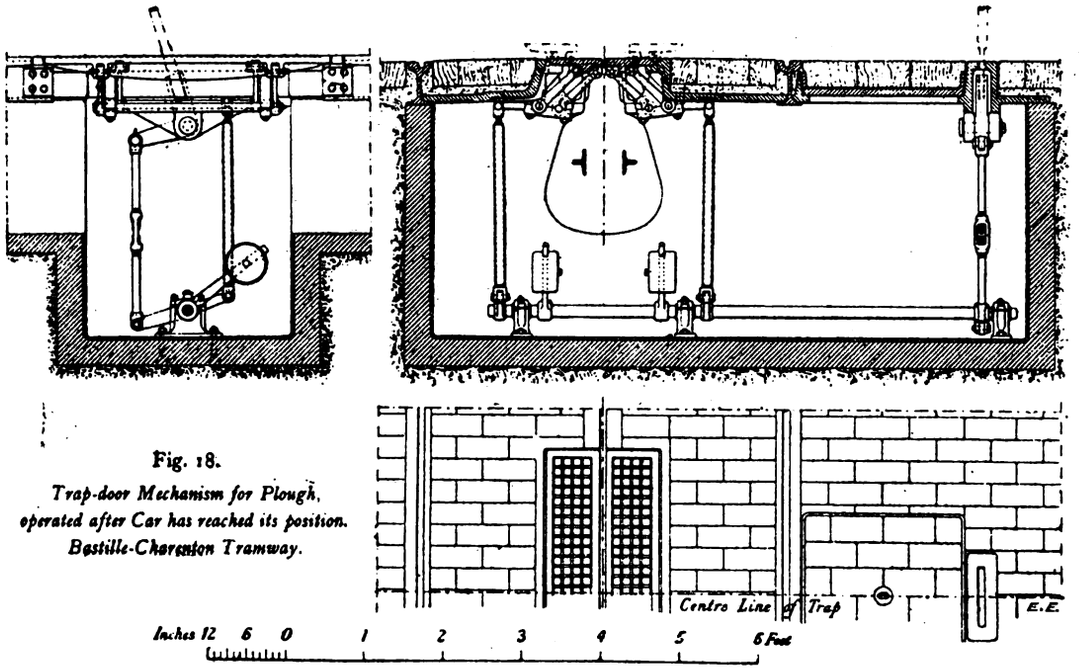

Fig. 18.

Trap-door Mechanism for Plough, operated after Car has reached its position. Bastille-Charenton Tramway.

motorman. At the same time the conductor loosens the bow sliding trolley, and the operation is complete. The entire change can be made without stopping the car. No more perfect contrivance to accomplish this purpose could be devised. In Brussels the plough is raised by the motorman, the inclined-plane feature being discarded. A wheel trolley is through the 1¼in. slot. The plough of this form is withdrawn easily, but it has to be specially weighted to make it descend, for it has only its own weight to overcome the tension of the flapper springs, so that they will take the vertical position necessary to pass through the slot.

There could be no good reason for not adopting one of

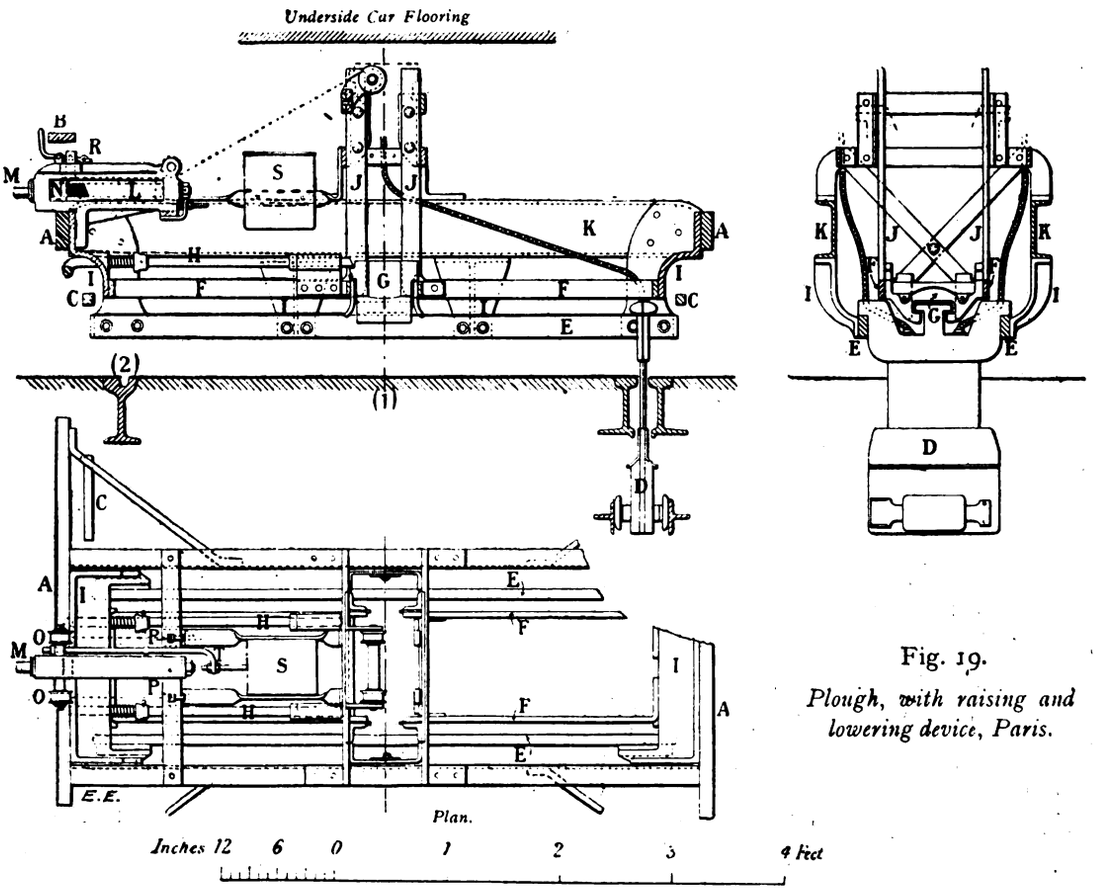

Fig. 19.

Plough, with raising and lowering device, Paris.

used, so that a stop is necessary to catch the trolley wire. Both of these systems involve the use of what the French call "clapets," which in English may be called "flappers." These are hung on horizontal axes around which is a coil spring, one end of which is fastened to the fixed axis and the other to the flapper. The springs make the the above plough designs for a side-slot conduit with 1¼in. slot—for a centre-slot, with ¾in. width, their use is out of the question—if no other complications were involved; but the plough is one of the most difficult problems connected with the conduit system. The successful installation of two bare conductors in an open-slot conduit is not

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as serious a matter as to take the current from these bars through the slot to the car motor. A plough must be strong enough mechanically to resist the shocks and wear and tear of ordinary usage, while not so strong but that it will yield before injuring the conductor-bar system in case of an accident. At the same time it must be electrically efficient under the most difficult conditions imaginable; bare collectors of current are connected to leads, which must be covered with insulation and mechanically protected by metallic wearing plates, the total width of which do not exceed ½in., with a ¾in. slot, this being the ordinary condition with a centre-slot conduit. The plough is often drenched with water and covered with slime and mud, which run down its sides from the open slot. The conditions are certainly severe for an apparatus to carry successfully a 500-volt circuit. No form of plough yet designed is so perfect that any of its advantages may be sacrificed to gain other features which can by any means be dispensed with. In the author's opinion the design of the plough should have the first consideration, and the conduit and special apparatus connected with a road should be built "around" the plough as the base. The flapper form of plough construction is weak mechanically. The friction of, and shocks due to, uneven joints in the conductor bars tend to twist the flappers about their horizontal axes. At the points where the bars are interrupted, such as at slot switches or at crossings, the shocks of this nature are very considerable. In actual practice the flappers are often wrenched off at these places. When released from their fixed position against the conductor bars the flappers take a position which is variable, depending upon the tension of the coil springs, which naturally cannot always be the same. A warped surface extension piece has to be fastened to the ends of the conductor bars, to guide the flappers to their normal position against the bars. These pieces give considerable trouble, and their use should be avoided, if possible. This form of construction does not permit the use of a fuse to connect the contact shoe with its lead; consequently a short-circuit in the body of the plough, not being protected by the car fuses, would short-circuit the line, and thereby stop the car traffic until the faulty plough could be discovered and raised out of the slot. The author believes it to be indisputable that other forms of plough are much more efficient, but none of them have the advantage of being able to be withdrawn from or lowered into the conduit without a special trap construction at a fixed point. Nevertheless, if the reasoning above given is true, one of these types of plough should be adopted, and it could be only a question of choosing the best existing one and adopting it.

In the light of present experience, the best plough is one having soft cast-iron shoes, pressed lightly against the vertical faces of the conductor bars by semi-elliptic springs horizontally placed. The shoes preferably should be carried by horizontal links, which take all the shocks to which they may be subjected, leaving the springs free to do the work only of pressing the shoes outwardly. In this way the risk of deforming the springs is avoided. The links should be constructed so as to limit the outward course of the shoes. The conductor bars at switches and crossings are simply cured slightly outwardly. The shoes are connected to the leads by copper fuses. This plough construction is simple; in actual results it has proved itself to be efficient. It certainly is an improvement upon the "flapper" type. The trap construction in its simplest form would be one in which the lids required to be lifted before the arrival of the car, and to be put back in place after its departure. This would be rightly considered a crude and laborious operation. Fig. 18 shows a form of trap which is operated after the car has reached its position. One throw of the lever opens the trap, which is so counterweighted that the effort necessary for this is almost inappreciable. This trap construction has given excellent results in France, where 40 of them are in operation. Where the flapper form of plough is used, the plough is lifted by means of an apparatus similar to a brake staff, which is placed on the platforms. The plough is connected to this staff by means of cables, which are guided by conveniently located sheaves. On account of the width of slot of the side-slot conduit, made necessary by the fact that it must be wide enough for the wheel flanges, the flapper form of plough has only been adopted for this construction of conduit. The ploughs are raised in guides attached to the side frames of the truck. In Brussels and Berlin the ploughs are not mounted on slides permitting a lateral motion across the car. The two slots of a double-track construction being located on the interior rails, it is necessary to carry two ploughs, with a raising and lowering mechanism for each. If the requirements of the road demand cross-over switches from one track to another, a third conduit is necessary for a short distance at such points. The deviation of the slot to the centre

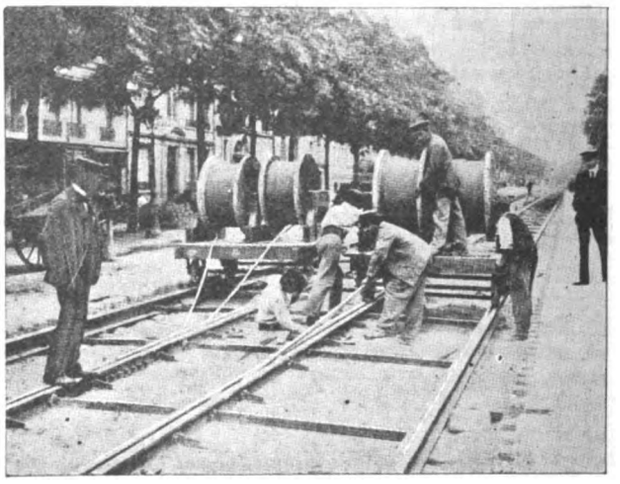

FIG. 20.—Method of Laying Feeder Cables in Conduits, Paris.

with the necessary plough-carrier construction entirely obviates the difficulty of two ploughs and of a third conduit.

The use of the slides seems to the author to be a valuable feature of conduit electric railroads, for the various reasons that have been given in the paper. Therefore the following explanation of a raising and lowering device for the plough, which will permit this sliding feature, is given in detail. Fig. 19 gives three views of such an apparatus. A are the side bars, B the top bar of the truck, and C the brake rods, which must be placed

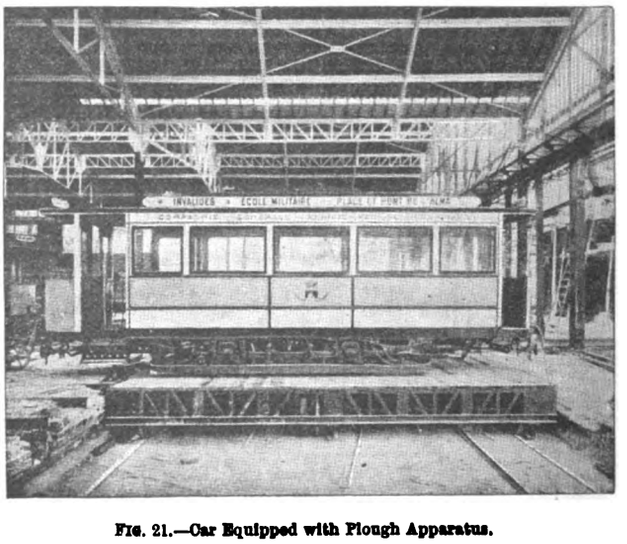

FIG. 21.—Car Equipped with Plough Apparatus.

outside the wheels as here shown. D is the plough, shown in position on the side-slot conduit. It slides from this position to that of (1) on the centre slot, or of (2) the position of the slot of the other track when crossing from the interior conduit on one track to the similarly placed conduit on the other track. The slide-ways are shown by the bars, E. The bars, F, prevent the plough raising or tilting in the conduit, except in the central position (1), where the casting, G, held in position by the lock, H, performs the same function. The sliding bars are held in position by the steel castings, I. The projecting central piece, J, braced as shown, holds the plough in its raised position. The whole

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apparatus is supported by the channel beams, K, which are bolted to the side bars of the truck. In this way the vertical variation in height is limited to the small movement in the journal-box springs of the truck. The plough is raised in the following manner. The fixed screw, L, is turned by means of a removable crank placed at M. The block, N, makes the course from one end of the screw to

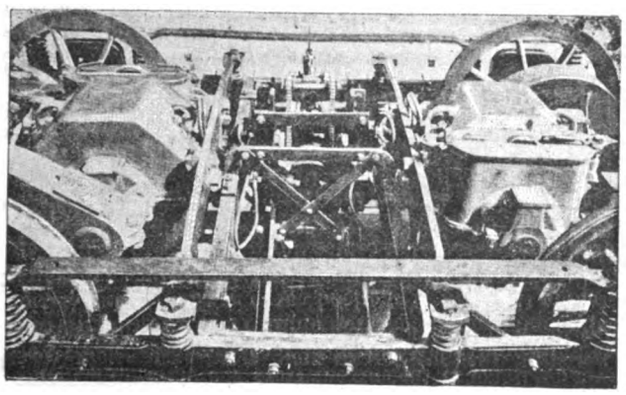

FIG. 22.—Truck of Car (Fig. 21) Equipped with Plough Apparatus.

the other. In the figure the block is in its position with the plough raised. This piece carries the two rollers, O, over which heavy link chains run. The latter are stationarily fixed at one end, P, and at the other end to the casting, G. The piece, G, is raised by an amount which is twice that of the course of the block, N. The latch, R, automatically locks the block, N, in place when it reaches the end of its

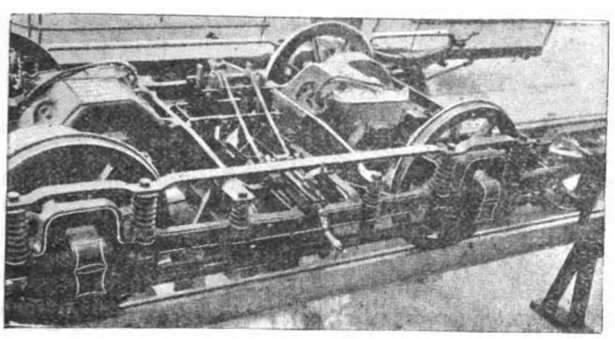

FIG. 23.—The same.

course. This prevents the trepidation of the truck from lowering the plough when it is in its raised position for the overhead trolley section of the road. The box, S, covers the double-pole switch which puts the car leads in circuit with the overhead or the conduit line as the case may be. This is done automatically with the raising or lowering of the plough by means of the rod, T, which

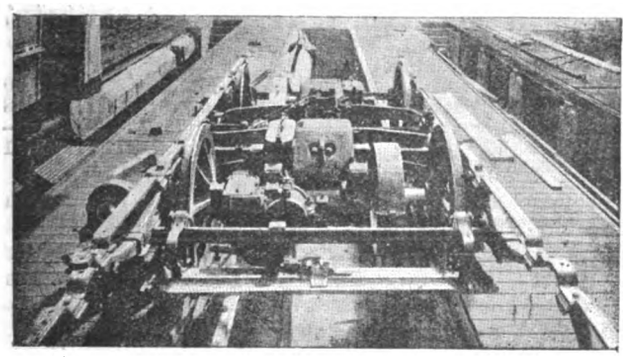

FIG. 24.—The same.

is moved by the block, N, when this is near the end of its course in each direction. Fig. 21 is a photographic view of a car equipped with this plough apparatus. It is given to show that externally the whole apparatus is nearly invisible. Figs. 22 and 23 are side views of the truck alone so equipped, and Fig. 24 is an end view of the same truck. The author is indebted to Mr. E. W. Mix, the chief engineer of the Société des Etablissements Postel-Vinay of Paris, for his invaluable assistance in the design and manufacture of the apparatus above described. That it has been successful is largely due to his efforts.

It is a good plan to form the piece M so that it will only fit a controller handle, which can only be removed from the controller on the "off" position. In consequence, if the handle is used to raise or lower the plough, there can be no movement of the controller until the operation is finished. Generally there are two traps at the junction points of the two systems, one for each track. The conductor of the car can operate the trap, but it is preferable to have a man specially stationed for the purpose, if the car traffic is at all frequent. In practice the operation is as follows: when the car has stopped with the plough over or under the trap—a mark on the track gives to the motorman the exact position to stop—the motorman gives his controller handle to the trap-man, who opens the trap, and lowers or raises the plough, closes the trap, and returns the handle to the motorman. At the same time the conductor lowers the trolley from or raises it to the trolley wire. The whole operation takes on the average 10 seconds when the men become accustomed to it. If these junction points coincide with regular stopping places to load or discharge passengers, the loss of time due to this operation is inappreciable. The only arcing at the conductor bars and at the automatic switch, S (Fig. 19), is that due to the lighting circuit. This is too small to have any injurious effect upon the plough shoes, and the construction of the switch with a quick break is such as to remove any danger there also. If electric heaters should be used requiring rather large currents, it might be necessary to cut them out of circuit during this operation. The car wiring for the mixed system is only slightly more complicated than for one system alone. The conduit circuit being completely insulated, the ground wire must be removed from the controller. Two wires are run from the controller to two points on the double-pole switch, S (Fig. 19). These two points are thrown in by the switch with one pair of points connected to the two plough leads, or with another pair connected to the trolley pole and the earth.

In the electrical apparatus the only special precautions to take due to the use of conduit is, first, to have the field coils insulated for 500 volts. With an overhead line the difference of potential between the field and the carcase of the motor is that due to the drop in the fields. But with the conduit it can happen that one pole of the conduit circuit is grounded, and that the fields are directly connected with the other pole. This would give 500 volts difference of potential between the carcase of the motor and the field winding. All standard motors should stand this condition, but it should not be omitted to be specified by the buyer. Second, when electric brakes are used, special insulation precautions are vitally necessary for the brake coils. A grounded conductor bar can subject these to 500 volts pressure during the entire time the car is on the conduit section. Not only is the annoyance due to burning up of the coils to be considered, but also that due to the short-circulting of the line. An interruption of this kind is overcome by lowering the line voltage by means of a rheostat at the station, so that a current, the amount of which is controllable at the switchboard, may be sent through the fault. This excessive current, will burn the plough fuses, thus clearing the line at the expense of leaving the faulty car "dead," to be hauled in by the succeeding one. With a combined trolley and conduit line the conduit section should have a separate circuit. It may be possible to operate it successfully with a grounded return, but few engineers would care to propose it. It is much better to increase the operating factor of safety by having both sides of the circuit insulated. In case the conduit section or sections are reasonably close to the power station, this may be done with a separate dynamo located there for the conduit circuit or by means of a motor-generator. If the cost of the leads to the conductor rails from the station is excessive, the motor-generator set may be stationed near the conduit section, and operated from the overhead circuit. The proper solution may be one of many different ones depending upon the local

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circumstances governing a specific case. As a result of actual tests, it has been found that the conductor bars of mild steel electrically connected with two bonds at each joint have a carrying capacity of about one-eleventh of copper bars of the same cross-section. These bars can be largely increased in electrical carrying capacity by attaching to them bare copper cables for this purpose. It can be readily seen what an economy this method affords over that of laying insulated cables in ducts. Fig. 20 is a view of the method of laying these cables as employed in Paris. The cables there shown have a cross-section of 250 square millimetres, or about 500,000 circular mils. The cables are electrically connected to the bars at very short distances apart to avoid electrolytic action between the two metals.

Cost of Conduits.—The question of the cost of conduits must be treated in a general way, local circumstances being such a large factor in the determination of cost that no other method is possible. Some notes as to details of cost will be found in Appendices I. and II. The side-slot conduit can be built for about £500 less per mile of single track than the centre slot. In the special work there is an economy in the side slot also as ordinarily built, as there are fewer frogs with three rails than with four. But if the slot is deflected to the centre, as has been recommended in the paper, the economy cannot be realised; on the contrary, the cost will be somewhat greater, due to the cast-steel deflecting pieces and the bent slot rails. It is generally stated that a conduit road costs twice as much as an overhead trolley road. This statement may be misleading, owing to the fact that an overhead trolley road may be very variable in its cost, depending upon pavement requirements, overhead construction adopted, and many other local conditions, such as the regulations for the return current by the rails. But the construction of the conduit part of a road is quite independent of these factors—that is, for an overhead trolley road which would cost £5,000 per mile of single track; it is quite probable that the same road with the conduit construction would cost £11,000 for the same length—that is, the conduit, properly speaking, would cost £6,000 in excess of an overhead trolley road. If the overhead trolley line should have a first cost of £10,000 per mile of single track, there is no reason why the use of a conduit on such a line would double the cost as in the first instance. Roughly speaking, the cost of a conduit in this latter case would be £16,000. To arrive at an approximate comparison of the cost of the two constructions, it is fair to assume that the cost of paving and of the wheel rails is the same in both cases. For the conduit there should be added per mile of single track approximately the following material and labour: 105 tons of slot rail, 40 tons of conductor rails, 210 tons of cast iron, £120 excess for bolts, etc., porcelain insulators £35, 1,400 cubic yards excess excavation, 1,200 cubic yards of excess concrete, £600 excess labour for track laying, £400 sewer connections. Crossings, turnouts, and special track work in general cost 200 per cent. more on an average for the conduit than for ordinary track. A cost which is wholly indeterminate is that of removing sub-service obstructions. This, as has been explained, can be often reduced by varying the conduit depth to suit special cases. Considering alone the items above enumerated they will amount to between £5,500 to £6,000. Deducting the cost of an average overhead construction, it can roughly be said that a conduit road will cost from £5,000 to £5,500 more per mile of single track than a trolley road under the same conditions, to which should be added the increased cost of special track work, and the removal of underground obstacles. Under ordinary conditions the difference in cost will vary between the limits of £7,000 and £9,000.

Appendix I.

Details of Cost in United States.—Table 1 gives the actual cost per single-track mile of the conduit roads installed by the author in 1895-6 for the Metropolitan Railway Company of Washington, D.C.

Cost of Metropolitan Railway Company, Washington, D.C.

Straight track	101,660 feet.
Curved track	9,190 ,,
	110,850—say 21 miles of single track.

	£ s. d.		£ s. d.
Rails and splice bars:			
Wheel rail	5 15 0	per ton.	
Slot rail	6 8 6	,,	
Guard rail for curve	9 10 0	,,	
Conductor rail	8 8 0	,,	
Joints complete	0 4 10	each.	
Per mile single track			1,858 6 8
Cast iron (yokes, insulator frames, covers, etc.), 215·5 tons at £5. 15s. 7d.			1,245 8 2½
Bolts, tiebars, clips, etc.			312 10 0
Bonds for conductor rails			97 18 4
Track laying (all labour and hauling)			589 3 4
Temporary track			33 6 8
Excavation of all kinds, except for cable ducts, 2,507 cubic yards at 3s. 10¾d.			488 6 10
Sewer pipes laid and brickwork for duct manholes			99 7 6
Cable ducts:			
10,616ft. 12-way duct at 4s. 9½d. 41ft. 8 ,, ,, 3s. 6½d. 21,354ft. 4 ,, ,, 2s. 2½d. 113ft. 2 ,, ,, 1s. 5d.	£4,894. 3s. 9d.		233 1 1
Excavation for cable ducts, 9,207 cubic yards at 3s. 4d. = £1,534. 10s.			73 1 5½
Concrete, first grade, for conduit (one barrel Portland cement, 12 cubic feet sand, 22½ cubic feet broken stone), 765 cubic yards per mile at £1. 9s. 2d.			1,115 12 6
Concrete, second grade, for paving base, etc. (one barrel Cumberland cement, 10 cubic feet sand, 20 cubic feet broken stone), 514 cubic yards per mile at 18s. 1d.			464 14 10
Stone paving, using old setts, 42,126 square yards at 3s. 3d.	£6,845 9 6		
Asphalte pavement, 91,716 square yards at 6s. 0½d.	27,705 17 6		
	34,551 7 0		1,645 6 0
Special track work and curves			783 6 8
Extra bills of street contractor			239 11 8
Removal of sub-surface obstructions			666 13 4
Total cost per mile of single track			£9,945 15 1

The metallic structure cost less at that date than it would now. The temporary track is a very low item, the authorities having permitted a flat strap-rail to be laid on the pavement (mostly asphalte) by means of flat tie-bars with special seats at their extremities. It should be stated that this city is an exceptionally favourable one for the construction of conduit roads, the streets being wide and with little traffic upon them, and the supervision being that of the thoroughly trained engineers of the United States army. The author has been given a pamphlet containing some diary notes kept by Mr. William C. Gotshall, engineer in charge of construction of the Second avenue Railroad Company, of New York. The pamphlet concludes with the following estimate of the cost of this road per mile of single track. It should be stated that this estimate is not Mr. Gotshall's, but the work of the compiler of the pamphlet:

Total Cost per Mile of Single-Track, Open-Conduit System, Second-avenue Railroad Company, Compiled from Diary of W. C. Gotshall.

Labour, digging trough, removing old track, repairing concrete, removing excess dirt, hauling all track work, £1. 10s. 11½d. per linear foot	£8,173 0 0
Insulators 5s. 8d. each	199 9 7
Ironwork, excluding yokes, 7s. 4d. per linear foot	1,375 7 0
Cost of iron yokes, 224·7 tons at £5. 4s.	1,168 8 10
Concrete, ⅔ cubic yard per linear foot, 8s. 2d. per yard	808 10 0
Haulage on yokes and ironwork	117 1 8
Total without paving	£11,841 17 1

The above total does not include cost of feeder duct.

In comparing this cost with that of the Washington conduit, it should be borne in mind that the items of cost of special track work, feeder ducts, paving, bonds, sewer connections, temporary track, are not included in this estimate, while they are in the Washington costs (Table 1). The cost of concrete is put down at 8s. 2d. per cubic yard. This low cost is evidently an error of compilation. Other information in the pamphlet seems to prove that this cost should be from 2½ to 3 times this amount.

Appendix II.

Estimated Cost in England.—The author ventures to submit the following estimate of cost per single-track mile in England at ruling prices of material and under fair average conditions. The construction here figured upon is a centre-slot conduit with yokes spaced 3ft. 6in. centre to centre,

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the yokes of the same weight and general dimensions of those used on the Paris lines. Yokes need not be inordinately heavy, but they should by all means be close together to preserve the slot width, a much more important matter for a conduit electric than for a cable road.

Estimated Cost of Single-Track Mile of Conduit Electric Tramway in England for Average Conditions (December, 1900).

		£	s.	d.
Wheel rails, 90lb., 141 tons per mile at £7	£987 0 0			
Joints, 0·67 ton at £8	5 8 0			
Slot rails, 66lb., 105 tons at £8	840 0 0			
Conductor rails, 28lb., 44 tons at £8	352 0 0			
		2,184	8	0
Haulage, 290·67 tons at 4s.		58	2	0
Bolts, washers, keys, etc., 4·16 tons at £18	74 18 0			
Tiebars, 13·5 tons at £15	202 10 0			
		277	8	0
Insulators complete with clip, 755 at 6s. 2d.		232	16	0
Cast yokes and insulator pit covers: yokes, 210lb. each, spaced 3ft. 6in. centre to centre, 210lb. × 1,510 = 317,100lb. = 141·5 tons. Insulated pit covers, 117lb. each, 755 × 117 = 88,335lb. = 39 tons. Total, £181·5 tons at £10		1,815	0	0
Haulage, 181·5 tons at 4s.		36	6	0
Bonds		110	0	0
Concrete for tube, 1 cement, 2½ sand, 5 stone, 0·2 cubic yard per 1 linear foot 5,280 × 0·2 = 1,056 at £1. 8s.		1,478	8	0
Concrete for paving, 1 cement, 3 sand, 6 stone, 0·10 yard per 1 linear foot × 5,280 = 218. 528 × £1. 4s.		633	12	0
Wood paving, 6,373 square yards at 11s.		3,505	3	0
Excavation, 2,950 cubic yards at 5s.		737	10	0
Sewer connections and manholes for same		400	0	0
Platelaying, including average amount of special track work, 5,280 at 3s.		792	0	0
Temporary track (one track laid and repaved on side of street with turnouts) at £1,350 per mile of street (divided into two tracks for double-track construction)		675	0	0
Special track work of cast steel construction with hardened centres		1,128	0	0
Obstructions (necessarily very indefinite)		1,000	0	0
Feeder ducts		800	0	0
Extras and contingencies		630	0	0
		£16,493	13	0

Certain costs, notably those for temporary track, feeder ducts, obstructions, special track work, and curves, must be largely hypothetical, but the author believes that for average conditions and for this type of construction this figure will be reasonably safe, except for the item of sub-surface obstructions. This may be small or again inordinately large, depending upon local circumstances.

In closing, the author wishes to emphasise one point: the transmission system for a conduit road being wholly an insulated one can be calculated for the most economical drop of potential, which is not the case of an overhead line with rail return. Considerable saving, either in copper or boosters or both, can so be effected, which should be put to the credit of the conduit system in any estimate of the cost of such a system.

Discussion.

The President (Mr. W. H. Maw) thought the paper was a most interesting one, and on a subject of very great importance. They were only just commencing the application on a large scale of electric traction in this country, and this paper came at a most opportune time. They were all very anxious to find out the defects of the present systems of electric traction, and he hoped, therefore, that the paper would have a thorough discussion.

Mr. J. S. Raworth said they were all aware that the London County Council were proposing to put down the conduit system of tramways in South London, and that, he believed, would be the first example of the sort in England. From his youth upwards there had been a violent antagonism to tramways in England, especially on the part of those who owned or rode in carriages, and the tramways in this country had been carried forward and brought to their present state of efficiency, or inefficiency, principally by the power and ability of companies. The main objection was to the rails in the roads. He thought they would agree with him that if they decided to put down this conduit system or any other system, it must be one in which the surface of exposed iron was less than the width of a horse's hoof. Mr. Connett had explained that it was possible to put down the conduit system with a slot of only ¾in. He was very glad to hear this, for at Budapest the slot in some places was wide enough for a cat to get in. In Brussels there was one line on which the slot measured from 1¼in. to 1⅜in. in width, but in some places it was much wider. They were not going to have that sort of thing in England, and the aim of all engineers in this work must be to reduce the exposed surface of iron as much as possible.

Mr. S. Z. de Ferranti considered that the value of this paper was shown by what Mr. Connett had put before them in the shape of a combination of the overhead and underground systems of electric traction. Anyone who had considered the problems must agree that the overhead system in a large city became an intolerable nuisance, and the great value of this paper was that it had pointed out what could be done with the combined system of conduit and overhead traction. With regard to the trolley system, they had heard a great deal lately from Liverpool, and yet another large city, Manchester, was going to adopt the same method of conveying the electrical energy to the tramways, and run the same risks. In his opinion the combined system ought to be adopted—*i.e.*, to have the conduit in the towns, and change over to the overhead system in the suburbs. In some towns, however, especially manufacturing towns in Lancashire, where it was rather damp, he thought it better to have the overhead system. There was one point not touched upon in the paper, and that was the question of obstructions under the streets of our English cities. These were simply enormous. There had been very little system in carrying out the underground work—the laying of gas and water mains, etc.—in this country, and he thought that the difficulties from this source would be very great indeed, and would lead to heavy expenditure in laying the conduits. Taking an average, he calculated that these obstructions could not be removed for less than £3,000 a mile. The underground system required very careful consideration and practical experience on the part of the people who were entrusted with the design of the conduit, and he advised that it would be better to follow what had already been done than to try something new, which might result in approximate failure.

Mr. E. W. Monkhouse had had the advantage of seeing most of the systems to which the author had referred. The Budapest system was the oldest in the world, having been in operation since 1881, and if he mistook not, the form of plough used there was about as cheap an article as could be constructed for that purpose; it cost 7s. 6d. With regard to the width of the slot, he believed that the New York conduit systems had a slot only ¾in. wide, and as they had many miles in operation, he thought there could be no doubt that a ¾in. slot was very practicable. With regard to obstructions underground, that was a very serious question no doubt, but he did not believe that it would entail an expenditure of anything like £3,000 a mile, as stated. The author had not touched at all upon the surface-contact system. He thought a good deal might be done in that direction if they could find some way of preventing live contacts being left behind the cars. If a subsidiary contact system could be devised, it would be a capital thing for the centre of towns without risk of underground obstructions. He thought, however, that Mr. Connett had done the tramway industry a great service by bringing forward this paper.

Mr. M. Holroyd Smith was pleased to find that what he had ventured to propose some 12 years ago—viz., the conduit system for the principal towns and cities and the overhead wires for the suburbs—had now been recognised. It was true the Budapest slot was much too wide to be adopted in any of our cities, and the object must now be to reduce this as much as possible, and to construct the surface of the conduit in such a way that it would be sufficiently strong and yet would present no broad surface for the horses' feet. A method he had adopted in a particular case was this: The surface of the conduit consisted of channelled steel, and what he did was to fill in this groove or channel with blocks of wood. The width of the metal sides was then only ⅜in. each. It was a successful solution of that problem. If it would be of any advantage, he would be very pleased to add an appendix to the paper, giving numerous little details which might be useful to those engineers who had charge of the design and construction of tramway conduits.

Mr. E. Kilburn Scott thought there was something to be said in favour of the side-slot over the centre-slot system. Up to the present the side slots had always been laid along the two interior rails, and that had made it necessary to have two ploughs. But there was no occasion for this. The side slots could well be laid down the same side of each track, and one of the two ploughs could thus be done away with. The side slot would not be more expensive. This system had been put down in Berlin, the width of the slot being 1$\frac{5}{16}$in. Mr. Connett mentioned in his paper that owing to the various junctions of the lines, the slot must be ¼in. wider at these places. If the slot were ¾in. in width, that would bring it up to 1¼in. at the junctions. The author gave a description in his paper of a means of raising the plough vertically. This was not necessary. He thought the plough could be made to go to the side of the conduit, and so be clear of the conductor. It was in these little points of construction that Mr. Connett had done a very great service to electrical engineers in bring them to their notice.

Mr. W. R. Cooper asked for information as to the cost of maintenance with the conduit system per car mile. The author had only given the capital cost.

Mr. James N. Shoolbred hoped it would now be recognised by corporations that it was possible to combine the two systems of electrical traction. The paper pointed out in a simple and clear manner that the change from the trolley to the conduit system could be made with comparative ease. With regard to the extra cost of the conduit system, he thought that ought not to be taken into consideration in determining which was the better system to adopt. At the present time several corporations—notably Liverpool—were trying this system of overhead trolley wires right into the middle of their towns, and in consequence there was an outcry on all hands against the way in which the principal streets had been defaced. With regard to details, it had been pointed out

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that Brussels had the advantage over other cities in that the change could be effected without stopping the car. That might seem a matter of considerable importance, but it was not nearly as important as it appeared to be at first glance, especially when it was considered that the point at which the change would take place would naturally be an ordinary stopping place for passengers. With regard to Manchester, he thought it would be a great pity if a mistake occurred, such as was made at Liverpool, in causing the very centre of the city to be defaced by the overhead trolley wires.

Mr. E. Tremlett Carter said there was one point which was not touched upon in the paper—viz., the fact that the conduit system not only did away with the alleged unsightliness of the trolley system, but it also provided for an insulated return of the current from the car. This was considered in certain circumstances to be necessary in order to prevent electrolysis of the gas and water mains. There was certainly more risk of this dangerous electrolysis occurring in the cities than in the rural districts, and the conduit system obviously, therefore, adapted itself to the cities and the overhead system to the rural districts. The change from the one system to the other did not occupy more time than it took to change from the horse to the cable traction at Kennington on the County Council tramways. With regard to the width of the slot, it was extremely important to have it as small as possible.

Mr. Roger T. Smith, dealing with the question of design, said the most important thing was to reduce the depth of the conduit as much as possible, so as to lessen the chance of obstruction. Mr. Connett stated that the first thing to settle was the height of the conductor bars. In one illustration given by the author there were only 2in. allowed between the surface of the road and the top of the insulator. Another instance given by the author, in which the insulator was fixed on to the slot rail, brought down the top of the conductor bar so low that the depth of the conduit was very great indeed. It was quite possible to design other forms of insulators differently fixed in which the depth might not be so great. It remained to be seen what depth below the conductor bar they must have to clear away the water. He would ask the author if the very great depth that was shown in the illustrations for the accumulation of dirt and water was really necessary. In London there was a conduit line at Brixton for cable system, and at its lowest point the cable was 5in. from the bottom. There was no difficulty in working with that depth below the cable. The cost for cleaning was £70 or £80 per mile single track per annum. Would it not be worth while to go to this expense to keep the conduit clean? As to the question of the central slot rails, Mr. Raworth spoke of 6in. as the width of the surface on the road. In his opinion, it was quite possible to reduce that figure to 4½in., which was a width which would not very seriously interfere with the working of the ordinary street traffic.

Mr. Alfred Baker asked the author his opinion with regard to the design of the yokes. In America the conduit was on the centre-slot construction, the slot itself being about ⅜in. in width, and the yokes were designed not only to form a tube, but also to carry the running rails. He should like to know whether the author would advocate the use of such a yoke in this country if the centre slot were adopted.

Mr. Connett, replying on the whole discussion, dealt first with the width of the slot. The question depended entirely upon whether the side or the centre slot were adopted. All side slots were wider than the centre slots. In Paris, with the side construction, the slot was about 1¼in. wide, but with the centre slot the width could have been reduced to ⅜in. In New York the width of the slot was ⅜in., and the same at Washington. About the width of the conduit surface a special construction could reduce that very readily. He himself believed in giving a fairly good width, and keeping the road operating at all times. In Paris, for instance, the authorities objected to another band of iron in the street, and for that reason it was necessary to devise the side slot. He personally thought the centre construction was the better and more simple, but the side slot was all right, although he must admit it was much harder to uphold the insulation of the plough with the side slot. In Paris they had had more or less trouble through the ploughs breaking down. After a snowstorm the dirt and water got into the conduit, and considerable damage was done in consequence. They had taken precautions now to take the ploughs out of the conduits every night and dry them before replacing them, and since then they had had no trouble at all. In his opinion the two slots on the two interior rails made the best construction. The advantage of the conduit having an insulated circuit was, of course, evident in itself. With regard to the cost of the operation of the conduit system, he would give it in a comparative way between the conduit and the trolley lines in Brussels. There the difference was as follows: The cost of operating the conduit lines per car mile was 1¼ farthings in excess of the trolley lines. Including the fees charged, this figure was increased to 2⅛ farthings. As to the cost of cleaning the conduits in Washington, the figure was £5. 10s. per mile of single track per annum. With regard to the depth of the conduit and the space to be allowed between the bottom and the conductor, he still believed it was necessary to have 8in., 9in. or 10in. He might say that the case was one entirely different from a cable road. It was better to have a good depth of conduit rather than have it too shallow, which might result in a partial failure. As regarded the yoke, when he was in America, in the earlier constructions they never thought to make any yoke which did not carry both slot and running rail, but one had only to go to the Continent to see that this was absolutely unnecessary. The iron which was taken to carry the steel rail was entirely thrown away. For himself, he would never put it in again.

A vote of thanks was accorded the author.

ELECTRICAL WORK AT THE FRONT.

Earl Roberts in his dispatch to the Secretary of State for War, dated April 2, gives a general *résumé* of the good work done by the various departments of the army in South Africa, and of the difficulties which had to be overcome. Special attention is paid in the dispatch to the great difficulty of maintaining a continuous service of supplies over the large areas involved. Great credit is given to the various officers engaged both in repairing and maintaining the railway lines, and in organising the disembarkation and forwarding of the stores. The figures given of the quantities of material which had to be handled day by day are most interesting, coupled with the fact that these supplies were practically always to hand when wanted. It is, however, with the telegraphs and signalling that our readers are more closely concerned, and we give the following extracts from the report to show Earl Roberts's appreciation of the work done by these branches of the service:

"*Army Telegraphs.*—The duties performed by the army telegraphs under Lieut.-Colonel R. Hippisley, R.E., throughout the war have my entire approbation. No portion of the army has had more work or greater responsibility than this branch. With a *personnel* of 25 officers and 1,221 operators, linesmen, etc. (of whom 4 officers and 153 non-commissioned officers and men have died or been invalided), nearly 2½ millions of messages have been dealt with during the past 13 months, some of containing as many as 4,000 words. The telegraph systems taken over, repaired, and maintained exceed 3,300 miles in length, with over 9,000 miles of wire. In addition, 959 miles of air line have been erected and 1,145 miles of cable laid. Great credit is also due for the quick way repairs to the lines, so frequently interrupted by the Boers, have been carried out. This is most dangerous service, as there is always a chance that the enemy may be lying in wait near the break, but there has been throughout the most unhesitating promptitude in its performance. The young officers in charge of cable carts have also often had perilous work to perform when winding back their wire, alone or with a very small escort.

"*Submarine Telegraphs.*—The working of the submarine telegraphs was most satisfactory, and the liberality of the companies in giving special rates for soldiers was much appreciated by the army.

"*Signalling.*—The work done by the signallers, under the experienced guidance of Major T. E. O'Leary, R.I.F., during the campaign has been very arduous, and has frequently been carried out at great personal risks. The young officers and the N.C.O.'s and men employed have risen to their responsibilities, and have in almost every instance acquitted themselves to my entire satisfaction. The establishments for the different units have been found to be too small, and the absence of signallers with the Militia and Royal Artillery has necessitated men being attached from other branches from which they could ill be spared. The electric searchlight used for signalling purposes in connection with the relief operations of Ladysmith and Kimberley was of great service, and was provided by the naval authorities."

Later on in the report, after describing the rearrangements which had to be made in the field transport, Earl Roberts says: "An account of the transport in South Africa would be incomplete without a reference to the steam traction engines and trucks, which were sent out in charge of Lieutenant-Colonel Templer, 7th Battalion King's Royal Rifle Corps. These were first landed in Natal, and afterwards transhipped to Cape Town, where some were employed for carrying stores from the docks, the remainder being utilised at Kimberley, Bloemfontein, Johannesburg, and Pretoria. At these centres, where coal and water were readily obtainable, the engines proved a valuable adjunct to animal draught, but owing to the absence of fuel they could not be used on the line of march, or to haul supplies to bodies of troops encamped more than 20 miles from a coal depôt. From a military point-of view, the defect of steam traction lies not only in the impossibility of working it unless coal and water are available at each halting place,

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but in the weight of the fuel and water which each engine has to drag along, thus expending much of its tractive force. This defect would be greatly lessened if an efficient oil motor could be substituted for the steam motor, as in that case no water would be wanted, while the coal would be replaced by a more portable and concentrated description of fuel."

BIRKENHEAD TRAMWAYS PLANT.

The accompanying illustration represents two of Messrs. Ernest Scott and Mountain's enclosed high-speed steam engines and dynamos which they have supplied in connection with the electric tramways for Birkenhead. These have been erected at the sub-station which the Corporation have recently erected in New Chester-road, adjoining the destructor buildings, and are to supply the electric current for the tramways for the southern portion of the borough. The plant consists of two of Messrs. Scott and Mountain's enclosed compound central-valve, self-lubricating high-speed steam-engines, each having cylinders of the following dimensions: diameter of high-pressure cylinder, 11½in.; diameter of low-pressure cylinder, 20in.; stroke, 10in., at a speed of 360 revolutions per minute and a steam pressure of 140lb. The engines can each develop 240 i.h.p. when condensing with a vacuum of 24in. The engines are each

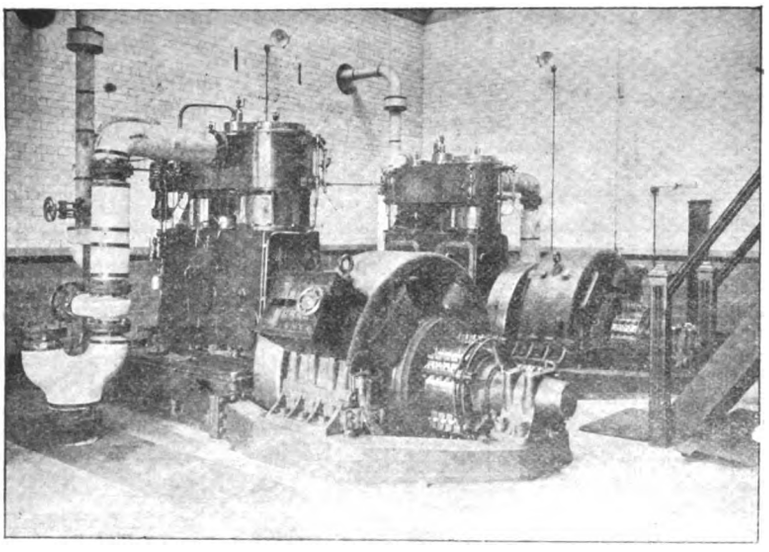

FIG. 1.—View of the Birkenhead Tramway Generators.

fitted with a governor of the throttling type fitted with by-pass, enabling the steam to enter the low-pressure cylinder direct in the event of a sudden overload being thrown on the engine. Steam separators, with connecting pipes and cocks, are also fitted, as well as indicator gear and the usual accessories. The engine is fitted upon a combination bed-plate of cast iron, which is arranged to take the generators.

The generators are of Messrs. Scott and Mountain's four-pole type with slotted drum armatures, each giving an output of 273 amperes at 550 volts. These dynamos, when running as shunt machines with all adjusting resistance of the magnets cut out, will be capable of giving an output E.M.F. of 600 volts at the normal speed. Each dynamo is complete with two shunt-breaking switches and resistances, two shunt-regulating switches and resistances, two series diverting switches for adjusting the strength of the compounding coils on the machines. The same firm have also just completed four similar sets for the Darlington Corporation of 400 h.p., three sets for Worksop Corporation, three sets for Worthing Corporation, and three sets for the Hill-of-Howth electric railway in Ireland.

LEARNED SOCIETIES' CONGRESS.

The first sitting of the congress of the International Association of Learned Societies was held in Paris on Tuesday last, M. Darboux, the permanent secretary of the Paris Academy of Sciences, presiding. Delegates attended from some 16 scientific bodies in Europe, the following being the list of cities represented: Amsterdam, Berlin, Brussels, Budapest, Christiania, Göttingen, Leipzig, London, London, Munich, Paris (Académie des Inscriptions et Belles Lettres, Académie des Sciences, and the Académie des Sciences Morales et Politiques), St. Petersburg, Rome, Stockholm, Vienna. London was ably represented by Prof. H. E. Armstrong, Prof. A. R. Forsyth, Sir Michael Foster, K.C.B., Sir Archibald Geikie, Prof. E. Ray Lankester, Sir Norman Lockyer, K.C.B., Prof. A. W. Rücker, Prof. A. Schuster.

M. DARBOUX opened the sitting with an admirable speech, explaining the object of the work of the International Association, which has been in existence for 14 or 15 months. He attributed the original idea of association for scientific research to Lord Bacon, recalling the curious conception of the College of the Six Days' Work or the House of Solomon, which, however, was never realised. To-day, such was the range of scientific activity, no such scheme could ever be realised, and only the common agreement and reciprocal support of the nations could suffice even to undertake the solution of the problems which were now imposed in all their multiplicity on the attention of the world. Such agreement had been secured for a certain number of special questions, such as the International Bureau of Weights and Measures, the International Geodetic Association, the Association for the Map of the Heavens, and notably the international catalogue of scientific literature due entirely to the initiative of the Royal Society. The task that they had undertaken might appear difficult, but it had become absolutely necessary, and the spirit actuating them ought to give them the assurance that they should succeed by their united efforts in overcoming all difficulties. The association would render to civilisation and science a service of which it was impossible to exaggerate the importance. Thanks to it the man of science devoting his life to the most delicate or the most abstract researches would cease to feel himself isolated, while still preserving that independence which was the greatest good and the primary need for the investigator. By uniting in the different academies all those who were studying the same subjects, by giving them, if they wished it, the opportunity of joining in a common work, by drawing the attention of the Governments to all the schemes the speedy realisation of which was necessary or desirable, by indicating to them also the means of executing these schemes in the most favourable conditions and with the greatest possible saving, and by proposing and preparing through the common understanding of *savants* in the domain of theory the agreements of peoples on the basis of practice and facts, their association was destined to become rapidly one of the most powerful instruments of concord and of progress.

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The chairman having concluded his remarks by declaring the first general assembly of the association open, the bureau was chosen as follows: Hon. presidents, Dr. Mommsen, M. de Goeje, Sir Michael Foster, M. Berthelot, and M. Gaston Boissier; acting president, M. Darboux; vice-president, Dr. Diels; secretaries, MM. Gomperz and Moissan.

Among the items on the list of works for examination was a scheme relative to the mutual loan of manuscripts, and a committee, constituted as follows, was appointed to consider the question: M. Léopold Delisle, Dr. Mommsen, Prof. E. Ray Lankester, M. E. Perrier, M. de Goeje, and Herr Krumbacher. Another committee, composed of Dr. Diels, M. Darboux, M. Picot, M. Gréard, M. Lindemann, and Dr. Mommsen, was appointed to examine the idea of the publication of a complete edition of "Leibnitz."

Later on, Count de Franqueville, the president of the Institute, gave a reception at his residence, the Château de la Ninette. During the course of the evening the orchestra performed Balfe's overture to the "Bohemian Girl," in the honour of the Royal Society of London.

ACCUMULATOR TRIALS.

The testing of accumulators is not such a simple matter as it seems to those unaccustomed to the work, and the value of the results arrived at depend rather largely on the procedure adopted in carrying out the tests. Amongst other things, it is highly essential that a large number of charges and discharges should be made in order to arrive at reliable results. We give below an article which appears in the March number of the *Automotor Journal*, with a view of illustrating the way accumulator trials should not be made. We have not reproduced the voltage curves which are given in the original article, because the diagrams are not sufficiently clear to be of value. The article reads as follows:

In October last, in connection with the Rosenthal-Joel electric car, we gave a fully-illustrated description of the "National" (then called the Rosenthal) accumulator. We were then only able to give the makers' figures with regard to weights and capacities, and as the results claimed by them appeared to us to be very high, we expressed a hope to be in a position to verify the figures given at no very distant date; but we pointed out that it was difficult, even after seeing the grids and the plates, to credit such a satisfactory combination of durability and capacity.

Since then Mr. Joel has been good enough to send us one of the 32 cells which formed the battery upon the vehicle which ran three times to Brighton, and which took part in the trials at Chiselhurst last November. We are assured that this particular cell has been in use upon the car throughout these runs, and that the vehicle has made about 500 miles in all with its assistance. We are also assured that no renewals of any kind have been made to it during that period.

Upon receiving the cell we examined it thoroughly, and it appeared to be in excellent condition. The results which have since been obtained fully confirm this point, and, as will be seen, this cell comes up to the claims originally made by Mr. Joel. It is with great pleasure, therefore, that we publish herewith a full account of our tests, and we frankly admit that, if all the Rosenthal cells are as good as the one sent to us, we do not know of a better lead-lead accumulator as regards capacity × weight × durability.

The cell consists of five positive and six negative plates, each of which is 6¾in. high by 3½in. wide by 3/16in. thick, and the weight complete with acid is 23¾lb. The normal capacity is given at 140 ampere-hours, and the rate of charge and discharge at 20 amperes. The maximum safe charge and discharge rate is put at 40 amperes, and the capacity at this high rate is said to be lower.

The tests carried out by us were as follows: When received (Feb. 7) it was charged (although sent out fully charged) at 20 amperes for 2½ hours = 50 ampere-hours, and the acid then had a specific gravity of 1·290.

It was then discharged at 20 amperes until the acid stood at 1·160, and the voltage had fallen from 2·08 to 1·86. This discharge lasted 6¾ hours, giving a capacity of 135 ampere-hours. Although not fully discharged the watt-hour capacity was 270, or over 11½ per pound of cell.

The following morning (8th) the acid showed specific gravity 1·150, and the cell was recharged at 20 amperes for six hours, when the acid read 1·270. On Feb. 9 a further charge of three hours at 20 amperes brought the acid from 1·275 to 1·280, and the cell was allowed to rest over Sunday. On Monday (11th) a further charge of two hours at 20 amperes brought the acid up to 1·285, when a discharge was taken at a rate of 20 amperes.

This discharge gave a capacity of 140 ampere-hours between 2·1 and 1·82 volts, and 150 ampere-hours to 1·54 volts. At the lower figure we get 279 watt-hours, or nearly 11¾ per pound, and, taking the full discharge, we get about 296 watt-hours, or nearly 12½ per pound. The acid at the end of this discharge was 1·130.

On the 12th a charge of 160 ampere-hours, and on the 13th of 40 (at the 20-ampere rate), were given, and as the acid then stood at 1·285, it was brought up to 1·340 by the addition of 1·400 acid.

A discharge was then taken at 20 amperes, and between 2·13 and 1·82 volts 150 ampere-hours were given, which equals 304 watt-hours, or 12·8 per pound. The acid then showed 1·195, and the following morning (14th) was 1·185, when a fresh charge of 190 ampere-hours at 20 amperes was given.

On the 15th a short charge of half an hour at 20 amperes brought the acid to 1·320, and the fourth (20 amperes) discharge was taken. This time the capacity was 145 ampere-hours from 2·16 volts to 1·8 volts, another five ampere-hours of discharge reducing the E.M.F. to 1·5, and the acid to 1·190. The capacity to 1·8 volts works out at 287 watt-hours, or 12 per pound. The cell remained in this condition until the 18th, when the acid stood at 1·175. It was then recharged at 20 amperes for 9½ hours (190 ampere-hours), and on the following day for 2½ hours (50 ampere-hours), when the acid reached 1·320. A discharge at 30 amperes was taken immediately after this, and 142½ ampere-hours brought the voltage down from 2·1 to 1·82, and to 1·53 at the end of the next 15 minutes. The acid fell to 1·185. Taking the useful capacity as being 145 ampere-hours to 1·8 volts, we get about 290 watt-hours (nearly 12½ per pound).

Recharging 190 ampere-hours (at 20) on the 20th, and 50 ampere-hours (at 20) on the 21st, brought the specific gravity of the acid from 1·180 to 1·320. A discharge at 30 amperes on the 21st gave 142½ ampere-hours from 2·12 volts to 1·8 volts, 145½ ampere-hours to 1·7 volts, and 150 ampere-hours to 1·57 volts. The result of the test is very similar to the previous discharge. On the 22nd a charge of 30 amperes for one hour, on the 25th of 20 amperes for seven hours, and on the 26th of 20 amperes for three hours (total 230) were given, and the acid then stood at 1·315.

The cell was again discharged at 30 amperes, and this time it gave 165 ampere-hours between 2·15 volts and 1·8 volts, or 172½ ampere-hours to 1·6 volts. The former gives 330 watt-hours, or 13·89 per pound, and the latter 341 watt-hours, or 14·35 per pound. The acid fell to 1·180.

On the following day (27th) four hours' charge at 25 amperes and 113 ampere-hours at 30 amperes were put in, bringing the acid up to 1·305, and on the 28th a further charge of 55 ampere-hours (at 20) was given. The acid at the end of this exceptionally long charge (268 ampere-hours) stood at 1·310. A further discharge at 30 amperes was then taken. The capacity was 165 ampere-hours to 1·82 volts (from 2·12 volts), 172 ampere-hours to 1·74 volts, and 180 ampere-hours to 1·66 volts (acid 1·160). The respective watt-hours are 330, 342, and 356, and the capacities per pound are 13·89, 14·4, and 15 watt-hours. On March 1 charging was carried on at 40 amperes for three hours (acid 1·290), and the following day at 40 amperes for 2½ hours (acid 1·305). A discharge at 40 amperes was then taken, 140 ampere-hours being obtained with a drop of voltage from 2·14 to 1·8, and 150 ampere-hours to 1·67 volts (acid 1·190). We here get a capacity of 296 watt-hours, or 12½ per pound.

Recharging one hour at 30 amperes on the same day, four hours at 40 amperes on the following day, and 2½ hours at 40 amperes on the 6th, the acid rose to 1·310. A discharge at 40 amperes was then taken, with results similar to but slightly less than those of the previous discharge; 140 ampere-hours reduced the voltage from 2·12 to 1·78, and it further fell to 1·56 at 150 ampere-hours (acid 1·190).

At the conclusion of this discharge the cell was given a one-hour charge at 20 amperes, and on the following day it was given a further charge of six hours at the same rate and three hours at 30 amperes (total, 230 ampere-hours). The acid then stood at 1·305, and the cell was left on open circuit from March 7 to 11, when (acid 1·290) a discharge at 20 amperes (no charge having been given to it since the 7th) gave 100 ampere-hours between 2·06 volts and 1·71 volts.

The above tests, therefore, give the results of four discharges at 20 amperes, of four at 30 amperes, and of two at 40 amperes. The last test—that of 20 amperes after a rest of 88 hours in a fully-charged condition—being made with the object of ascertaining the loss on open circuit; and, as will be seen, this resulted in a somewhat unsatisfactory discharge.

The first thing which strikes one in looking through the above account of experiments carried out by the staff of the *Automotor Journal*, is that a special attempt was made to

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obtain a large discharge in ampere-hours from a given cell. In order to do this, it will be seen that the cell was always charged up more than once. In certain instances the charge was put in on three separate occasions, and we gather that in every case except the last the discharge was taken immediately after the last charge had been given to the cells. Again, in working out the capacities of the cells in watt-hours from the discharge in ampere-hours, it is curious to note that the experimenters have assumed, in practically every case, that the average voltage during the discharge was two volts, in spite of the fact that the discharge was carried down to about 1 8 volts. In fact, in certain instances the factor by which the ampere-hours was multiplied is slightly higher than 2. Although the curves given do show the first portion of the discharge being taken out at more than two volts, we think that from experience elsewhere these higher values are erroneous, and that the voltmeter may have been at fault. If with the high discharge rates employed an average of 1 9 volts was got, it would be even then considerably higher than one would expect. The most essential feature, however, in connection with the report which calls for adverse comment is that although great stress is laid on the high number of watt-hours obtained from an accumulator of small weight, there is no remark made as to the efficiency of the cell or that the efficiency is reduced in consequence of the high discharge. We have taken out the efficiency figures in each case, and find that most discordant results are obtained, which bears out our remarks as to the need of lengthy experiments before any real conclusions as to the capacity and durability of an accumulator can be arrived at. We cannot, from the figures in the report, get at the actual energy efficiency, but have to restrict our remarks to the ampere-hour efficiency, which is, of course, very much higher than the energy efficiency. In the three discharges at 20 amperes the efficiency as the ratio of ampere-hours in the discharge to ampere-hours in the charge comes out at 63·5, 75, and 72 5 per cent. respectively. When the discharge was increased to 30 amperes, the efficiency in the four cases was 59, 60, 72, and 60 per cent. Again, with the 40-ampere discharge, the efficiency was 64 per cent. in the first experiment and only 48 per cent. in the last. Even with the best of the figures so obtained it is clear that on the energy basis the efficiency of the accumulator would fall below 50 per cent. for the 20-ampere discharge rates, and to an abnormally low figure with the higher discharge rates.

It seems to us that the one reason for the low efficiency of the cell is the method of charging, which is not that which would be adopted in actual practice. It is the more to be regretted that the efficiency question was not taken up in the report, because we believe that the cell might be made to give good results if treated in the ordinary way. As it is now, the claim in watt-hours per pounds is high for two reasons, the first being that the efficiency was sacrificed in order to obtain these high figures, and the second reason being an error in converting ampere-hours into watt-hours. It is interesting to compare the results obtained with those which were arrived at in Paris last year on the extensive trials carried out by the Automobile Club of France on a great variety of accumulators. At these trials the best cell was of English make, and it stood 135 charges and discharges in the course of the test with an energy efficiency of just 70 per cent. The number of watt-hours per pound of cell, however, was 5·25. Another battery which did good work at these tests, having 100 charges and discharges, gave 6·8 watt-hours per pound of plate, and had an overall energy efficiency of 66 per cent. The efficiencies were worked out in this case for the whole period of trial, but the cells for individnal weeks gave considerably higher results, which went up even to 77 per cent. Our conclusion on the matter is that the figures arrived at by our contemporary are unreliable in view of the methods employed in testing, and that the unduly high capacity found per given weight was accompanied by an exceedingly low efficiency, which would very greatly increase the cost of working an automobile equipped with these accumulators.

CATALOGUES RECEIVED.

The Brush Electrical Engineering Company have forwarded to us a new catalogue they have just issued, dealing entirely with electric traction plant. Our attention is called to the fact that the company make complete equipments for electric traction, including engines, dynamos, alternators, motors, controllers, trucks, and car bodies. The works at Loughborough have been specially altered in recent years to enable tramcar motors and cars to be manufactured in quantity. In the catalogue before us some valuable information is given of the performance of the traction motors manufactured by the firm. In every case the rating is on the basis of the output for an hour with a maximum temperature rise of 115deg. F. The range of motors commences with a 17-h.p. size, and goes up to a motor of 50 h.p., for which, however, a 4ft. 8½in. gauge is required. The curves given of the performance of these motors will be found of use when making a selection for any particular line. We notice, among other things, that the company have adopted a maximum traction track for their large bogie cars, and that this type is being supplied by them to the Manchester Corporation.

We have received from the Electrical Company, of 122-124, Charing Cross-road, their new reference list of dynamos and motors, which give particulars of the various installations to which they have supplied machines in the United Kingdom. The total output of these dynamos and motors aggregates over 12,000 h.p. The same firm have also issued a list of their quick-break knife switches of voltages up to 550 volts.

We have received a new and revised edition of Messrs. W. B. Haigh's catalogue of wood-working machinery. Among the changes introduced into this edition we particularly notice the inclusion of machines complete with electric motor, and in anticipation of the growth of this branch of the business, the firm have recently installed new machine tools for the manufacture of their own dynamos, motors, and electrical accessories.

FORTHCOMING EVENTS.

FRIDAY, APRIL 19.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Mr. Wm. H. Maw will deliver his presidential address.

Royal Institution.—At 9 p.m., Prof. J. J. Thomson on "The Existence of Bodies Smaller than Atoms."

SATURDAY, APRIL 20.

South-Western Polytechnic.—At 7.30 p.m., annual conversazione and prize-giving by Sir William Preece, K.C.B., F.R.S.

MONDAY, APRIL 22.

Society of Arts.—At 8 p.m., Cantor lecture, "Alloys," by Sir William Chandler Roberts-Austen, K.C.B., F.R.S.

TUESDAY, APRIL 23.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., annual general meeting.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "Modern Practice in the Manufacture and Distribution of Gas," by Mr. Harry E. Jones.

WEDNESDAY, APRIL 24.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "Patent Law Reform," by Mr. Alexander Siemens. The Right Hon. the Lord Chief Justice will preside.

Institution of Civil Engineers.—At 3 p.m., students' visit to the shipbuilding department of the Thames Ironworks, Shipbuilding, and Engineering Company, Limited.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper on "Distribution of Energy in Coal Mines," by Mr. F. E. Pring.

THURSDAY, APRIL 25.

Institution of Civil Engineers.—At 8 p.m., special meeting. The ninth "James Forrest" lecture, by Prof. Frank Clowes, D.Sc., on "Chemistry in its Relations to Engineering."

Institution of Junior Engineers.—"Works Management," by Mr. A. H. Barker (lecture VI.).

FRIDAY, APRIL 26.

Society of Arts.—At 8 p.m., Howard Lecture. Paper: "Polyphase Electric Working," by Mr. Alfred C. Eborall.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On the Thermodynamical Correction of the Gas Thermometer," by Prof. Callendar, F.R.S.; "On the Production of a Bright-Line Spectrum by Anomalous Dispersion and its application to the Flash-Spectrum," by Prof. W. R. Wood.

Royal Institution.—At 9 p.m., Dr. Hans Gadow on "Colour in the Amphibia."

SATURDAY, APRIL 27.

Institution of Electrical Engineers—Students' visit to the works of Messrs. Easton, Anderson, and Goolden, Erith.

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TO CORRRSPONDENTS.

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UNSATISFACTORY EDUCATIONAL SYSTEM.

Prof. Perry has issued his presidential address, with various other articles and letters, in the form of a pamphlet. The whole gives some food for thought and is lively reading, for the author is nothing if not vivacious. He has genius, ability, and natural aptitude for teaching. Some points he exaggerates, some need interpretation, but generally his arguments carry conviction. We are going to ask him in another address, article, or letter to define the sphere of technical education. Let us suggest the problem: How far does proper systematic education lead to invention or the perfection of the crude invention? It seems to us that its sphere more directly concerns the latter than the former. Examine into a few of the great departures of the past. Watt, who practically gave us the modern steam-engine, can hardly be said to have been the product of scholasticism. Stephenson, who evolved the germ of the modern locomotive, was a self-taught man. "Brindley, the neglected son of a dissipated father," hardly able to write his own name, carried out works to surpass which would tax the abilities and experience of many of the great engineers of the present day. Harrison, a poor carpenter, gave us the chronometer, while Arkwright gave up his trade of collecting hair for barbers in order to devote his attention to the introduction and perfection of Wyatt's idea of spinning by machinery. Arkwright was steeped in poverty, unable to spell or write correctly, once mistaken for a vagabond; yet he triumphed, and gave "Britain a new character in the commercial world." Dr. Cartwright, knowing nothing of mechanics, and had never seen a loom previous to making his own, evolved the power loom. A blind man constructed many of our best roads. Coming to recent years, and more directly to electrical engineering matters, we fancy that neither Edison, Gramme, nor Swan had scientific training in the modern acceptation of the term. Bell was probably more a philologist than a physicist. Nature endowed these men and others that might easily be named with inventive powers, while education endowed other men equally well known with the acumen to investigate, the power and ability to suggest and execute the alterations required to bring about greater perfection in the apparatus originally devised. We may be altogether wrong, but appeal to history seems in our favour, that scholastic training rather retards and trammels the inventive faculty, while it increases even when it does not create the power of perfecting what is obtained in a crude state. We are fain to admit the chemist to be in a somewhat different category to other workers. Here the laboratory reigns almost supreme; analysis and synthesis are the tools of the expert, and to the expert we look for progress. Our purpose in making these remarks needs explanation. We object to this continued iteration of Shakspere's view, that this country must be followers rather than initiators, when he says:

> "Proud Italy,
> Whose manners still our tardy apish nation
> Limps after in base imitation."

For many long years we have initiated improve-

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ments, and there is no indication that we are yet played out. Our cousins in America—men of our own race and blood—are quite as capable as ourselves in initiating, and it would be a strange spectacle if one brother arrogated to himself the power to start without remembering that his brother with the same training as himself possessed similar advantages, and was quite capable of making a start also. Why deny equality to the brains of America? So doing seems childish. We simply deny superiority either of intellect or energy. Here is the whole case in a nutshell. Prof. Perry says, "Much of the evil we suffer from" (we do not agree that the evil exists) "is due to our average young men being pitchforked into works where they get no instruction as soon as they leave school." "Where they get no instruction"—well, let the *proper* instruction go on contemporaneously with the practical work. The words of a writer in the fifties are as true to-day as they were then, and we fear the fact portrayed by them has as much to do with our present position as anything. The writer says: "It is a singular and a mournful fact that every one of the great improvements to which Britain owes her present prosperity has fought its way in the world against clamour, knavery, and contempt."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

POLYPHASE SUB-STATION MACHINERY.

SIR,—Referring to the account published in your issue of the 12th inst. of the discussion which took place at the Institution recently, after the reading of the above paper, I would ask you to allow me to add a few remarks in this column, as your reporter has somewhat altered the sense of my reply.

I opened my reply by stating that it was a matter of regret that one of the most important points connected with the design of large polyphase plants of the character in question had been barely referred to by the speakers. I referred, of course, to the question of the design and arrangement of the power station generating units, which is a question discussed at some length in the text of the paper It is (as I stated) one of the most difficult questions the designers of such plants have to solve, particularly when the generating units are of very large size running at slow speeds. Considering that the successful running of all synchronous sub-station machinery depends to a very large extent upon the suitability of the power station plant, it certainly does seem a pity that the paper was not criticised on this point by those present directly interested in the subject; judging by the large correspondence I have had on the matter since the paper was read, it would appear that a very profitable public discussion on this particular and very important point might have taken place, if those with a practical knowledge of the subject had not been so reluctant to give the meeting the benefit of their views.

Now, with regard to the damping coils, my point is that they are of relatively little use if placed round, or through, the pole-shoes; the copper is wanted principally along the pole-horns (parallel to the shaft)—that is, between the poles. I am quite convinced of this from personal observation, and I think that the explanation given in the paper regarding the distortion of the field flux of a rotary converter when hunting is sufficient to account for it. Since the paper was read, I see that Mr. Short, at Manchester (who has a large American practice to go upon), has stated the same thing, while my statement is further confirmed by the Central London rotaries (presumably designed under the eyes of Mr. Parshall or Mr. Steinmetz), in which the pole-shoes are bridged by copper plates, as described. I do not say that piercing the pole-shoes for the insertion of copper bars is useless, but I certainly think that for solid pole-pieces it is quite unnecessary, while for laminated pole-pieces it is a needless expense.

The use of choking coils in the feeder circuits is to get rid of or minimise the pulsations in the pressure due to the *synchronous machinery* fed from them, and it certainly pays to use them when lighting has to be done directly from the same feeders. Then with regard to the relative merits of distribution with direct current from the sub-stations and direct distribution with three-phase currents, what I stated was shortly as follows: that the conversion of the polyphase current into direct current is rendered necessary simply because polyphase electric *tramways* are entirely out of the question at the present time. On the one hand, direct-current equipments are standardised in every detail, and give excellent results from all points of view; on the other hand, the polyphase *traction* motor is greatly inferior for the purpose (with regard to speed control, starting performance, mechanical design, etc.), the heavy wattless currents throughout the system are very objectionable and wasteful, two overhead conductors are necessary (this objection disappears with conduit systems), and the balancing of a large system is very difficult. It is for this reason we need sub-stations and converting machinery, and we shall continue to need them until conduit systems are more usual, and until the performance of the polyphase *traction* motor can equal or excel that of the direct-current motor in the above respects.

For a combination of lighting and industrial power work, the case is quite different; for such purposes there can be no doubt that transforming sub-stations are an unnecessary expense; I should be the last one to recommend their use for such work. The balancing troubles we hear so much about in connection with three-phase systems of this kind are really non-existent with well-designed systems; they exist only in the imaginations of those who have no practical acquaintance with the subject, and in those installations that have not been properly arranged. Naturally, success with any three-phase system cannot be attained if the generators have a large drop on inductive loads, or if the feeders and distributing mains are not properly arranged, or if three single transformers are used instead of properly-constructed three-phase transformers. These latter help automatically to balance the system, as pointed out in the paper—it is only after about 100 kw. that they become somewhat heavy and expensive in comparison, but there is seldom any gain in using individual units larger than this size in the transforming sub-stations.

Yours, etc.,
A. C. EBORALL.

49, Cannon-street, E.C., April 13, 1901.

CENTRAL LONDON RAILWAY BOILER PLANT.

SIR,—I am somewhat surprised to learn that enquiries are being made in connection with the above plant for the addition of Lancashire boilers, which appear to be altogether unnecessary, for as far as I know the plant has never been worked to its normal output judging by the train service.

I find from articles which recently appeared in the technical magazines that there are 16 Babcock boilers, each with 3,580 square feet of heating surface, and I also find there are six main generating engines, each of 1,300 i.h.p., thus giving more than seven square feet of boiler heating surface per indicated horse-power. Now, each square foot of heating surface should evaporate at least 3lb. of water per hour, and this works out at 21lb. of water per indicated horse-power hour of engine, and certainly it is more than necessary for the requirements of this or any other well-designed plant.

The only possible reasons for this state of things can be the use of excessively bad coal or bad management in the running of the plant, and to bear out this statement I have learnt from a very reliable source that one of these engines was recently run by the contractors at full load for about 12 consecutive hours with steam from two

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boilers only, which burnt less than 2lb. of coal per indicated horse-power hour, and even this coal was not of the very best quality. On this basis, and making due allowance for the auxiliaries, the four engines which are in daily service should certainly be run with 10 or even less boilers, leaving six spare.

Every practical engineer knows that it is not economical to burn cheap and low-grade fuel, and the remedy I would suggest is to burn better coal, at far less total cost, and avoid being continually fined on account of smoke nuisance.

AJAX.

DANGERS OF CABLE-LAYING.

It is impossible to adequately appreciate the difficulties of cable-laying in wild regions, but the following details may convey some idea of the hardship and suffering endured by two corps of soldiers and engineers who were engaged in constructing a telegraph line between Dawson City and Fort St. Michael in Alaska. It appears that a miscalculation was made, and the two corps, working from opposite ends of the line, missed each other by 70 miles, and a relay expedition had to be dispatched to rescue the workers from death. The *Electrical World* publishes a letter from a Mr. Willard, dated at Eaton Reindeer Station, Dec. 31, 1900, in which he states that in the middle of the winter word was brought by travellers that Lieutenants Smith and Grimm, who were in charge of one of the two bodies of engineers and soldiers, after building 18 miles of line, were in distress and in danger of starvation. The mule team had gone through the ice of a river, and the only provisions they had with them were lost. All the men were turned out to shovel snow in an effort to move forward. This proved useless, for the mules at every step left a track of blood; their hoofs were torn and their legs cut. As soon as he heard of their condition, Lieutenant Offley, in charge of the other corps, took a dog team and started to find them. He discovered them in a frightful condition. They had leather shoes, which were of no use in that country, and their feet, hands, ears, and faces were frozen, and they were living on half rations. The expedition, after suffering great privations, was ultimately rescued by a party from the Eaton station, who set out with 30 reindeer hauling sledges.

PROGRESS IN PHILADELPHIA.

The annual report of the Philadelphia Electrical Bureau states that more conduits were laid in the city in 1900 than ever before in the same period of time. In all 438,000ft. of duct were laid during the year, of which the city owns a little over 10 per cent. About 6,383ft. of this was for electric light cable. Again, 1,143,346 calls and connections were made on the city's telephone switchboard, and 41,393 messages received and transmitted. The report further shows that there are 6,857 miles of telegraph and telephone wire in the city, 2,011 miles of electric light wire, 1,614 miles of wire owned by the city, and 675 miles of trolley wire—making a total of 11,155 miles. The practice in Philadelphia is to let the whole of the contracts for street-lighting to a single company, and the bureau expresses its approval of this system, as simplifying the supervision of the work and lessening the cost of power.

INSTITUTION OF ELECTRICAL ENGINEERS.

On the Use of Storage Batteries in Connection with Electric Tramways.

BY G. A. GRINDLE, M.I.E.E.

The excitement that attended the introduction of the storage battery to the public in a practical form, some 20 years ago, is doubtless well within the memory of many of those present this evening. To those to whom it is not, it would be a lengthy and almost impossible task to even attempt to describe the enthusiasm with which it was hailed, or to recount the marvellous predictions of the wonders it was destined to effect. The oft-repeated story of the wonderful box with the millions of foot-pounds of energy in it, and its celebrated journey from London to Glasgow, first heralded forth to the world through the columns of the *Times*, is now ancient history; but at the time when everything was electrical mad, it was just the incentive wanted to cause imagination to run riot. A glance at the patent records of those days, when provisional patents were published, is a most amusing means of verifying the fantastic ideas that prevailed as to what or for what a storage battery was or ought to be. As can very naturally be supposed, it was eagerly seized upon as the great solution of all the difficulties which beset electric traction, in which practically nothing so far had then been done, mainly owing to the difficulty of getting the power to the car, in those days the trolley system being undreamt of.

With the perfected accumulator, as it then posed to be, all these difficulties vanished in the eyes of the enthusiasts, and the hopeless attempts to solve the difficulty by means of Bunsen and other types of primary cells were forgotten. All these hopes, however, were doomed to disappointment, and for upwards of 10 years no practical result of the storage battery mark the pages of the early history of electric traction. During that period from time to time spasmodic efforts were made to introduce storage battery traction on different lines, but with very indifferent success. Every new accumulator that came to light—and their name in those days, as now, was legion—was duly announced as being the cell that was to solve the electric traction question; but nevertheless the problem remained unsolved, and up to the present time (in Great Britain, at any rate) no practical demonstration has taken place that can be deemed an unqualified success.

It is not my intention in the present paper to discuss this particular problem of the application of storage batteries to electric traction, and I purpose only making a passing reference to it. The problem is an extremely intricate one, and one which I regret to say I feel absolutely convinced has never had the attention paid to it that its importance merits. The cocksureness with which it was first looked upon as a certainty undoubtedly seriously militated against its success, or, more properly speaking, perfect development. If a line was a failure by any other system—by reason of its nature, the amount of its traffic, or by any other cause whatever—it was promptly offered to the first storage battery advocate that came along, who promptly started in with the idea that it was simply the storage battery that was required to be the salvation of the line, no attention whatever being paid as to whether there was the capability in the line itself being a paying concern, or as to the mechanical equipment involved. The most serious attempt made in Great Britain so far has been that made at Birmingham commencing in the year 1890, but here the result has been, owing entirely to the nature of the equipment and the capacity of the line anything but a success. Up to 1894 the losses on the line were attributed to the cost of upkeep of the batteries. At that date, however, with a view of ascertaining the true facts of the case the supply of batteries was undertaken on a definite figure per mile. Since that date unfortunately and significantly no data of running costs has been forthcoming, but batteries have been supplied and car miles run to the extent of over 1,100,000 miles, and from the accumulator view of cost with highly satisfactory results. With accurately kept figures on an aggregate mileage of this amount something more than theoretical calculations can be obtained, and the result is such as to firmly convince me that in spite of its failures hitherto there is a very great future before this method of traction. Its adoption at the present moment in New York on Thirty-fourth Street is attracting considerable attention. The closest attention is there being paid to details, and in view of the extended experience available as to mechanical equipment and its problems, the system will most probably at last have an effective opportunity of demonstrating its capabilities. As with the trolley system America promises to demonstrate to this country the value of the storage system, and how to operate it.

To revert, however, to the early eighties and the progress of other systems of traction, in Great Britain the usual result which seems by fate to attach itself to all new ideas, ran its course—namely, a laudable effort, and then a long tedious period of inactivity. The first serious attempt at electric traction was made at Portrush in Ireland, when in 1882 a line was equipped on the third-rail system some six miles in length, running from Portrush to Bushmills, and some years later this was followed by a second line in Ireland, on somewhat similar lines, running between Bessbrook and Newry, with both of which your chairman for the present year was closely indentified, and in the case of the second one, was actually responsible for. In the meantime, abroad, far more particularly in America, matters had been marching steadily onwards. The third-rail system, as adopted on the two lines just mentioned, was experimented with on sveral lines, but after having been given a careful trial, was found to be wanting, at any rate in its capacity to meet the demands of American practice, and somewhere about the year 1884 the idea was conceived—by whom actually I believe some doubt exists, the idea having

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been claimed and attributed to several—of stringing the conductor overhead from pole to pole, and obtaining the power from it by means of a collector. It is an interesting fact that a similar method of collecting power was adopted in the same year on the Bessbrook and Newry Tramway, where at wide road crossings the third rail was interrupted, and the current collected from a suspended overhead wire. In none of these schemes, however, was a storage battery utilised, and it was not until 10 years later, or 1894, that the first recorded instance of its employment occurs. In that year two tramway systems came into operation, on both of which batteries were adopted, one being the Douglas and Laxey Tramway, in the Isle of Man, for the design and equipment of which again your chairman was responsible; the other case was the Zürich electric tramways.

As to on which system it was first contemplated to employ accumulators it is impossible to say, or whether the designer of either scheme was aware what the other was doing or contemplating. It is possible that the idea of employing batteries was arrived at in both schemes entirely independently; at any rate the object and method of employing them was entirely different. In the first instance the battery was employed at an outlying sub-station situated somewhere about midway between the terminal points of the line. The battery in this instance was operated by means of a special feeder from the generating station at Douglas, the charging being effected by means of an ordinary motor-generator installed in the battery-house. The function of the battery was to assist the line load, which at the point of the line where the battery was installed was of an exceptionally heavy nature at times, generally to assist in maintaining the line potential at or about the centre of the system, and to obviate the necessity of sending the maximum amount of current demanded over the long feeders from the power-house. Variations of the battery potential were compensated for by a portion of the battery being employed as regulating cells, the regulation being effected by hand. In the second instance the battery was installed at the power station, the principal functions of the battery being to equalise the load on the generators, allowing a much smaller power plant to affect the operation of the line. The battery in this case was charged by means of an auxiliary generator in conjunction with the main generator, and the regulation effected by means of regulating cells cut in or out as necessary by means of an automatic switching arrangement. These two first instances of the adoption of batteries to traction working, though neither of them can, when compared with recent practice, be considered as ideal methods of employment, nevertheless are distinctly interesting in view of the subsequent development, and have gone far to demonstrate the

Necessity for a Storage Battery.—One has only to take a glance at the load curve of any traction system to see the necessity and call for the employment of a storage battery. The usual load curve reminds one of nothing so much as an attenuated mountain range, with one moment lofty peaks ranging skywards, and the next moment low-lying passes down at times to "sea-level." The load curves that you have in your hands will very clearly show this, and though the wide ranges may tend to decrease in number on large systems, the liability to their occurrence still exists and has to be provided for. Nothing more detrimental to a generating plant can well be imagined, the violent stresses between full and no load occurring so suddenly and often consecutively following on each other. The necessity also arises when it is desirable to maintain the voltage as nearly as possible constant. No matter to how fine a point the governing of the engine is carried, it is impossible for it to respond with anything like the rapidity with which the variations in the load take place. The most perfect mechanical governor has a distinct time factor as compared with that of switching on a motor, nor can even a generator itself respond so quickly, with the result that the voltage of the line rises and falls. Diagram No. 1 shows an interesting example of the difference of the load on the generator obtained on the same line before and after the installation of a battery under precisely similar conditions. Diagram No. 2 shows the results obtained in the variation of the voltage. The upper curve in each diagram giving the result before, the lower after the employment of the battery, the upper curve and lower curves in No. 2 show the results upon the voltage before and after respectively. The variation in the load you will note on Diagram No. 1 before the introduction of the battery was as high as 270 amperes, while subsequent to the employment of the battery it amounts to 50 amperes only. These curves, however, must not be taken as in any way approaching what can be effected with a battery. In this instance the battery was installed without any boosting or special compensating arrangements. In conjunction with a suitable booster there would be at the least as much improvement again. The results to be obtained by employing a suitably designed booster will show as great an improvement over the results obtained by the employment of a battery as the employment of a battery shows over working without. A battery is, further, a distinct necessity where it is desirable to centralise as much as possible the operating plant, as is nearly always the case, and often save an additional station with its attendant staff. A battery is an absolute necessity where the available power is limited to little more than the mean day load, as is often the case where water power is employed, and in many instances small falls of water, which by themselves would be quite inadequate to successfully operate a small line, with the assistance of a battery can do so easily.

Admitting, therefore, the necessity for a battery, we will next consider the advantages to be obtained by the inclusion of a battery on the power system. The first and undoubtedly foremost advantage to be gained by a reliable battery, properly

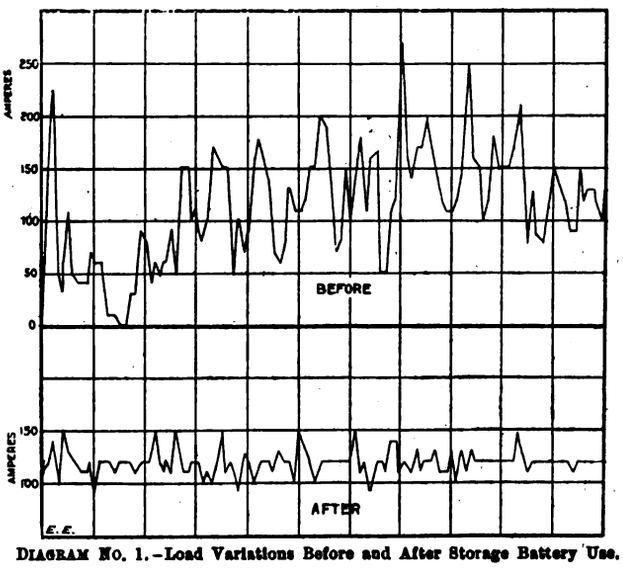

DIAGRAM No. 1.—Load Variations Before and After Storage Battery Use.

installed and duly proportioned for the work it has to effect, is the simplification of the question of generation of energy, resolving this from being one of a constantly varying nature, varying from nothing to several times its mean, to the one simple question of generating an even, steady, and predetermined load. By enabling the prime motor to be run constantly at an even load, it naturally follows that this load can be arranged to be the most economical one for the motor employed, which will result in an enormous economy over what could be obtained by employing a prime motor, which would of necessity have to be at least three times its size, in order to enable it to cope with the maximum demand which may from time to time be thrown upon it. In fact, it is almost impossible to conceive an engine being run under more disadvantageous conditions than those

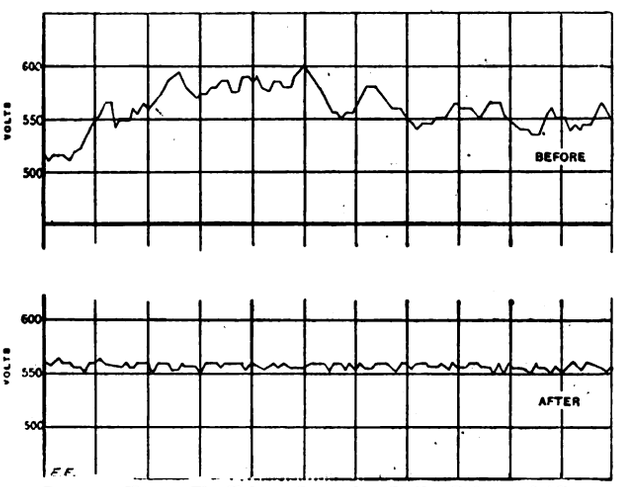

DIAGRAM No. 2.—The Voltage Curves in a Station Before and After Installing Storage Batteries.

which obtained in the production of energy for an average railway system, where no battery is employed. This advantage is best evidenced by the coal bill. The pounds of coal per horse-power hour on electric traction systems is, I think it will generally be admitted, beyond all reason, in many instances ranging up to 10lb. and even more; by the employment of a storage battery there is not the slightest reason why this should not be reduced down to the best engine practice—namely, from 2lb. to 2½lb. An advantage, and an important one from a point of cost, is the reduction of the engine-room hours. In this country few, if any, tramways run the full 24 hours, but where they do (and it is as well to bear in mind that there is a growing tendency towards its adoption), what may be termed the "night load" is of the smallest nature; this load can be taken entirely by the battery. Apart from the question of where a 24-hour system is in force, and where the current English practice has only to

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be provided for, the employment of a storage battery enables a considerable reduction of hours to be made in the daily work, and will in most instances easily bring the running of the station within the limits of two shifts, leaving the early and the late cars to be both operated entirely off the battery. In an average station this should mean at least a saving of from £150 to £200 per annum. It is a distinct advantage in the saving of wear and tear of machinery, not only in the power plant, but also the cars, the sudden and violent variations of voltage, which must of necessity continuously occur where no battery is used, throw a large amount of unnecessary strain on the running motors, which is much modified, if not entirely eliminated, when a battery is employed. A distinct advantage is shown in the running of the cars; better time can be kept and more even running. The car lighting will be steadier, and the destruction of lamps decreased. An important advantage is the safeguard it effects against accidents, more particularly flywheel accidents and breaking of belts in cases where the latter are employed, as in the event of a "short" or sudden overload on the line, the extra demand of current will be immediately taken by the battery and not by the generator. Should the "short" be sufficiently great to throw out the circuit-breaker, there will still be no variation on the generator load, the battery absorbing it all. While when the circuit breaker is closed again, even though the cause of throwing it out may have been removed, there is almost certain to be an abnormal demand on the line for current, due to the almost simultaneous restarting of the cars. All this will be immediately taken by the battery, without any abnormal load whatever being thrown upon the engine. In fact, the investment in a battery may be looked upon as a very excellent form of machinery insurance. In cases where belts are used for driving, experience has shown that where a battery is not employed, a severe shock will almost invariably break the belt before releasing the cut-out. While where a battery is in operation, the circuit breaker will invariably operate first saving the belt. Another advantage, and one of considerable importance, is that the battery will often carry through, where without one a stoppage would be absolutely inevitable. I do not say that every accident which has caused the stoppage of an electric line might have been prevented by the employment of a battery; but a vast number of stoppages which have occurred have been due in many instances to mere trifles, and would never have taken place. The advantage of being able at any time to shut down an engine for a few minutes, I venture to think, will be universally acknowledged. A very strong factor amongst the advantages of employing batteries on traction systems is the facilities they afford when, as is often the case, extensions or increased car service become imperative. By the installation of batteries at the extremities of existing lines extensions become feasible without any interference whatever with the existing arrangements and consequent expense, in many cases saving the necessity for additional power sub-stations, which, unless the extensions are very great, must work under most disadvantageous conditions. Having admitted the necessity and the advantage of employing a battery, there yet remains one great factor to be consulted, and one which in the present day there is a very lamentable tendency to unduly exalt, and at the shrine of which many a good scheme and many a good job have been unfortunately sacrificed; it is

The Question of Cost.—There are two things that require to be very carefully avoided—first, schemes that cannot possibly pay if properly carried out; second, lavish expenditure that cannot be recouped. Eliminating these from our consideration, and provided that no cheese-paring policy is adopted of endeavouring to make one pound's worth do the work of two, or, in other words, it being ensured that an adequate battery will be properly installed and equipped, as to whether or no the necessary outlay which must be incurred to include such a battery on a traction system is justified there are no two questions, as there is not the slightest doubt whatever that it is the means of a material saving both in the prime outlay on operating plant and the subsequent cost of operation of same.

(To be continued.)

LIGHT RAILWAYS.

A modified order has been issued authorising the construction of light railways between Bromsgrove railway station, Bromsgrove Town, and Lickey End, and the erection and use of buildings and apparatus for the generation of electricity to work the line. The railway company, however, have the option to employ either animal or mechanical motive power, subject to the approval of the local authorities and of the Department.

The Board of Trade have recently confirmed orders authorising the construction of light railways in the county of Kent, from Hollingbourn to Faversham; in the parishes of Hemsworth, Ackworth, and Badsworth, in the West Riding of the county of York; in the county of Salop, from Cleobury Mortimer to Ditton Priors; and in the rural district of Pateley Bridge, in the West Riding of the county of York, from Pateley Bridge to Lofthouse.

The Kinver light railway has been opened for traffic, and cars are running to and fro between Coalbournbrook, Stourbridge, and Kinver. A supplementary line is to be made, which will connect the centre of Stourbridge with the present line not far from Wollaston Church.

It is probable that a new light railway will be made in North Notts from Retford to Haxey, in Lincolnshire. This will join the Great Northern and Great Eastern Joint Railway, the authorised Isle of Axholme light railway, and the authorised Tickhill light railway.

A public meeting was held at Epworth last week, at which the following resolution was passed: "That this meeting of the inhabitants of the Isle of Axholme, having considered the proposals in the North-Eastern Railway Bill, 1901, so far as they relate to the acquisition of the light railways between Goole and Haxey, and the extension of the railway to Tickhill and the collieries beyond, are unanimously of opinion that such proposals, if carried out, would be for the advantage of the district." A committee was appointed to appear before the committee of the House of Commons in support of the Bill, and it was also decided to ask the Hon. Seymour Ormsby-Gore to give the Bill his support.

With regard to the proposed Warrington and Northwich light railway, we learn that the Board of Trade have sanctioned the construction of a double line of tramways in Liverpool-road, between Thewlis-street and Green-street, at Warrington. The Town Council are prepared to support the application for the order so far as it relates to railway No. 1, on condition that all agreements and clauses settled between the promoters and the County Council, Runcorn Rural District Council, the Manchester Ship Canal Company, and others, with regard to railway No. 1, are submitted for their approval.

Sir Courtenay Boyle last week approved of an amended order for the Blackpool and Garstang light railway after having heard the objections of the Blackpool Corporation, the Lancashire Council, the Cyclists' Touring Club, and others to certain clauses. This order, it will be remembered, was passed by the Light Railway Commissioners as an electric railway with the ordinary gauge of 4ft. 8½in. The railway opens up a district which has been hitherto practically unserved by any railway, and will enable agriculturists to more readily get their produce to Blackpool and other markets. The railway will also enable persons coming from the North to Blackpool to go direct from Garstang without having, as now, to take two sides of a triangle by coming through Preston. The distance of the proposed railway from Garstang is 13½ miles, while the distance to Blackpool *vid* Preston is over 30 miles. There will be stations at Layton, Newton, Hardhorn, Singleton, Singleton Village, Thistleton, Elswick, Great Eccleston, St. Michaels, Churchtown, and Catterall, and in other places as may be arranged. The engineers for the railway are Messrs. Myers, Veevers, and Myers, of Preston and Blackpool, and the solicitor who has had charge of the Bill is Mr. H. P. May, of Blackpool.

At a recent meeting of the Main Roads Committee of the Denbighshire County Council at Wrexham it was decided to recommend that body to increase the loan to the Glyn Tanat light railway from £3,000 to £4,500. Recently the Liverpool Corporation increased their loan from £3,000 to £5,000. Liverpool is interested in the railway, the termini of which are Oswestry and Llangynog, on account of its serving the neighbourhood of Vyrnwy. The Montgomeryshire County Council has also increased its loan by 50 per cent.

ELECTRIC LIGHTING OF ARTISANS' DWELLINGS.

The following is the full report of Mr. James K. Book to the West Ham Borough Council on the question of the electric lighting of artisans' dwellings:

GENTLEMEN,—In accordance with your instructions I have pleasure in presenting the following report on the electric lighting of artisans' dwellings: When it was decided by the Council to instal the electric light in the Bethell-avenue houses, and to make a charge of 6d. per week for the supply of current to the same, there was no precedent regarding the cost of supplying the electric light to artisans' dwellings by which to profit, consequently no rule could be laid down by which to estimate the charges necessary to be made, as the amount of current used would entirely depend upon the habits of the occupiers, and the care and conscientiousness exercised in the use of the light. The lighting of the Bethell-avenue houses must, therefore, be regarded entirely as a test case. Accordingly, in order that an idea as to the actual consumption of light in these dwellings might be gained, a meter and demand indicator was installed to register the total current used in each block of houses. By treating each block as one consumer, it is possible to show the difference between the actual

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price obtained and the price which would have been obtained if the current had been sold by meter. As these readings range from July to January, and consequently include the heaviest half of the year, there can be no question that the total average current metered for a full year would certainly not be greater, and probably would be less, than this average. It is necessary, however, to bear in mind the fact that if the current is sold by meter, it would necessitate a deduction of 1½d. per week from the income received from each dwelling in order to pay the interest and repayment on the additional capital expenditure incurred by installing meters. Another point to be considered is the annual saving in the cost of cleaning, painting, etc., as there is no doubt that this is a very considerable item; and as the Corporation, as the owner, benefits by this, I think that it would be perfectly justifiable to charge a portion of the cost of the electric light to repairs and maintenance of the dwellings.

Quarter ending Sept., 1900.	Block 1. 20 tenements. (14 weeks).	Block 2. 16 tenements. (14 weeks).	Block 3. 18 tenements. (11 weeks).
Units registered by meter	150 at 7d. ... 500 at 2d.	137 at 7d. ... 348 at 2d.	150 at 7d. ... 232 at 2d.
Price by meter	£8. 10s. 10d.	£6. 17s. 11d.	£6. 6s. 2d.
Average price per tenement per week by meter	7½d.	7½d.	7½d.
Average price obtained	6d.	6d.	6d.

Total average price per tenement per week by meter ..... 7½d.
Total average price per tenement per week obtained ..... 6d.

Quarter ending Jan. 4 1901.	Block 1. 20 tenements (14 weeks).	Block 2. 16 tenements. (14 weeks).	Block 3. 18 tenements (18 weeks).
Units registered by meter	192 at 7d. ... 1,404 at 2d.	160 at 7d. ... 1,186 at 2d.	246 at 7d. ... 1 259 at 2d.
Price by meter	£17. 6s.	£14. 11s.	£17. 13s. 4d.
Average price per tenement per week by meter	1s. 2⅜d.	1s. 3½d.	1s. 1d.
Average price obtained	6d.	6d.	6d.

Total average price per tenement per week by meter ..... 14½d.
Total average price per tenement per week obtained ..... 6d.

Average price per tenement per week for the half-year if sold by meter ..... 11d.
Deduct 1½d. for repayment of meters ..... 1½d.

9½d.

Average price per tenement per week received for the half-year ..... 6d.
Deduct cost of lamp renewals, etc. ..... 1½d.

4½d.

It will be seen from the above figures that, in order to place the artisans' dwellings on the same basis as ordinary consumers, it is necessary either to increase the charge per week; to instal ordinary meters and demand indicators; or to instal prepayment or penny-in-the slot meters. If the prepayment meter is adopted, it will be necessary to arrange a fixed price per unit at which the light will be supplied. The present charges for electricity are 7d. per unit for an average of one hour per day, and 2d. per unit for all units over this quantity. Accordingly if the light is used for an average of one hour per day, the average cost would be 7d. per unit, two hours 4½d. per unit, and three hours 3⅜d. per unit. The whole question of the cost depends on the probable period during which the maximum number of lights are used.

I submit the following suggestions: That prepayment meters be installed in all the artisans' dwellings. That any consumer, so desiring, may have a prepayment meter installed for a private dwelling, if the installation does not exceed three amperes (five 16-c.p. lamps at 100 volts, or 10 16-c.p. lamps at 200 volts). That the charge per unit, if prepayment meters are used, should be 4½d. per unit. (At this rate one 8-c.p. lamp would cost 1d. for seven hours.) That prepayment meters should only be installed at this rate in private dwellings, as shops, etc., being shorter-hour consumers the conditions are changed. By doing this all dwelling-houses are offered the same terms as the artisans' dwellings.—I am, gentlemen, your obedient servant,

(Signed) JAMES K. BOOK.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

369. What are the advantages and disadvantages in the use of superheated steam?—K.

370. What would be the best way to calculate exact difference of pull on armature core of two-pole and multiple-pole generators when they are fully excited, and the top pole or poles are nearer to the armature core than the bottom pole or poles?—W. H.

ANSWERS.

Question No. 363.—In wiring an installation we had 11 lights in a row, the first light on one switch and the remaining 10 on one switch. We wired the 10 lights, each light a loop off the previous one, and the first light we looped one pole and brought a switch wire from the other. On switching on the first light it lights perfectly, but on switching on the 10 lights it goes out, and on putting the 10 lights off it relights. The current is continuous and the pressure 100 volts. Please explain this.

(N B—We regret that we cannot publish more of the very numerous correct answers received to this question.)

Answer to No. 363 (*awarded* 7*s.* 6*d.*).—If the wiring of the 11 lamps had been correctly done, this curious effect could not possibly have taken place. A mistake was made in the wiring of the first light. The wiremen had two wires running from the 10 lamps—one going to the negative main and the other to the switch. They tapped a wire from the switch wire instead of from the negative main, and took it to the first lamp, and then took another wire from the lamp to the first switch. The sketch (Fig. 1) illustrates how the wiring was actually done.

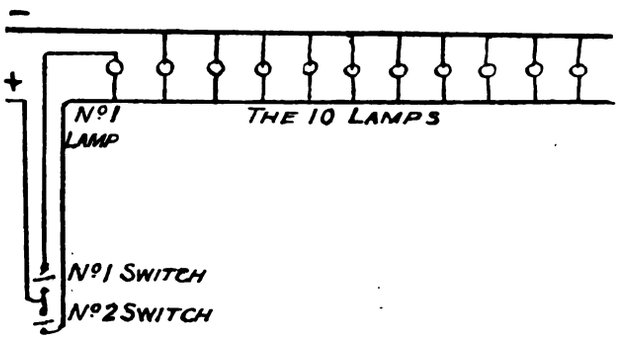

FIG. 1.

1. When the first switch is made, No. I. lamp lights up. This is only what was expected, but the conditions are unusual. The following diagram shows the conditions for this case. I will suppose that the 11 lamps are all of 16 c.p. The resistance of one 16-c.p. lamp is 166·6 ohms, and the resistance of 10 16-c.p. lamps in parallel is $\frac{166\cdot\dot{6}}{10} = 16\cdot\dot{6}$ ohms. The combined resistance of No. I. and No. II. in series is $166\cdot\dot{6} + 16\cdot\dot{6} = 183\cdot\dot{3}$ ohms. Therefore the current that would pass through the circuit would be $C = \frac{E}{R} = \frac{100}{183\cdot\dot{3}} = \cdot 545$ ampere. This current flowing through the circuit would not affect the 10 lamps in

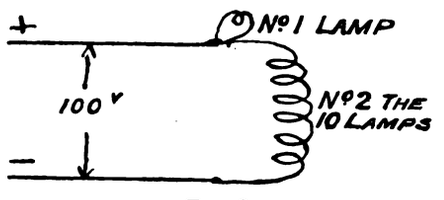

FIG. 2.

parallel, owing to their low resistance, but would bring to incandescence the filament of No. I. lamp because of its high resistance. As the current the lamp is getting is so close to what it should actually receive—*i.e.*, ·6 ampere—the brightness of the lamp would be practically the same.

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2. When No. II. switch is made the 10 lamps are lit, and No. I. lamp goes out. Fig. 2 is the diagram for this case. The current now goes straight from the 10 lamps to the + main instead of first going through No. I. lamp, as in the first case. The 10 lamps will, of course, take six amperes, while the first lamp is merely idle resistance, and will receive no current whatever.

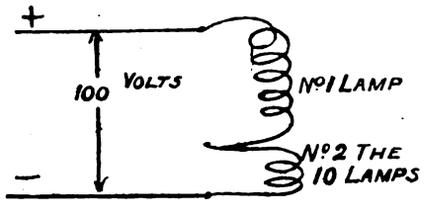

FIG. 3

3. When the No. II. switch is broken the 10 lamps go out, and the No. I. lamp lights again, because the conditions are now the same as in the first case already explained.—W. A. T.

Answer to No. 363 (*awarded* 7*s.* 6*d.*).—There are two methods by which a lamp may be put out of circuit: (*a*) by breaking the circuit by means of a switch or other

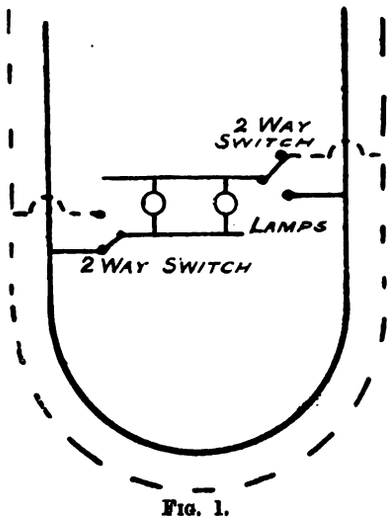

FIG. 1.

similar device; (*b*) by joining the two lamp leads to the same main. It is evident that the first method has not been adopted, as it is only when the circuit is closed by in a circuit which joins the negative main to the negative lead for the 10 lamps. If, now, all the lamps are 60-watt 16-c.p. lamps, the resistance of each lamp is 166 ohms, but the resistance of 10 lamps in parallel is 16 6 ohms. If, now, both switches are closed, no current will flow through the single lamp. If, however, switch No. 1 is open and No. 2 closed the resistance in the circuit will be 166 + 16 6 ohms = 182 6 ohms, which will allow approximately 0 55 ampere to flow through the lamp in place of 0 6 ampere. This will cause the lamp to burn a little less bright, but will not affect the other lamps, as only 0·055 ampere will flow through each—not enough to make

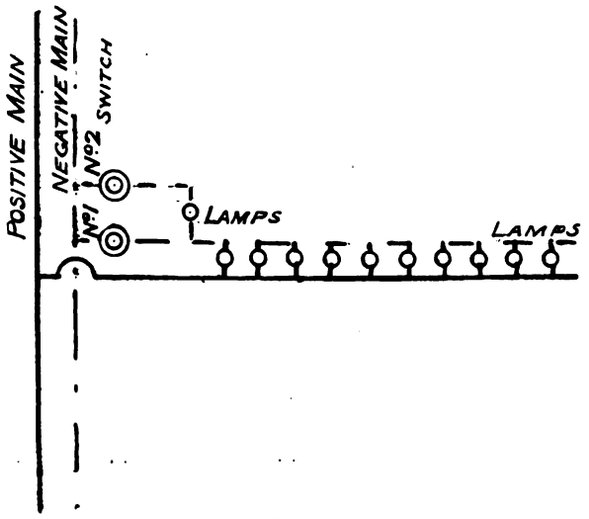

FIG. 2.

them incandescent. Fig. 2 shows in a diagrammatic form the connections which have been made, and if it is necessary to correct this, all that is requisite will be to transfer the connection from the positive to the negative lead of the 10-lamp circuit.—M.

Answer to No. 363 (*awarded* 7*s.* 6d.).—You have evidently crossed your wires in the casing somewhere. Your connections should be as in diagram No. 1, but by the results you get your connections are as shown in diagram No. 2. The only way to rectify the mistake is by taking the lamp L wire off the positive main on the lead side of switch, *s*, and putting it on the – main. With the connections as you have got them now, when switch, *s*, is "on," the current "flows" through *s*, lamp L

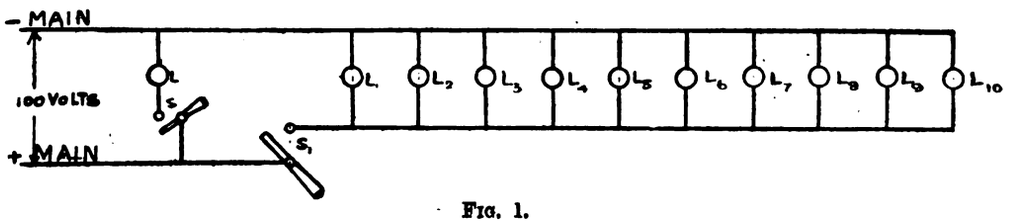

FIG. 1.

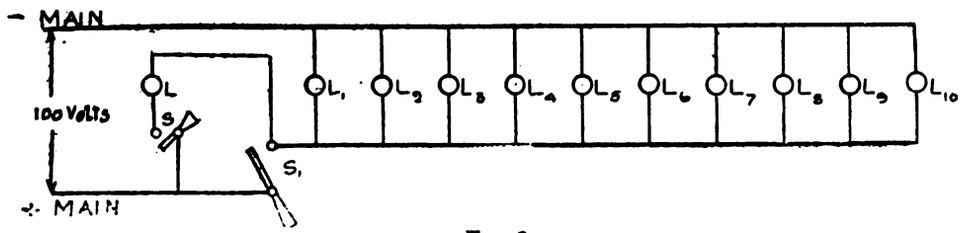

FIG. 2.

its own switch and that the other switch is open that the lamp will light. The second method is one which is chiefly made use of for corridor lamps, etc., which are controlled by two switches, one at either end of the corridor. These are of the two-way type, and are so arranged that the current can be switched on or off the lamps at will from either end. Fig. 1 is a diagram which shows how this is done.

Returning to the question, assuming the switches are in the negative leads, it is evident that the single lamp is (the first lamp), and on through L_1, L_2, L_3, L_4, etc., the whole of the 10 lamps being in parallel, which gives a total resistance of $\frac{\text{resistance of one}}{10}$. Now, the cold resistance of a 16-c.p. 60-watt 100-volt lamp is about 300 ohms; the hot resistance is $R = \frac{E}{C}$. R resistance, E volts, C current; $= \frac{100}{\cdot 60} = 166$ ohms. $C = \frac{W}{E}$; W = watts $= \frac{60}{100} = \cdot 60$. Then

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the current in the lamp $L = C \frac{100}{166 + \frac{300}{10}} = \frac{100}{166 + 30}$

$= \frac{100}{196} = \cdot 51$. The volts across the lamp $L = R \times C$ $= 166 \times \cdot 51 = 84$ volts, not sufficient to give a perfect light. When *s* is switched on, the lamp L is shorted, consequently "goes out."—T. W. S. H.

Question No. 364.—A four-pole, steel-clad, ventilated motor is capable of giving 20 b.h.p. continuously, without the temperature rise exceeding 80deg. F. at 800 revolutions per minute at 400 volts. What power will it be capable of giving continuously for six hours if entirely enclosed and airtight for working among explosive gases?

Best Answer to No. 364 (*awarded* 10*s.*).—The output of a large motor is reduced by being enclosed by a greater percentage than that of a small motor, for two reasons: First, the area of the surface of the shell does not increase in the same ratio as that of the armature. Suppose a stationary armature be placed in a room and a current passed through it. It will rise a certain amount above the atmosphere; now let it be surrounded by a sheet-iron case of very slightly larger dimensions than the armature, and supported so as not to touch it. The case has practically the same cooling surface as the armature. Consequently, the case will rise to the same temperature as the armature did before; and in order that the armature may radiate its heat to the case, its temperature must exceed that of the case by the same amount as the temperature of the case exceeds that of the room—that is to say, the casing doubles the rise of temperature of the armature. If the casing be enlarged so as to double its cooling surface, its temperature will be reduced to half, and in that case the temperature rise of the armature will be increased $1\frac{1}{2}$ times by encasing. Now, in different sizes of motors the limbs are approximately of constant length, and consequently the surface area of the case does not increase in the same proportion as that of the armature.

Secondly, the cooling surface of an armature is proportional to the linear dimensions, but the volume and, therefore, the hysteresis and eddy-current losses are nearly proportional to the cube, not quite, because of the hole in the centre. This means that the iron losses become far more serious in a large size. If a small armature is run for some time on light load it will keep quite cool, but a large armature will get perceptibly warm. It is clear, therefore, that there is less room for $C^2 R$ loss in the large size.

Tables I. and II. give the relative output for motors, open and enclosed, of two different makes. It will be seen that they agree fairly closely. Column I. gives the output when fairly well ventilated; column II. when completely enclosed; and column III. gives the ratio $\frac{\text{output enclosed}}{\text{output ventilated}}$.

TABLE I.

I. Output ventilated. B.H.P.	II. Output enclosed. B.H.P.	III. Ratio.
4	2½	·625
6½	4	·615
9½	6	·63
13	7½	·58
20	12	·6
26	15	·58
32	18	·56

TABLE II.

I. Output ventilated. B.H.P.	II. Output enclosed. B.H.P.	III. Ratio.
23·2	15	·65
12·4	8	·645
2·7	2	·735
1	·75	·75

Both tables show that the output of a 20-h.p. motor would be reduced to about 12 h.p.—J. W.

Answer to No. 364 (*awarded* 5*s.*).—This question reduces itself to the comparative radiation of heat from a motor, which in one case is cooled by currents of cold air circulating round and through the armature, and in the other case by the radiation of heat from the steel or iron casing. I make the comparison in the first instance between an open motor of 20 b.h.p. and an entirely enclosed and airtight motor, and from this comparison deduce an answer to the question. My figures refer to the rise of temperature in the armature only, as the temperature of the field will vary at much the same rate.

In the case of the entirely enclosed motor the armature would lose its heat almost as rapidly, if it were stationary, as its motion does not draw in any cold air. Making a comparison on these lines:

Diameter of armature (drum-wound) = $11\frac{13}{16}$in.; length = $16\frac{7}{8}$in.

Surface = 625 6 square inches = 1,967 square centimetres.

I assume the watts wasted in the armature to be 439, which is a fair allowance for 20 b.h.p.

Armature revolving at 800 revolutions per minute:

$$\theta \text{ deg. C.} = \frac{55 \times W}{S\{1 + \cdot 00018\,V\}};$$

where W = watts, S = surface in square inches, V = velocity of the surface in feet per minute.

$$\theta \text{ deg. C.} = \frac{55 \times 439}{626 \cdot 5(1 + \cdot 00018 \times 2{,}472 \cdot 75)} = 26\ 67\text{deg. C.} = 80\text{deg. F.}$$

Now, assume tentatively that 16 b.h.p. will be the value obtainable with the fixed temperature rise from the entirely enclosed motor. Watts wasted = 355.

Stationary armature—

$$\theta \text{ deg. C.} = 250 \frac{\text{watts wasted}}{\text{surface in square centimetres}}$$

$$\theta \text{ deg. C.} = \frac{250 \times 355}{1\,967} = 45\text{deg. C.} = 113\text{deg. F.}$$

The ratio of the temperature rise in the revolving armature at 20 b.h.p. to that in the stationary armature at 16 b.h.p. is as 1 to 1·413.

The surface of the steel or iron casing available for radiation to atmosphere is 2,520 square inches; surface of armature (as before) is 626 5 square inches. From certain works on physics, I find the comparative capacity of shellac and cast iron to radiate heat is as 72 to 20, and I take these two values to represent the rate of radiation from armature surface to motor casing.

Stationary armature to iron casing, 72 to 20.
Revolving ditto, 1·413 × 72 to 20 = 101·75 to 20.

Thus I get 626·5 square inches × 101 75 = 63,650.
2,520 square inches × 20 = 50,400.

Or a 20-b.h.p. motor of the open type would if entirely enclosed and airtight give

$$\frac{50{,}400}{63{,}650} \times 20 = 15\ 86 \text{ b.h.p.}$$

This is 79·3 per cent. of the output of the open motor for the same temperature rise, and these being the two extreme cases the enclosed ventilated type will develop some value between the two limits, depending on the extent of the ventilation. Assume 90 per cent., then the three outputs will in this particular case vary as:

Open motor.	Enclosed ventilated.	Airtight motor.
100	90	79·3

An answer to the question estimated on the lines laid down above would give the output of the entirely enclosed and airtight motor as 18 b.h.p., the same motor enclosed and ventilated having an output of 20 b.h.p.—R. A. C.

Answer to No. 364 (*awarded* 5*s.*).—If the motor is capable of giving 20 h.p. when ventilated, it will be equally capable of giving the same horse-power when entirely closed and rendered absolutely airtight. It may be that the rise of temperature may be so excessive as to melt out any shellac, or char the cotton insulation; but then if the motor be entirely enclosed, this is what might happen even were the machine run on open circuit, and the rise in temperature might not cause any extra loss in efficiency.

The *main* sources of the heat which is generated in running a shunt dynamo or motor are threefold: (1) heat

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caused by hysteresis in the armature core; (2) heat caused by the current overcoming the resistance of the armature windings; (3) heat caused by the current overcoming the resistance of the shunt winding.

Now, No. 2 is the only one which is affected by the load. Nos. 1 and 3 will be the same whether the machine runs light or fully loaded, for No. 1 is dependent upon the mass of iron, the induction, and the speed, and No. 3 is always approximately the same, provided the E.M.F. is kept constant in any machine, as a certain definite value is required for the magnetising force or a certain definite shunt current.

Now, with an open-type dynamo, where the air can freely permeate to all parts, if the armature has a peripheral speed of 3,000ft. per minute, the rise in temperature will be:

For the armature— $\frac{W \times 64}{A}$;

For the fields— $\frac{W \times 100}{A}$;

where W = watts lost;

A = area in square inches.

If the air cannot flow freely to all parts the rise in temperature will be higher, not because more energy is dissipated in the form of heat, but because the machine cannot throw off the heat which accumulates.

Now, if the motor be thoroughly enclosed, the heat due to the armature will be added to that from the fields, and one formula must be found for the two. Much must depend upon the thickness of the metal. The writer has found that for the temperature *inside* the case the formula $\frac{W \times 220}{A'}$ gives the rise, where A' is the exposed area of the *outside* of the case. It may be that the heat due to Nos. 1 and 3 will cause the inside temperature of the case to rise to such a degree that it is impossible to work the motor enclosed at all; so "T. R." will see that while the motor will give off the same power, the rise of temperature, which limits the load, must depend upon the outside area. In order to obtain a larger cooling surface, Messrs. Thos. Parker, Limited, corrugate the cases of their motor, with good results.

Some years ago Mr. Wilson Hartnell, of Leeds, took out a patent for an enclosed motor filled inside the case with nitrogen or other non-combustible gas to prevent explosions due to sparks in a coal-mine. The writer has suggested in place of this that the motor should only be made partially airtight, and that a pipe should be fixed from the motor case to a cylinder of compressed nitrogen; this would supply the fresh nitrogen in place of that which must in practice leak away, while at the same it would keep the motor cool, owing to the cooling action of any gas when expanding, as this gas would as it passed from the pipe into the case. It was suggested to the writer that the bed-plate might be made a receiver, into which a small pump driven off the armature shaft pumped compressed air, and this air was allowed to freely expand in the case to keep it cool. The objection to this course is that you heat up the bottom part in compressing and cool the top in expansion, and as it is all part of the same machine, little gain would result, owing to the conduction and convection of heat.—M.

APPOINTMENTS VACANT.

Resident Engineer, Sutton Coldfield Corporation, £200 per annum, April 25 Details in our advertisement columns.

Electrical Engineer, Colliery. Details in our advertisement columns.

Junior Mains Assistant, £120 per annum. Apply to chairman of Electricity Committee, Town Hall, Manchester, April 20.

Clerk of Works.—The Colne Town Council will shortly advertise for a clerk of works, £2 per week.

Typewriter (male), knowledge of electrical business. Details in our advertisement columns.

Consulting Electrical Engineer, Guardians of Willesden. Apply to Mr. J. Hutton Haylor, clerk, Guardians' Offices, 329, High-road, Kilburn, N.W., by 23rd inst.

NEW COMPANIES.

The following new companies have been registered since our las issue:

Kenworthy and Co., Limited.—Capital, £2,000. Objects: to carry on the business of mechanical, electrical, and general engineers, builders, etc.

Anglo-American Aluminium Company, Limited.—Capital, £1,500. Object: to carry on the business of aluminium manufacturers, metallurgical, chemical, electrical, and mechanical engineers, etc.

T. C. Williams and Sons, Limited.—Capital, £20,000 (4,000 preference). Object: to acquire the business carried on by W. W. Williams at Reading as T. C. Williams and Sons, and to carry on the business of manufacturers, ironmongers, mechanical and electrical engineers, etc.

Maund and Robson, Limited.—Capital, £10,000. Object: to carry on the business of carriers of passengers and goods, electric engineers, contractors, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic, and other apparatus, mechanical and chemical engineers, etc.

William Wilson and Co., Limited.—Capital, £30,000. Object: to acquire and carry on the business of an ironmonger, engineer, and electrician, now carried on by William Wilson under the style or firm of William Wilson and Co. at 50, 52 and 54, King-street, and 3 and 5, St. James's-square, Manchester, and at Middleton.

George Leek and Sons, Limited.—Capital, £3,000. Object: to take over all or any of the businesses carried on at Hope-street Foundry, Salford, by G. Leek and G. A. Leek as George Leek and Son, and to carry on the business of ironfounders, mechanical and electrical engineers, toolmakers, brass founders, metal workers, boilermakers, etc.

Vancouver Engineering Works, Limited.—Capital, £40,000. Object: to acquire from the Vancouver Agency, Limited, the engineering works and business now carried on by Armstrong, Morrison, and Co., on the harbour of Vancouver City, and to carry on the business of marine, mining, hydraulic, electrical, and general engineers, shipbuilders and repairers, etc.

COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report of the directors for the half-year ended Dec. 31 last shows that the gross receipts have amounted to £360,889, against £339,450 for the corresponding half-year of 1899 The working expenses, including £23 586 for maintenance of cables, absorb £104,640, against £116,935 for the corresponding period of 1899, leaving a balance of £256,249. From this is deducted income tax, interest on debenture stock, donations to the Indian Famine and Foochow Flood Relief Funds, and £1,500 for a testimonial to the late chairman as recommended by the shareholders, leaving as net profit £242,029. After adding £16,833 brought forward, there is an available balance of £258,862. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also recommended to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for 1900, leaving a balance of £146 362. After deducting £4,880 towards providing the agreed dividend on the new issue of shares, there remains £141,482, which has been transferred to the general reserve fund. This fund has also been credited with the premium of £150 000 received on the new issue of shares, and debited with £125,137, the amount of expenditure to date on the Cape-Australian cable. The company, in conjunction with the Great Northern Telegraph Company, has constructed land lines between Taku, Tientsin, and Pekin, in connection with the international cables recently established by them to the north of Shanghai. These land lines have been opened to the public without any additional charge being made on telegrams exchanged between Europe and China. Further reductions of rates were brought into force on Jan. 1 last for telegrams exchanged with South Australia, Western Australia, and Tasmania. The Government of New South Wales has since accepted the agreement, and the reduced rates were applied to telegrams exchanged with that State as from Feb. 1 last. The ss. "Anglia," with the first section of the Cape-Australian cable—namely, between Durban and Mauritius—left the Thames for Natal on the 29th ult. A contract has been entered into with the Netherlands Indian Government for supplying and laying on account of that Government a cable between Java and Borneo. The cable is expected to be laid during the current half-year.

INDO-EUROPEAN TELEGRAPH.

The directors' report for 1900, to be presented to the meeting on the 30th inst., states that the directors are still negotiating with the Imperial German Government for an extension of the Company's concession. The general tariff to Australia has been reduced, and the Company has assented to bear its share of a reduction in the rate to India. This reduction, it is expected, will be made before long. The lines of the Company continue to work most

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efficiently, and both the Wheatstone and duplex systems are giving satisfaction. The revenue amounted to £151,643, as compared with £142 343 for 1899, an increase of £9,300. The expenses were: on commercial and general account, £39,532; on maintenance account (expenses and charges), £38,827—total, £78,359, an increase of £3,702. Deducting the above expenses a balance remains of £73,284, from which income tax paid, £3,560, has to be deducted. To this the amount brought from 1899, £7,692, has been added, and also a repayment by the Persian Governmnt of £17,238, making a total of £94,654. From this amount £25,000 has been placed to reserve, and that sum, together with £10 625 amount to interim dividend, and a provision for depreciation of securities of £15,000 have to be deducted, leaving £44 029. The directors propose a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. Further, the directors recommend a bonus of 20s. per share, making 10 per cent. for the year, carrying forward £12,154.

DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The general meeting of the shareholders was held on Wednesday at Donington House, Norfolk street, Strand.

Mr. C. Shirreff Hilton, who presided, said that since the last meeting 8,211 shares had been issued to the British Electric Traction Company in part payment to them as contractors, and 19,370 shares had been issued to the public, thereby increasing the total capital of the Company to £200,000. The running expenses during the period under review had been £8 874, as compared with £4,493 in 1899, this being due to a large extent to the opening of new lines and also to the enhanced cost of fuel. They might look for rather better results, however, in this direction during the current 12 months. In the traffic receipts there had been an increase from £11,000 in 1899 to £18 290, mainly due to the opening of new lines. The Netherton and Cradley Heath route was opened for traffic in October last, and the Kingswinford and Wardsley section in December, and so far there was every reason to be satisfied with the results obtained from them. The directors recommended that of the sum available for distribution £2,000 should be set aside towards a sinking fund to provide against the expiring tenure of the Company, that £1,500 should be placed to depreciation fund, and that a dividend of 4 per cent. be paid on the ordinary shares, leaving £746 to be carried forward. The extension along the High-street, Stourbridge, was expected to be ready for traffic in a few weeks, and, therefore, the directors thought it would be a wise thing now to proceed with the continuation of this line to the Lye. He hoped the Company would then have arrived at the end of their capital outlay for some time. To provide for the additional expenditure involved by these extensions, and for any sum still due under the old contracts, it was proposed to issue debentures on debenture stock. An issue of £60,000 would probably cover all their requirements. The outlook for the current year was, in his opinion, favourable in every direction. In conclusion, he mentioned that, owing to the pressure of other engagements, Mr. Emile Garcke and Mr. J. S. Raworth had resigned their seats on the Board, and moved the adoption of the report and accounts.

Mr. Percy Sellon having seconded the motion, it was carried unanimously.

BLACKHEATH DISTRICT ELECTRIC LIGHT.

The third ordinary general meeting of the proprietors took place at the Cannon-street Hotel, under the presidency of Sir John A. Willox, M.P., on Wednesday.

The Chairman, in moving the adoption of the report, said they were in hopes that the works would have been finished in October or November last, and that they would have had the advantage of a winter service, but as it was they only got to work from their own generating station on Feb. 14, and the delay involved a serious loss of revenue. Part of the loss, to the extent of £1,200, had been recovered from the contractors as compensation for delay in the delivery of the machinery. The business of the Company was now steadily increasing, and no interruption of the service had occurred since they started on Feb. 14. The number of lamps connected on Feb. 14, 1900, was equivalent to 5,957 of 8 c.p., and on Dec. 31 was equivalent to 14,473. During the same period the number of consumers increased from 132 to 342. On March 31 the connections amounted to an equivalent of 16,520 8 c.p. lamps, and applications for a further 4,907 8-c.p. equivalents had been received, making a total of 21,427 8 c.p. connected and applied for. The prospects were certainly encouraging.

The report was adopted *nem. con.*

OSWESTRY ELECTRIC LIGHTING AND POWER.

The report of the directors for 1900 states that the gross profit for the year amounts to £251. 8s. 11d., which, with £20. 9s. 2d. brought forward from 1899, makes an available balance of £271. 18s. 1d. The accounts show continued progress, although the high price of coal has seriously reduced the available profit. The directors have written a further sum of £18. 0s. 6d. off the preliminary expenses, and have charged to revenue the balance of the cost of the renewal of the batteries referred to in their last report. They recommend the declaration of a dividend at the rate of 4 per cent., leaving £1. 4s. 5d. to be carried to next account. With much regret the directors record the death of two of their colleagues during the past year, Mr. R. R. Lloyd and Mr. Edmund Williams. To fill the vacancies thus created, the directors have elected Mr. John Minshall and Mr. Richard Taylor. The directors retiring by rotation are Mr. A. Wynne Corrie and Mr. E. Bremner Smith, who are eligible, and offer themselves for re election.

NORTH STAFFORDSHIRE TRAMWAYS.

The directors in their report for 1900 state that the expenditure on the electrical equipment, permanent way, depôt, etc., has amounted to £14,348. There is still owing to the Potteries Electric Traction Company £17,842. The profit from the rental of the lines, after payment of debenture interest, is £4,858, which, added to £12 11s. 2d. brought forward from last account, makes an available balance of £4,870. They now recommend a dividend of 6 per cent. per annum on the preference shares, a dividend on the ordinary shares of 5 per cent. per annum, and to carry forward £70. The lines are being worked by the Potteries Electric Traction Company under the terms of the agreement which was sanctioned by the shareholders. The meeting of the Company will be held on the 25th inst.

CALCUTTA TRAMWAYS.

The directors' report for the year ended Dec. 31 last shows that the gross receipts were £80,946, expenditure under all heads £65 720, and revenue balance £15,225. This, added to the credit balance of £25,642 brought forward from last year, gives a total of £40,868. From this amount has to be deducted £7,198 for interest on debentures for the year, and £11,567 for charges in connection with the premium on redemption of the 5 per cent. debentures, and the issue of the £250 000 4½ per cent. debenture stock at 98, which leaves £22,101. The directors recommend that out of this sum £7,000 be carried to reserve, which will bring that account up to £10,000, and that a dividend at the rate of 3 per cent. per annum be paid, free of income tax leaving a balance of £4,769 to be carried forward. For the first half of the period under review the work of reconstruction continued to prejudicially affect the receipts, but during the second half, when reconstruction was complete on most of the lines, the traffics began to show a very satisfactory expansion, which is well maintained. The necessary works for the electrical equipment of the system are proceeding rapidly. Several valuable plots of freehold land for the power station buildings and car-sheds have been acquired, and the work of construction is well forward. The contractors' work is also being pushed forward, and much of the plant is already on the spot, and being dealt with by the contractors' representatives. The whole of the £250,000 of 4½ per cent. debenture stock alluded to in the last report has been allotted, and is now officially quoted on the Stock Exchange. The directors will shortly issue the remaining £100,000 created, to provide for the payments to the contractors necessary to complete the electrical equipment. There still remain some small portions of line to be reconstructed. The report concludes with the remark that it is satisfactory to report that the relations of the Company with the Corporation and other authorities in Calcutta continue to be of a friendly character.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Dundee.—The Town Council invite tenders for the supply of copper bonds. Tenders by May 1. Details in our advertisement columns.

Rochdale.—Tenders are invited for an electric lift at Dearnley Workhouse Infirmary. Apply to the architects, Messrs. Butterworth and Duncan, South-parade, Rochdale.

Motherwell.—The Electric Light Committee invite tenders for cast iron lamp columns, arc lamps, switches, fittings, etc. Tenders by May 18. Details in our advertisement columns.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the annual supply of stores and materials. Tenders by May 14. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for the erection of a refuse destructor to work in conjunction with their electricity works. Tenders by April 27. Details in our advertisement columns.

Wells.—The City Council are desirous of absolutely disposing of their electric lighting order, 1896, and invite offers for the purchase of the same. Offers by May 1. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for six water-tube boilers and accessories. Preference will be given to straight-tube boilers. Tenders by April 27. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of main switchboard and instruments and battery of accumulators and accessories. Tenders by April 29. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply and erection of main steam, feed, suction, and exhaust pipes, etc., and additional panels to traction switchboard. Tenders by April 26. Details in our advertisement columns.

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Cardiff.—The Corporation invite tenders for poles, bases, refuge pillars, etc., brackets, feeder and section pillars, etc., trolley and other wire, and insulators and line suspensions. Tenders by April 30. Details in our advertisement columns.

Ashton-under-Lyne.—The Electricity Committee invite tenders for two continuous-current generating units, each of 250 h.p. to 300 h.p., with double-acting enclosed engines. Tenders by April 29. Details in our advertisement columns.

Alloa.—The Electric Lighting Committee invite tenders for insulated cables, joint-boxes, etc., public arc lamps, lamp pillars, etc., and sub-station equipment and sundry connections. Tenders by April 30. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane, and workshop equipment. Tenders by April 22. Details in our advertisement columns.

Wrexham.—The Town Council invite tenders for supplying and fixing electric calls for the fire brigade. Specification, etc., can be obtained on application to the resident electrical engineer to the Corporation, Willow-road. Tenders by April 24.

Edinburgh.—The Corporation invite tenders for arc lamp carbons, cast-iron pipes, pavement and road box frames, and covers, etc., for their electricity supply stations for the year from May 15. Tenders by April 20. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for supply of cast-iron pipes. Specifications, etc., may be obtained from Mr. Charles Hopkinson, M.I.C.E, 29, Princess-street, Manchester, or 26, Victoria-street, London. Tenders by April 23.

Poplar.—The Guardians invite tenders for the provision and carrying out of the necessary steam, exhaust, hot and cold water piping, valves, water-meters, etc., at their new works adjoining the union buildings in High-street, Poplar. Tenders by May 1. Details in our advertisement columns.

Turkey.—The following works will shortly be taken in hand: (1) renewal of submarine cables between Galata and Stamboul; (2) new telegraph line between Bassora and Nedsch (in the interior of Arabia); (3) new telegraph line from Lohya to Lith (along the coast of the Red Sea, about 650 miles).

Metropolitan Asylums Board.—The Board invite tenders for the supply and erection of a complete electrical generating plant and a complete boiler plant for heating at the asylum now in course of construction at Tooting Bec., S.W. Tenders by April 24. Details in our advertisement columns.

Madrid.—Tenders are invited by the Spanish Post Office for a concession for the establishment and working of a telephone system at Denia. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by May 10.

Madrid.—Tenders are invited by the Spanish Government for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by June 3.

Madrid.—Tenders are invited by the Municipality of Lopera (Jaen) for the concession of the exclusive right of lighting the town by electricity for 10 years. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m., or at the office of this journal. Tenders by April 28.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Bloom-street generating station of: (*a*) two electrically-driven coal cranes; (*b*) steam, exhaust, drain, and suction pipes for feed pumps. Specifications, etc., may be obtained on application to Mr. F. E Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by April 25.

Middlesbrough.—The Electric Lighting Committee invite tenders for boiler-house plant—one 30ft. by 8ft. 6in. Lancashire boiler and accessories; engine-house plant—one 300-kw. high-speed steam dynamo and accessories, together with steam, exhaust, and feed pipes, etc.; condensing apparatus—ejector condenser, with circulating pumps. Tenders by April 30. Details in our advertisement columns.

Barrow-in-Furness.—The Corporation invite tenders for the supply of (A) paper-insulated, lead-covered concentric cables; (B) disconnecting and joint boxes, pavement covers; (C) cast-iron pipes, etc.; (D) earthenware conduits and pipes; (E) balancing transformer and switchboards. Specifications, etc., may be obtained upon application to Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness. Tenders by April 24.

Palencia (Spain).—Tenders are invited for the installation and working of a telephone system for not more than 20 years; 10 per cent. of the annual receipts will have to be paid to the Government. Tenders may be addressed to the General Post and Telegraph Department by April 21. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Battersea.—The Borough Council invite tenders for the carrying out of work in connection with the supply of water for condensing purposes to their central electric generating station, Lombard-road, adjacent to the River Thames, as follows: electric pumps, pipework, etc., for condensing water; river work, pipes, and pits for condensing water supply. Specifications, etc., may be obtained on application to the Town Clerk, Municipal Buildings, Lavender-hill, S.W. Tenders by April 30.

Portsmouth.—The Corporation invite tenders for supplying and laying telephone conduits and cables, copper wire, iron and steel stay wire, insulated wires, lightning and high-tension guards, arm bolts, nuts, and washers, miscellaneous ironwork, insulators, switchboards, batteries, telephone instruments, fixing subscribers' instruments, creosoted poles, oak arms, erecting poles, arms, stays, insulators, wires, etc., and silicium bronze wire. Tenders by April 30. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (Specification No. 1) water-tube boilers; (No. 2) plant of 15,000 i.h.p. in generating and sub-stations; Sections A, B, and C) steam-engines, with condensing and auxiliary plant; (D) three-phase generators; (E) motor-transformers. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by May 7.

Plymouth.—The Plymouth, Stonehouse, and Devonport Tramways Company invite tenders for the reconstruction of the existing tramway lines in Plymouth, Stonehouse, and Devonport, and the reduction of the gauge from 4ft. 8½in. to 3ft. 6in., and the bonding of the rails for electric traction. The rails, points, crossings, tie-bars, fishplates, fishbolts, copper bonds, and any granite setts that may be required will be supplied by the tramways company. Particulars can be obtained on application to Mr. John Glen, C.E., engineer, 11, Queen Victoria-street, London, E.C.

Ludlow.—The Corporation invite tenders for the supply and erection of one water-tube boiler to be erected and fitted for connection with a refuse destructor, with electric motor, injector, etc.; one ditto, ditto, for a coal-fired boiler, and furnace connected therewith; two quick-revolution compound two-crank self-lubricating engines, coupled direct to compound-wound dynamos, equal to an output of 35 kw. each, with motor-transformers and accessories; steam, exhaust, and feed pipes; overhead travelling crane (six tons); switchboard and instruments; accumulators; electricity supply mains; and public arc lighting and glow lamps, the latter on existing pillars. Tenders by May 20. Details in our advertisement columns.

Tenbridge (Kent).—The Urban District Council invite tenders for the supply and erection of (Section A) boiler-house plant—two Lancashire boilers and accessories, steam pump, injector, and economiser; (B) engine-house plant—two 50-kw. steam dynamos, motor-transformer, and accessories; (C) condensing apparatus and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) electricity supply mains; (H) public arc lighting; (I) house meters; (K) public incandescent lighting, for the municipal electricity works. The whole bound up in one specification. Specifications, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders by May 30.

Battersea.—The Borough Council are prepared to consider schemes for the wiring of consumers' premises for electric lighting, free of all initial cost to the Council or the consumer. The wiring rules and the general conditions under which the work would have to be carried out can be obtained on application to Mr. W. Marcus Wilkins, town clerk, Lavender-hill, S.W., upon the deposit of £1. 1s., to be returned on the receipt of a bona fide tender. The conditions admit of payment to the contractors for the work carried out by them in one or more of the following ways: (*a*) by one cash payment by the consumer; (*b*) by the easy payment system; (*c*) by a fixed rental per annum; (*d*) by a small extra charge per unit supplied to the consumer, to be collected by the Council and paid by them to the contractors. Tenders by May 14.

RESULTS OF TENDERS.

Whitehaven.—The Town Council have accepted the tender of Callender and Co., Limited, for the supply of mains, at £2,782.

Maidstone.—The Town Council have accepted the tender of Aiton and Co. for the extra work on steam mains, piping, and valves for the new engine, at £260.

Brighton.—The Corporation have accepted the tender of Sattin and Evershed for erection and completion of a motor-room and offices with trowelled cement at the Corporation electricity works at £1,250.

Rochdale.—The Corporation have accepted the following tenders: Askham Bros. and Wilson, Steel Foundry, Sheffield, tiebars; Ibbotson Bros. and Co., Limited, Globe Steelworks, Sheffield, bolts and nuts.

Bolton.—The Electricity Committee have accepted the following tenders: English Electric Manufacturing Company, Limited, for the supply of a couple of 900-kw. generators; Mather and Platt, for the coupling together of two balancers.

Darwen (Lancs.).—The Corporation have accepted the tender of the British Insulated Wire Company, Limited, Prescot, for supply and delivery of feeder cables, pillars, and overhead electrical equipment in connection with the electric tramway.

Harrogate.—The tender of Messrs. Ritchie has been accepted for the supply of cast-iron water circulation and discharge pipes and cooling gutters; and that of Messrs. Lloyd, at £12. 10s., for supply of special tee-piece for the new turbo alternator. Quotations from Messrs. Hayward Bros. and Eckstein for a new glass switchboard platform have been referred to the chairman and engineer to deal with.

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Bournemouth.—The following tenders have been received for the Corporation tramways:

Contract No. 1.—32 electric cars, etc.

Bramigk and Co.	£35,025	0	0
Siemens Bros. and Co., Limited	30,970	0	0
R. Blackwell and Co.	30,374	0	0
Hungarian Railway Carriage and Machine Company...	30,030	0	0
Hurst, Nelson, and Co.	29,472	4	0
British Thomson-Houston Company	29,364	2	0
Brush Electrical Engineering Company, Limited	28,381	0	0
British Westinghouse Electric and Manufacturing Company, Limited (accepted)	28,020	0	0

Note.—One informal tender was also received.

Contract No. 2.—Four steam dynamos, etc.

Brush Electrical Engineering Company, Limited	18,930	0	0
British Westinghouse Electric and Manufacturing Company, Limited	17,857	0	0
British Schuckert Electric Traction Company	17,453	0	0
Brush Electrical Engineering Company	17,250	0	0
British Westinghouse Company	16,234	0	0
British Schuckert Company	16 145	0	0
Anchor Electric Company	15,900	0	0
Johnson-Lundell Electric Traction Company	15,135	0	0
Lancashire Dynamo and Motor Company, Limited	15,406	0	0
British Schuckert Electric Traction Company	15,485	0	0
Anchor Electric Company	15 200	0	0
Anchor Electric Company	15,100	0	0
Lancashire Dynamo and Motor Company	14,844	0	0
Siemens Bros. and Co., Limited	14,890	0	0
British Thomson-Houston Company, Limited (accepted)	14,733	0	0
Johnson-Lundell Electric Traction Company	14,283	0	0
British Thomson-Houston Company	13,993	0	0
Bow, McLachlan, and Co.	14,000	0	0
C. A. Parsons and Co.	13,418	0	0
British Westinghouse Company	11,932	0	0
British Thomson-Houston Company	12,321	0	0
C. A. Parsons and Co.	12,531	0	0
Siemens Bros. and Co.	12 199	0	0
Lancashire Dynamo and Motor Company	11 982	0	0
C. A. Parsons and Co.	12,239	0	0

Note.—Five informal tenders were also received.

BUSINESS NOTES.

TRACTION.

Salford.—The agreement between the Corporation and the Manchester Tramways Company is all but concluded.

Wolverhampton.—The proposed new electric tramways will involve the expenditure of nearly £56,000 on paving, etc.

Taunton.—The Town Council have agreed to the plans of the proposed tramways submitted by the tramways company.

Leamington.—The Board of Trade have passed the Warwick and Leamington tramways order subject to certain alterations.

Willenhall.—The British Electric Traction Company have deposited plans for the proposed new tramways with the Town Council.

Audenshaw.—The District Council have determined to apply for two years' extension of time in which to construct the proposed tramways.

Sheffield.—Following close upon the inauguration of the electric service to Broomhill and Crooks, the section to Darnall has now been opened.

Ashton-under-Lyne.—The surveyor has been instructed to procure tenders for the necessary rails, etc., for the intended electric tramways within the borough.

Llanelly.—The Light Railway Commissioners have approved the scheme for electric light and traction, and have submitted it to the Board of Trade for confirmation.

Bury.—The Rochdale Corporation have intimated to the Bury Board of Guardians that the present is not an opportune time for extending the electric tramways to Bamford.

Wigan.—The opposition of neighbouring authorities to the Corporation Tramways Bill has resulted in an agreement as to certain of the clauses to which objection was taken.

Sunderland.—The conductors of the municipal electric trams are seeking an advance of wages from 22s. 6d. to 25s., with a rise of 2s per week at the expiration of six months' service.

West Ham.—The question of the municipalisation of the tramways will shortly engage the attention of the authorities interested, the London County Council, and the tramway company.

Llandudno.—The engineer to the Great Orme tramway, which has now been commenced, has laid plans before the District Council, and has undertaken to produce complete plans as soon as possible.

Motorcar Race.—The German Emperor has announced his intention of offering a prize to the winner of the motorcar race between Paris and Berlin, which is to take place in the course of the summer.

Eccles.—The Town Council have decided to accept the offer of the Salford Corporation to pay an annual rental of £250 for the use of the Eccles tramways until they are reconstructed for electric traction.

Hull.—The tramway statistics show that since the inauguration of the electric tramways on July 5, 1899, to March 31 last, 23,482 984 passengers have been carried, the receipts amounting to £97,845. 15s. 4d.

Dundee.—A run was made over the new Blackness road route on Monday by one of the electric cars, and everything was found in good working order. The route is expected to be opened for traffic in the course of next week.

Keresley.—The District Council have almost completed the preliminary work in connection with laying the new tramlines and running the cars through their district. The electric current will be supplied by the Farnworth Council.

Calcutta.—*Indian Engineering* announces that the electric cars will probably be running in another three months. The engines are on their way out, and by the beginning of June will probably be busy on the Kidderpore and Kalighat sections.

"Tube" Enquiry.—The enquiry into the damage to 2, Lancaster-gate, alleged to have been caused by the construction of the Central London Railway, was concluded at the Surveyors' Institute on Wednesday. The umpire reserved his award.

Stourbridge.—At the last meeting of the old Board of Guardians a letter was read stating that the electric tramway company would extend the stage from the bottom of Brettell-lane to the workhouse entrance, in answer to a request from the Guardians.

Gateshead.—The electric tramlines will be inspected by a representative from the Local Government Board on the 22nd inst. The official opening, however, will not take place until May 8. A trial trip over some of the lines was made on Saturday last.

Admiralty Tramway.—A recent issue of the *Gazette* contains an order of the Board of Trade empowering the Admiralty to take by compulsory purchase land for the construction of a tramway from Teapot Hard to the naval magazine at Chattenden, in Kent.

Burslem.—The Council have received a letter from the Potteries Electric Traction Company in reference to their proposed tramway extension from Hanley to Sneyd Green, and stating that they intended to commence running steam omnibuses to Milton on May 1.

Blackburn.—During the month of February the Corporation trams ran 42 856 miles and carried 323,822 passengers, the total receipts being £1 568 12s. 9d. On the Blackburn and Darwen section 11 964 miles were run, 124 179 passengers carried, and £526. 0s. 6d. earned.

Limerick.—The tramway company have petitioned the Corporation to amend their original agreement with respect to the proposed tramways in the city, involving an outlay of £100,000, by making the term of purchase 50 instead of 21 years. The matter is under consideration.

Wakefield.—At the City Council meeting on Tuesday, the Mayor said there was no intention on the part of the Corporation to prevent the laying of tramways in the city; in fact, they were all willing to give their support so long as the interests of the town were safeguarded.

Hove.—The Town Council are considering the question of acquiring the tramway system with a view to establishing electric traction throughout the district in conjunction with the other authorities interested. A wire conduit is to be built under Church-road at a cost of about £880.

Northampton.—The Corporation have finally decided to take steps to acquire by compulsory powers the Northampton street tramways. The committee acting on behalf of the Corporation offer £37 500 and the tramways company ask £45,000. The total cost of the undertaking which has been in existence 20 years, was £56 000.

Aberdeen.—At the last meeting of the Town Council a long discussion took place over the question of the utilisation of the property purchased for the tramway undertaking at the foot of Constitution-street. It was decided that the existing building be allowed to remain, and the car-sheds erected on the vacant ground adjoining.

St. Helens.—At the local county court on Wednesday a lady obtained £16 damages for injury from the St. Helens and District Tramways Company, a settlement being arrived at. She stated that she had suffered shock to her nervous system through a collision between two electric cars, in one of which she was a passenger.

Liverpool.—On Saturday an electric car coming into the city with a load of football enthusiasts, ran with much force into a stationary car at the junction of Scotland-road and Cazneau-street. So great was the impact that an explosion took place in the fuse box, and there was at once a stampede of passengers. No one was reported injured.

Newcastle.—The entire tram service is stopped the company having failed to come to fresh terms with the Corporation as to a renewal of the lease pending the installation of the municipal electric tramways. Until the Corporation's cars are ready, which will probably be by the end of this year, it is expected that Newcastle will be without a tram service.

Paris.—It is claimed that the Metropolitan Railway has beaten the world's record for the number of passengers carried on any railway line. From Jan. 1 to March 31 the system carried 11,315,799 passengers. This would be at the rate of 32 millions a year. On Easter Sunday the Metropolitan carried 182,216, or double the greatest number on any day during the Exhibition.

Military Automobiles.—On the suggestion of Colonel Crompton, who is a member of the committee which has been formed in connection with the Military Exhibition which is to take place at

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Earl's Court during the forthcoming summer, the Automobile Club have been asked to assist in securing an exhibition of automobiles or automobile carriages and plant adapted for military field purposes.

Swindon.—The Board of Trade, we learn, have granted the Corporation a provisional order to construct about 10 miles of electric tramways in the borough. A site for a generating station has been fixed upon, the contract for the supply of engines, dynamos, etc., having been obtained by Messrs. Siemens Bros. and Co. Tenders will shortly be invited for the erection of the necessary buildings.

Lowestoft.—A ratepayers' meeting was held on Monday to consider and determine upon the expediency of consenting to the promotion of the Corporation Bill, which, among other things, asks for power to construct and work tramways and to make further provision in regard to the electric lighting undertaking of the Corporation. Further, to empower them to supply electricity in bulk beyond the borough, and to supply electrical fittings. A resolution was ultimately passed favouring the promotion of the Bill.

New Zealand.—The Roslyn Tramway Company have just established a line of electric tramways in Dunedin. The overhead trolley system has been adopted, and the whole of the work in connection with the track, cars and power station equipment has been carried out by the British Westinghouse Company. The Dunedin City Council have resolved to buy up the local tramway companies' undertakings, and equip them throughout with electric power transmitted from some waterfalls distant about 12 miles from the city.

Huddersfield.—The tramway employés have considered the question of Sunday trams. The men have unanimously resolved not to approve of the proposal, stating that they much prefer to have their Sundays off duty than accept pay and a half, or even double pay, in consideration of a whole or even half-day Sunday service. At the Town Council meeting on Wednesday it was resolved that it should be an instruction to the Tramways Committee to make arrangements at an early date to run Sunday cars on those sections of the system which have been electrically equipped.

Bradford.—The opposition of the Shelf Tramway Company to the Corporation Tramways Bill has now been withdrawn upon compromise under which the Corporation will reconstruct the lines, with the option of taking them over with contingent terms based upon the estimated profits, and the acquisition of a certain proportion of the fixed plant and buildings. Similar terms were offered to the Bradford Company, but were not accepted. The differences, however, are now mainly of detail, and an agreement is likely to be arrived at. The whole of the leases of the Bradford lines expire on Jan. 31, 1903.

Southport.—A sub committee of the Tramways Committee has been appointed to negotiate with the Birkdale and Southport Tramways Company for the surrender of the company's running powers on the infirmary and Kew Gardens section of the Corporation tramways on Saturday next on conditions, including the payment of £200 to the company. At the local police court on Monday, Isaac Georgeson, an electric car driver employed by the Corporation, was summoned for furiously driving his car in Lord-street on Easter Monday. Evidence was given to the effect that at one particular spot the car was proceeding at the rate of 15 miles an hour, and the magistrates imposed a fine of 10s. and costs.

Halifax.—A meeting of ratepayers of Skircoat Ward has been held to consider the question of the incline tramway which the Town Council have decided to construct at Salterhebble, and which is intended to connect ordinary tramlines between Halifax on the one side, and others yet to be formed to Elland, West Vale, and Sowerby Bridge, on the other, so as to avoid a steep and roundabout connection *vid* Salterhebble Hill. A fear was expressed that the present tramways, if properly dealt with as to depreciation, were not really yielding a profit. The time had arrived when, it was urged, the Corporation ought to stay their hands. After a protracted discussion, the meeting passed a resolution against the incline tramway, which would involve an outlay of £12,000.

Leeds.—At the meeting of the Tramways Committee on Monday the chairman presented a highly satisfactory return showing the receipts and car mileage for the financial year ending March 25. The receipts for the twelvemonth amount to £180,283. 0s. 3d., as compared with £126,656. 6s. 4d. for the year ended March 25, 1900, or an increase of £53 626. 13s. 11d. On the electric routes the earnings total up to £133,449. 11s. 5d., or £70,013 1s. more than in the previous year. As was expected, the receipts from the steam and horse cars show a falling off. While the electric mileage has been nearly doubled, there is no decline in the receipts per car mile; in fact, there is a slight increase, the earnings for 1901 being 12·77d., as against 12·62d. for 1900. The actual increase is ·15d. For the moment the year's profits are unknown. The total number of passengers carried during the year stands at 39,334,475. Of these 29,116 270 were taken on the electric cars.

Cardiff.—Major Druitt has held an enquiry with reference to the application of the Corporation for sanction to a loan of £277,630 for tramway purposes. The evidence of the Mayor showed that the total indebtedness of the borough was £2,434,999. The proposed tramways were to be worked on the overhead trolley system. Reduced to single lines, they ran 15 miles. Track-laying work commenced on Dec. 18 last, and cable work on Dec. 28. The contract of the carshed had been let, and the tender had been accepted for the power station. As to the £850,000 authorised under the Cardiff Corporation Act, 1898, £261,510 was estimated to be expended for the construction and electrical equipment of the tracks and wood paving of the roads, and after providing for other expenses there remained a balance of £144,614 to be borrowed for new tramways, and this sum was included in the sum of £277,630, the subject of the present enquiry. A further application would be made in due course for sanction to a loan for the acquisition and conversion of the existing tramways. The inspector will report in due course. The question was raised at the last Tramways Committee meeting why the lines in Cathedral-road were not laid to the borough boundary, and it was explained that the Corporation had no power to do so, and that a provisional order would be necessary. It was further stated that the additional work would cost between £3,000 and £4,000. The question will be considered at the next Town Council meeting. The Electrical and Lighting Committee have decided to accept the offers of the Property and Markets Committee to fit up the upper portion of the fish market as offices for tramways and lighting purposes, provided a seven years' lease be taken.

Manchester.—The budget of the Tramways Committee for the ensuing year presents several interesting features. It is estimated that the electrical energy supplied by the Electricity Committee during this period will cost £11,200; traffic expenses, £27,640; salaries and general expenses, £13,056; maintenance and renewals, £5,450; and depreciation, £5,000. Under the head of special charges occur the following items: amount payable to the Manchester Carriage and Tramways Company in respect of lines taken over by the Corporation under the agreement of July 21, 1900, £15,822; amount payable to the Salford Corporation in respect of receipts on Bury New road route, £6,000. Repairs to tramways are estimated to require £1,500. Other fixed charges bring the total estimated expenditure to £115,410. The amount of income from traffic during the year is expected to be £116 370. The lines leased to the tramways company are estimated to produce £16,300. The amount payable by the Salford Corporation in respect of rent and running powers is put down at £6 700. Miscellaneous receipts bring the estimated total income of the Manchester tramways undertaking for the ensuing year to £140 410. This leaves an estimated surplus on the year's working of £25,000. At the beginning of last year it was calculated that the committee would only be able to relieve the rates to the extent of £12,000. On last year's account the Tramways Committee find themselves with a balance of £4 408 in hand. This, added to the estimated balance for the year just commenced, places a total of £29,408 at the disposal of the committee. It has been decided that £5 600 of this should be transferred to the permanent-way renewals fund, £3 808 to the general reserve fund, and that the balance of £20 000 should be contributed to the city fund in aid of the rates. The capital account of the committee stands at £625,000. Turning to the affairs of the Carriage Company, the directors' report for the half-year ended Feb. 28, states that the receipts were £285,069, an increase of £10,000 on the corresponding half of last year. Out of the disposable sum of £56,354 the directors propose to pay 2½ per cent. on the preference shares, and 5 per cent. and a bonus of 2½ per cent. on the ordinary shares. Twenty thousand pounds is to be added to the reserve, and £5 258 carried forward. Twelve months ago the total paid-up capital was £410,000. A sum of £375,000 was invested in outside securities, and the reserve fund was £190,000. The total undivided profits were £643,000, or 50 per cent. more than the paid-up capital.

LIGHTING AND GENERAL.

Dorchester.—The draft provisional order for electric lighting has been passed by the Board of Trade.

Doncaster.—The Rural District Council have decided to support the Yorkshire Electric Power Company's Bill.

Wolverhampton.—Sanction has been obtained to the borrowing of £59,942 for the purpose of supplying electricity.

Morley.—Mr. H. H. Law held an enquiry on Wednesday into an application to borrow £7 035 for electric lighting.

Montrose.—Sites for 20 arc lamps have been fixed. The lighting of the burgh hall and public buildings has been suggested.

New Cable.—The cable-ship "Anglia" began on Sunday the laying of the direct cable connecting Ascension with the mainland.

Maidstone.—The feeding main from the police station to Albion-place is to be extended at an estimated cost of £291. 13s. 2d.

Horsforth.—The District Council intend to support the Yorkshire Electric Power Company's Bill at the forthcoming conference in Leeds.

East Grinstead.—The new Electric Light Committee consists of Messrs. G. Brinkhurst, Chignell, Dalziel, Milburn, and Whitehead.

Clacton-on-Sea.—An offer from a private firm to supply electricity for a number of arc lamps on the front is being considered by the Council.

Shipley.—The District Council intend to oppose the Bills of the South Yorkshire Electric Power Company and of the Electric Power (Yorkshire) Company.

Gildersome.—The District Council have resolved to take no action in the matter at present with regard to the South Yorkshire Electric Supply Company's Bill.

Lyndhurst.—The Local Government Board have forwarded to the local authorities a copy of an electric lighting order it is proposed to issue for Lyndhurst.

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Aberystwyth.—Endeavours are being made to obtain an extension of the telephone trunk line to Aberystwyth, the nearest town connected at present being Oswestry.

National Company for Distribution of Electricity.—The petition of Mr. Adam Scott for compulsory winding-up of this Company has been dismissed, with costs.

Lichfield.—The provisional order for electric lighting in the city has been issued by the Board of Trade, and the Confirmation Bill introduced into the House of Commons.

Coventry.— The Coventry Electric Light Committee have appointed Mr. J. A. Jeckell, of South Shields, manager of the electric light works, in succession to Mr. Ram.

Bucknall Torkard.—The Urban District Council have resolved to convene a town's meeting with the object of opposing the Notts and Derbyshire Electric Power Company's Bill.

Telephones.—It is reported that the Western Electric Company, of Chicago, have received an order for telephone switchboards for the new London system of the value of £1,000,000.

Brimington.—The Parish Council have agreed to a petition from the Derbyshire and Nottinghamshire Electric Power Company for powers to introduce electricity in the district.

Sunderland.—The Finance Committee are about to take the requisite steps for the borrowing of the amount required for placing 104 arc lamps in the principal thoroughfares of the borough.

Whitehaven.—The engineer has been authorised to engage experienced jointers to assist in laying the cables. The question of appointing a permanent assistant stands deferred for the present.

Thornaby.—The Corporation in committee have decided to oppose the South Durham and Cleveland Electric Power Bill in the House of Commons on the 24th inst., and will be represented by counsel.

Burton.—During the past month the quantity of electric light sold by the Town Council was equivalent to 14 962 Board of Trade units, showing an increase of 1,593 units over the corresponding month of last year.

River Plate Electric Light and Traction Co.—A petition for compulsory winding-up of this Company has been allowed to stand over in order to allow of an arrangement to be made to sell out the undertaking in Argentina.

Aberdeen Telephones.—The Town Council have instructed Mr. Bennett to draw up a report as to the approximate cost, etc., of a municipal system of telephones covering the present area of the National Telephone Company in the city.

Hastings.—The Vestry of Christ Church, Blacklands, have been discussing the installation of electric light. The estimate for putting it in the chancel is £24. 15s. 6d.; for extra lights, £5; and for other items, £5. 4s.—making a total of £34. 19s 6d.

Harrogate.—New lamps are to be placed in various streets, and other extensions of the lighting are being made. The engineer is preparing estimate of the cost of carrying overhead conductors from the farm to the isolation hospital for the purpose of electric lighting.

Great Northern Telegraph Co.—The directors recommend a final dividend of £1 per share, making a total distribution of £1. 10s. per share for the year 1900, placing £166,667 to reserve, £55,556 to the renewal fund for cable steamers, and carrying £64,989 forward.

Bexhill.—The Urban District Council last week adopted a report recommending the extension of the electric cables and the erection of additional arc lamps. It was mentioned that since the previous meeting of the Council applications for 500 8-c.p. lights had been received.

St. Marylebone.—The Council have agreed to an application from the Metropolitan Electric Supply Company to the laying of a low-tension armoured service along the west side of Tottenham Court-road from the north side of Oxford-street, to connect the Oxford Music Hall.

Edinburgh.—A new clock was inaugurated a few days ago by Mrs. Steel, wife of the Lord Provost of Edinburgh, in the tower of the premises of the National Savings Bank at Stockbridge. The clock will be lighted by electricity. Messrs. James Ritchie and Son are the makers.

Removal.—Callender's Cable and Construction Company, Limited, have removed to larger offices at Hamilton House, Victoria-embankment, London, E.C. We are asked to state that all communications should in future be addressed to the company, and not to individuals.

Leith.—The Electric Lighting Committee have resolved to recommend the Town Council to reduce the price of electric energy for lighting purposes from 5d. to 4d. per unit, there being now about 280 consumers connected with the mains, or an equivalent of 25,830 8-c p. lamps.

Wireless Telegraphy.—We understand that the Cunard Company contemplate fitting an instalment of the Marconi wireless telegraph system on board their Atlantic ships. Mr. Marconi is at present conferring with the Naval Board at Newport, Virginia, on the adoption of wireless telegraphy.

Midsomer Norton.—At the last meeting of the Urban District Council a lengthy report was received from the engineer on the proposed scheme for lighting Midsomer Norton and Radstock by electricity. It was resolved that the same be printed for distribution among the members of the Council.

Leigh.—The Telephone Company are about to provide separate communication with the town clerk's office and the offices of other borough officials in exchange for certain privileges as to continuing certain poles and wires, laying underground wires, etc.

Birmingham.—Messrs. Vickers, Sons, and Maxim propose to erect extensive works here for the manufacture of the material required in the carriage-lighting system of the Consolidated Railway Electric Lighting and Equipment Company, the sole rights for which the company have acquired for Europe.

Finchley.—The *Barnet Press* says the District Council have obtained an interim injunction against the Finchley Electric Lighting Company. It is but fair to add that the injunction was granted upon an *ex parte* application, and that the electric lighting company will later on—on the trial of the action—put its side of the question before the Court.

Price-List.—The Hart Accumulator Company, Limited, are now issuing a pocket edition of their price-list of storage batteries. All necessary information concerning the cells and instructions for their erection are concisely put in a remarkably small space, and the convenient size of the list, which is well illustrated, will no doubt recommend itself to engineers and contractors.

Norfolk.—The County Council have sealed agreements with the National Telephone Company, Limited, (1) authorising the company to erect telephone poles alongside the main road from Coltishall to the junction of the road leading to Stratton Strawless Hall; and (2) providing for telephonic communication between the Norwich Shire Hall and the company's exchange at Norwich.

Charing Cross and Strand Electricity Supply Co.—We are informed that the Company's issue of £250,000 4 per cent. debenture stock at par was so largely over-subscribed that the directors closed the subscription lists at three o'clock on the 11th instead of leaving it open until the 12th, as was previously intended. Letters of allotment and regret in connection with the above issue were posted to the applicants on the 16th inst.

Glasgow Exhibition.—The correspondent of the *Morning Post* says the great feature of the Machinery Hall—which is, in spite of the prominence given to fine art, the most valuable element in an essentially industrial exhibition—is the display of electric motors. In all probability, indeed, the exhibition will be noted in history as marking the triumph of electricity all along the industrial line in Great Britain as well as in the United States.

Ramsgate.—The Mayor, Aldermen Wood and Hodgson, and Councillors Gwyn, Bear, Hawkes, White, Poole, and Dowling, have been appointed a committee, to be designated the Electricity Enquiry Committee, to enquire and report as to the steps which it is expedient the Corporation should take in carrying out the Ramsgate Electric Lighting Order, 1900, and that the committee be authorised to obtain expert evidence on the subject.

Sheffield.—With regard to a note in our last issue, we are informed that the supply of electrical energy in this city has only been cut off once during the last six months, due to a large 1,100-kw. alternator suddenly breaking down, and that the minor extinctions which our correspondent mentioned only affected a very few consumers, through the blowing of a fuse in a local transformer, and in some cases only affected one consumer.

Hendon.—The Board of Trade have informed the District Council that they do not appear to have any power to grant an extension of the Electric Lighting Order, 1899, but that they will defer consideration of the question of the revocation of the order for a period of 12 months from May 17. If at the expiration of the period mentioned definite steps have not been taken, the Board will not be prepared to allow the order to remain in force.

London Gazette.—The first meeting *re* the estate of J. Brown, 278, High street, West Sunderland, will be held on April 19 at 3 p.m. at Official Receiver's office, 25, John street, Sunderland, and the public examination on April 18 at 11.15 a.m. at Court House, John-street, Sunderland.—At an extraordinary general meeting of the New British Incandescent Electric Lamp Company, Limited, Mr. E. C. Moore, 3, Crosby-square, Bishopsgate-street, E., was appointed liquidator.

Walsall.—On Tuesday Colonel W. Langton Coke held an enquiry into an application of the Town Council for sanction to borrow £3,000 for purposes of electric lighting. The Town Clerk stated that the Corporation loans were £381,898. The demand for electric lighting had greatly increased, and as the present transformer stations were over-taxed, it was proposed to erect a new sub station in Freer-street. Between 1899 and 1900 the units sold showed an increase of 81,392.

Indo-European Telegraph Co.—The directors, after adding £25,000 to reserve fund, recommend a dividend for the six months ended Dec. 31, 1900, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, in all 10 per cent. for the year. The thirty-fourth ordinary general meeting of this Company will be held at the Company's offices, 18, Old Broad-street, E.C., on April 30 at 12.30 p.m. The transfer books will be closed until that date.

Railway Block System.—The Great North of Scotland Railway Company have instructed Mr. Alexander Spark, electrical engineer, to make alterations on the block system, in accordance with a Clearing House arrangement which affects all the railway companies. These operations, which will occupy considerable time, will necessitate the fitting up in each cabin on the main line and the branches of a supplementary telegraph instrument, the object of which is to render the block system absolutely perfect.

Manchester.— The Electricity Committee on Wednesday adopted estimates for the current year, showing a probable deficit of £5,000. This is attributed to the fact that during the past year

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cables have been laid far beyond the supply of current obtainable, and consequently for the present this work has produced no revenue. Last year the committee handed over in relief of the rates between £11 000 and £12,000. It is anticipated that the deficit of £5,000 will be taken from the reserve fund, which stands at £13,000.

Heywood.—The application of the Corporation for a loan of £15,000 for electric lighting purposes has been sanctioned, but the Local Government Board have finally declined to sanction a loan of about £2,000 for the free wiring of consumers' premises on the ground that the granting of powers for such a loan would establish a precedent. Mr. W. S. Johnston, of Sheffield, has been appointed clerk of works in connection with the electricity works, with the probability of becoming manager of the works after their completion.

Bournemouth.—In consequence of a recent conference at the Board of Trade offices, at which the Corporation, the Pokesdown Urban District Council, and the Poole and District Electric Supply Company were represented, the Corporation have agreed that the Board of Trade be requested not to grant the order asked for by the electric supply company in respect to the urban district of Pokesdown this year, looking to the fact that the Council had applied to the Local Government Board to include Pokesdown in their district.

Cardiff.—At a meeting of the Electrical and Lighting Committee of the Corporation on Tuesday, Mr. Ellis produced a return of figures dealing with the work of the department. In reply to a question whether it was true that there was a loss on public lighting, Mr. Ellis said they were practically making a profit of £300 a year on the electric street-lighting. They had about 80 lamps, and the total cost worked out to about £1,200 a year, including interest and repayment of capital expenditure. The income from them was £1,500 per annum.

Aberdeen.—The Town Council have decided to supply the new post office on the usual terms to consumers—viz: (1) for lighting—for the first hour daily of the maximum demand 6d., thereafter 3d. per Board of Trade unit; (2) for motive power—for the first hour daily of the maximum demand 3d., thereafter 1d. per Board of Trade unit. In consequence of a breakdown in connection with the 420-kw. generator at the Cotton-street electricity station, it has been found necessary to replace the engine almost entirely by a new one. This will be erected at the Ferryhill station on its being replaced.

Newport.—Messrs. Nettlefold and Co., of Birmingham and Rogerstone having purchased an extensive strip of land adjoining the River Usk on the eastern bank, the preliminary arrangements for the construction of the proposed works are now practically completed, and tenders will be invited in the course of a week. Messrs. Nettlefolds have decided to generate their own electricity, and for this purpose a 400-h.p. gas engine is to be erected. The cost of the engine and equipment will be about £4 000. We understand that a Newport firm of engineers has received the order for its erection.

Alfreton.—Mr. A. P. Trotter held a Board of Trade enquiry on Wednesday into the application of the Urban Council for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise them to supply electricity for public and private purposes within the Alfreton Ward of the urban district. The scheme was supported by Mr. Samuel Johnson and Mr. George Preston, members of the Council); Mr. Frederick Lee, builder and contractor; Mr. Charles A. Baker (Gibbings and Baker, electrical engineers); and Mr. J. S. Barnes, the electrical engineer. In opposition to the scheme, Mr. A. V. Frere called several witnesses from the Somercotes portion of the ward.

Chatham.—The Town Council have adopted the following report concerning the proposed purchase of the local electricity undertaking: "The Highway and Works Committee having further considered the proposal to purchase the electric light undertaking, as referred back by the Council, and having read a letter from the company's solicitors requiring the sum of £35,000 for the purchase, or that the price should be fixed by valuers to be appointed on behalf of the company and of the Corporation, it was resolved that after further consideration of the matter the committee regretted that they were compelled to recommend that the proposed offer of £20 000 made by the Corporation be not confirmed."

Kendal.—Mr. M. K. North held an enquiry on Wednesday into the application of the Corporation to borrow £14 000 for the purposes of supplying electricity to the town. The Town Clerk said the money was made up as follows: for buildings, £3,000; for equipment of station, £4,975; for the supply of underground mains, meters etc., £2,965; for cost of provisional order, engineer's fees, and expenses, £1,000; contingencies and extensions, £2 060. In July, 1899, an enquiry was made, and upon that occasion 1,273 letters were sent out. The compulsory area indicated in that application was slightly larger than the one now adopted, but there were then demands for 1,895 8 c.p. lights.

Bo'ness.—At last week's meeting of the Town Council a letter was read from Messrs. Crompton and Co. offering to put an installation of electric light into Bo'ness at their own cost and risk, and at reasonable charges to the public. The Council could acquire the installation after a certain number of years at a reasonable cost. The company had already obtained a footing in Dalkeith, Jedburgh, and Melrose. In view of the fact that the Council would have a greatly increased expenditure on street lamps next year, the proposal was very favourably received, and a special committee was appointed to confer with Mr. Purvis (of Edinburgh), who represents the company, with the view of coming to an arrangement.

Chester.—The total income from public and private lighting is £2,200 in excess of the previous year, and the balance of revenue account is £5,814. 9s. 11d. From this sum must be deducted the interest on money borrowed and sinking fund charges—viz, £4 005. 11s. 3d.—leaving a net balance of £1 808. 18s. 8d, which amount the committee propose to allocate as follows: special discount to consumers of over 5 000 units, £347. 10s. 8d.; addition to reserve fund, £1,400; and balance to be carried to next account as provision for bad debts, £61. 8s.—total, £1,808 18s. 8d. The reserve fund now stands at £2,496. 11s. 6d. (of which £2 465 1s. 1d. is invested in consols); the addition of the above £1 400 will bring it up to £3,896. 11s. 6d.

Hull.—A new automatic cut off apparatus, patented by Messrs. Bostock and Cheetham, of Brighouse, has been erected on the Hessle-road tram route, one of the principal and busiest thoroughfares of Hull. On Monday last a public test was made under conditions as nearly resembling an actual breakdown as possible. At a given signal a cable was cut, with the result that the cut off action automatically responded instantly, the two ends of the wires falling "dead" on the roadway, and all danger being averted. Many of those present took hold of the wires, and expressed astonishment that what a few seconds before had contained a powerful electric current should be so instantaneously "dead." Within a few minutes the cable was spliced, everything made good, and traffic was resumed with scarcely a break.

Accident.—An adjourned inquest was held by Mr. Schroder at St. Marylebone last week concerning the death of George Hopcraft, a boiler-cleaner, employed by the Metropolitan Electric Supply Company at their generating station. The evidence showed that Henry Taylor, foreman of the works, heard in his rounds a whistling noise, and, on examination, found this proceeded from a crack in the superheater pipe in the new boiler-house. The pipe was of copper encased with asbestos, and, apprehending danger, he set Hopcraft and other workmen to rake out the fire. While the men were so employed the pipe burst. There was a wooden ladder by which the other men escaped. The deceased who was about 9ft. distant from the ladder at the time, was scalded to death. The pressure of steam was 175lb. per square inch, and Taylor said he had known the pipe in question to bear a pressure of 195lb. to the square inch. The jury found a verdict of accidental death, and added: "The jurors would suggest for the consideration of the company the advisability of providing a safer means of egress from the stokehole. They are further of opinion that the witness Taylor before going to the old boiler-house to shut off the steam should have told the deceased and the other men to leave the stokehole." But for this error of judgment, the Coroner remarked, Taylor had acted properly as well as promptly.

Stock Exchange.—The Stock Exchange Committee have appointed May 2 a special settling day for City and South London Railway Company's further issue of 10 000 ordinary shares of £10 each fully paid, Nos. 60 001 to 70 000, and ordered the undermentioned securities to be quoted in the official list: Buenos Ayres and Belgrano Electric Tramways Company's £120,000 5 per cent. second debenture stock, in lieu of provisional certificates now quoted, and 100 000 ordinary shares of £5 each fully paid, Nos. 1 to 100,000; City and South London Railway Company's further issue of 10,000 ordinary shares of £10 each fully paid, Nos. 60,001 to 70,000; Kensington and Knightsbridge Electric Lighting Company's 21,000 ordinary shares of £5 each fully paid Nos. 1 to 21 000 and £90,000 4 per cent. debenture stock; Kensington and Knightsbridge Electric Lighting Company and the Notting Hill Electric Lighting Company's further issue of £26,991 4 per cent. debenture stock. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to General Electric Company (1900), Limited, 18,000 5 per cent. cumulative preference shares of £10 each fully paid, Nos. 7,001 to 25,000, and £150,000 4 per cent. first mortgage debenture stock, and to allow the following securities to be quoted in the official list: Edison and Swan United Electric Light Company's £100,000 5 per cent. second debenture stock, in lieu of the provisional certificates now quoted; Notting Hill Electric Lighting Company's further issue of 2,200 ordinary shares of £10 each fully paid, Nos. 10,001 to 12,200.

Scottish Electrical Contractors' Association. — We have received from the secretary of this association the recently-issued draft of its constitution, with which is also published rules which the members of the association are expected to comply with in connection with their employés. In the last portion of the little book is also given particulars of standard clauses to guide members in their negotiations with consulting engineers and manufacturers. We are pleased to note that the association are prepared to accept, with only slight modifications, the standard clauses agreed upon between the electrical engineering plant manufacturers and the Municipal Electrical Association in 1898. In looking through the constitution we note that in the qualification for membership firms engaged in telegraph and telephone work are not included. We fail quite to see the reason for this, although we do appreciate the object of the contractors in trying to prevent wholesale manufacturers participating in the advantages derived from their association. We think, however, that it will be found exceedingly difficult to prevent large manufacturers from supplying direct to large works, particularly when the materials required have to do with electric motors for driving machinery. As a whole, we think that the rules are well drawn up, and we trust that one result of the new association will be that there will be more higher-class work done at remunerative prices. Full particulars of the association can be obtained from the secretary, Mr. James M. Davies, jun., at 168, St. Vincent-street, Glasgow.

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Fire.—Shortly after one o'clock on Friday last an outbreak of fire was discovered in the packing department of the extensive works lately erected by the London Electrical Fittings Company Limited, in the Hampstead-road. We are pleased to note that owing to the energetic action of the firm's employés, and the readiness of the fire appliances, the flames were extinguished before the arrival of the fire brigade. We are informed that no damage was done to the plant or stock, so that no delay whatever will occur in the execution of orders.

Personal.—Mr. Oswald Dewey has been appointed assistant engineer to the Notting Hill Electric Lighting Company, Limited. Mr. Dewey has been until now distributing stations assistant of the Manchester Corporation, and during the last 18 months supervised the erection of continuous-current (high-tension) plant, and also of the three-phase plant which was described in our issue of the 5th inst. Our best wishes for success accompany Mr. Dewey to his new post.—Mr. W. B. Woodhouse, A M I M.E., has been appointed chief electrical assistant to the Newcastle upon-Tyne Electric Supply Company at their Neptune Bank power station.

Middlesbrough.—The installation of the electric light in the public library, says the *Northern Echo*, is a very great improvement indeed, and no doubt when the work is completed in respect to the newsroom portion it will be equally appreciated there—that is, if the committee refrain from purchasing cheap and nasty foreign lamps. The new illuminant must mean much less expense in the way of cleaning and painting, and also be much less destructive of the thousands of volumes on the shelves than was the case with gas. One of the surprising things is that the Corporation have not got it in other parts of the building, and especially in their committee-room.

Linlithgow.—The Town Council are negotiating with Messrs. Crompton and Co. with reference to the proposed installation of the electric light to the burgh. A draft agreement is being considered, under which Messrs. Crompton and Co. offer to apply for a provisional order, construct the necessary works, lay mains in the public streets, and supply the town with the light. The Town Council are given the option of applying for the provisional order themselves, and of taking over the works from the company, and the latter would allow a nominal sum of £25 yearly as rent for the use of the streets. Public lamps, giving a light equal to 16 candles, and burning for 1,500 hours, would cost £1. 1s. The charge would be 6d. per unit for domestic use and 3d. for cooking purposes.

Tunbridge Wells.—It is reported that the new engine at the electric lighting works has had a satisfactory preliminary run, and the committee hope to soon be at the end of their difficulties. The town clerk has been instructed to draft a form to be sent out to consumers upon receiving a complaint with respect to their account, and to embody the following points: If a consumer doubts the accuracy of his meter, it can be tested upon depositing 5s. with the engineer, which sum will be returned in the event of the meter proving incorrect, but otherwise the account must be paid forthwith; or the consumer, if he chooses, can desire the Board of Trade inspector to hold his test on the meter—a deposit of £2. 2s. being lodged with the engineer, which will be returned if the meter be incorrect.

Baking by Electricity.—A motor-driven bakery has been installed recently at Holbeck for the Leeds Industrial Co-operative Society by the National Wiring Company, who carried out the whole of the equipment, together with the two hoists, countershafting, and belting. There are eight Langdon-Davies motors, two of 1 h.p., one of 3 h.p., three of 4 h.p., all wound for 200 volts; and one of 16 h.p., wound for 400 volts. The electric light system consists of about 150 incandescent lamps. These motors are driven with current supplied from the Corporation lighting mains, and they afford another instance of the adaptability of the single-phase alternating current for power purposes. There are at present two motors, 9 h.p. and 12 h.p. respectively, on the Morley Corporation mains in successful operation.

Taunton.—A report has been adopted recommending the acceptance of the contract to be entered into by the Newton Electrical Works for the laying down of the electrical plant for the supply of energy for the trams. Negotiations between the Electric Lighting Committee, the tramways company, and Messrs. Newton have resulted in an arrangement under which the tramways company will postpone the date under which the Corporation is liable to supply energy—namely, July 1 to Aug. 1 next, on which latter date Messrs. Newton and Co. undertake by their contract that the Corporation shall be in a position to supply energy. Under the contract Messrs. Newton and Co. also guarantee the proper working of the plant for seven years. The connections to the electric lighting mains during the past quarter were equivalent to 1,873 8-c.p. lamps. This includes connections for motors.

Dublin.—The Lighting Committee met on Wednesday week in the city hall. In connection with the new electric lighting scheme, various reports were received as to the manner in which the work is proceeding, showing that the British Insulated Wire Company had already delivered a large quantity of the cables in Dublin, and would start the work of laying them immediately, and that Messrs. Stewart would be in Dublin that week to arrange for the commencement of the buildings at the Pigeon House Fort. Mr. Hammond reported that he had already received 40 applications from leading firms for specification No. 4, that specification 5 was in the hands of the printers and would be advertised the next week, and that specification 6, which would complete the work with the exception of that small portion of it connected with the building of the street pits, would be delivered to the printers in another week. Arrangements have been made for starting the work at the Pigeon House Fort within the next week.

York.—In addition to the choir and lady chapel, the crypt of York Minster has now been fitted with the electric light by Mr. Pepper, electrical engineer, of Minster Gates. Hitherto a few badly placed gas jets, supplemented by candles, have been the only illuminant, and visitors have thus obtained only an imperfect idea of the interesting Saxon and Norman remains preserved in the crypt. Now, however, the ancient recesses of the place, hallowed as they are by their association with the beginnings of the Church in the northern province, can be flooded in an instant by a brilliant light. Probably for the first time the visitor is able to examine with something like comfort the fragments of Saxon rubble work and herring-bone masonry, the incised zigzag and diaper patterns of Roger's Norman pillars. Tradition locates the spot of King Edwin's baptism in 627, and also the place where his head was buried, in the crypt.—*Wakefield Review.*

International Electric Company of Liege.—We are informed that Mr. Ernest Kilburn Scott, M.I.E.E., A M I C.E., has taken up the position of engineer and manager (for the United Kingdom, Colonies, and Egypt) to the International Electric Company of Liège, the London offices being at Clun House, Surrey-street, Strand, W.C. Besides the ordinary run of electric lighting work, Mr. Scott proposes to give special attention to the application of continuous and multiphase motors to machine-driving in factories, iron and steel works etc.; also to mining work, electric traction for tramways and railways, and to long distance power transmission. The International Electric Company of Liège was founded in 1899, and has, under the direction of the manager and technical director (Mr. G. J. Melms), created many new and special forms and types of machines for the application of electricity. The Company have already a good footing in the United Kingdom, having supplied machinery to a number of firms in Middlesbrough, Hartlepool, Sunderland, Dumbarton, Glasgow, Belfast, and South Wales.

Tonbridge Telephones.—At the last meeting of the Guardians the Workhouse Master reported that he had received from the municipal telephones manager a circular embodying a number of reasons why the municipal system should be adopted. It was pointed out that it was the only service which would enable subscribers to call up the fire brigade, the borough police, and municipal officers. It was also stated that there would be no intercommunication between the 500 municipal subscribers and those of the National Telephone Company's local system. The Master explained that at present the workhouse was connected with the National system, and there was also a local system connecting the various blocks. The contract for the telephones in the house expired shortly and if the matter was held over for a time he could ascertain what telephones would be necessary within the house, and what the municipal authorities would carry out the whole of the work for. He thought if this course was adopted money would be saved. It was stated the municipal system would be in operation in June, and it was decided to defer the matter to allow the master to report at a future day.

Lowestoft.—At the meeting of the Town Council last week the Electric Lighting Committee reported on the expenditure out of their loan, stating that £22 447 (including £250 bank interest) had been expended. The balance (after repayment of £1 200 principal), representing the amount of loan at this date, is £20,996. The committee recommended that the borough accountant be paid £50 per annum for his services to be rendered in connection with the electric lighting undertaking. The Engineer reported that on March 29 the equivalent of 4,600 8 c.p. lamps were connected for private lighting, and including public lighting, 5,400 8 c.p., and including motors, 5 570 8 c p. lamps. There are at present 65 consumers waiting to be connected, but these could not be taken till the extension plant was delivered. Letters were read from two residents calling attention to the serious effects likely to result to their property in Rotterdam-road and Norwich-road by the vibration of the engines at the electric light station. With a view to minimise vibration, the committee propose to put down a condensing plant which is provided for under the scheme, but which they had not intended to put down until their extension plant was received. Their success had really become somewhat of an embarrassment to the committee. It was almost unprecedented in the history of electric lighting that within six weeks of switching on the light they should have a full load. The extension plant would not be delivered until the end of June. The engineer was authorised to put in order the necessary distributing cables and feeders included in the extensions loan of £20,000.

Dorking.—The Urban District Council have adopted the following report on the electric lighting scheme: "The clerk submitted the draft deed of transfer of the powers of the provisional order from this Council to the West London and Electric Supply Company, Limited, together with counsel's opinion thereon. The committee having fully considered same, instructed the clerk to see that the following provisions are, *inter alia*, included in the conditions set forth—viz.: (1) site of generating station to be approved by the Council; (2) machinery, Messrs. Johnson and Phillips's plant to be used; (3) free wiring to be provided for on terms agreed; (4) costs of Council of and incidental to transfer to be paid by the company, provided such costs, together with expenses set forth in Clause 25 of the draft deed of transfer, are not to exceed in the aggregate £500; (5) the inclusion of the alternative option of purchase by Council marked (*b*) in the company's original offer; (6) stipulation that the works be completed within 18 months of date of the Board of Trade's sanction to the transfer, and failing which the indenture to be void, and the Council to resume powers at present vested in it. The clerk was further

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instructed to enquire whether (1) the company would be prepared in the event of the Council hereafter desiring to place the work of street-lighting in the company's hands, to lay mains in that part of the then lighted area not included in Clause 23 of the draft deed without additional cost to the Council; and (2) to ask for an explanation as to the exact meaning of the words, 'to make up a cumulative dividend of 7½ per cent. upon the capital expended.'"

Barnsley.—The Chamber of Commerce have decided not to take any action with regard to the Yorkshire Electric Power Company's Bill. The Guardians intend to apply for sanction to a loan of £4,000 to meet the cost of electric lighting plant and engineer's commission, tenders to the amount of £3,712. 19s. 6d. having been accepted. At Tuesday's meeting Mr. Marshall, chairman of the Electric Lighting Committee, stated that the Town Council had offered to supply them with electricity at 7d. per unit the first hour and 2d. afterwards, at which rate electric lighting alone would have cost them £324. 1s. 3d. The Council offered to supply power at 1½d. per unit, which amounted to £210. 12s. per year—to substitute electricity for the steam-engine, etc. The difference between the Corporation's supply and the Board generating its own power was this: The Corporation supply would cost £534 and in addition they should have to have an electrician, which would bring the cost to £685 per year. The present system, including £170 for gas, had cost them during the past year £580. They estimated the proposed installation to cost £370 a year, on which would come £248 for interest and redemption—together £618—so that, roughly speaking, there was about £100 difference between the present system, the proposed new system, and the offer of the Corporation. In any case they were bound to have a new boiler and a new engine, so that out of the £3,700 they should have to spend £1 400 in any case, so that they had to spend in round figures £2,400 on the electric lighting apparatus. He read the letter in which the Town Council made the offer of supply, and in which it was said that the benefit of any reductions would be given, and that the Guardians must guarantee that their bill for light and power should not be under £200 a year.

Peterborough.—Mr. M. K. North has held an enquiry into the application of the Town Council to borrow £12 200 for the purpose of electric lighting. This sum is made up as follows: completion of present works, £5,000; extensions (plant and mains), £6 000; and street-lighting, £1,200. Mr. J. C. Gill, the engineer, said that this amount of £5,000 will make the existing works complete in every detail. The £6,000 was necessary to increase the output of the works and provide spare plant. This amount might be divided into £3,280 to be expended in generating plant, and £2,720 in extensions of mains. These mains comprised 1,020 yards of distributors and 966 yards of feeder. The generating power would be doubled. The present plant consisted of two 60-kw. sets, and it was proposed to have another set of 120. The existing boiler plant comprised two Lancashire boilers, each 30ft. by 7ft.; it was proposed to add another one, 30ft. by 8ft. The extensions of mains were mostly short lengths in additional streets. An additional feeder would run from the generating station of Lincoln-road, and would there be connected with the distributing system. The generating power of the existing plant was equal to lighting 4,000 8-c.p. lamps. There were now 3,488 lamps connected, and an additional 1,103 were applied for. The £1,200 was required wholly for the installation of street-lighting by arc lamps in that portion of the borough where the electricity mains were now laid. At present the streets were lighted entirely by gas supplied by a company. The scheme was to put up 34 500-watt arc lamps to replace 53 gas lamps, for which the Corporation now paid the gas company £400, and this sum it was proposed to hand over to the electricity department. The arc lamps would be 55 yards apart on an average, and the cost of the current worked out at 2·15d. per Board of Trade unit. Their power was being rapidly taken up, and they were selling it a paying price—6d. per unit for lighting and 3d. for power. Mr. Gill further said that in 1895 he put the cost of each arc lamp at £17 per annum, which was then the amount charged by one party to another—*i.e.*, where the undertakers were not consumers. The argument in the present case was that as the light would be installed for the benefit of the ratepayers, who were the owners of the works, the current should be supplied at cost price.

King's Lynn.—Since the last meeting of the Town Council applications have been received for a further 205 lamps, making a total of 8,150 lamps of 8 c.p. from private consumers. The engineer has been empowered to fix six voltmeters at his discretion. A new scale of charges has been adopted as follows: For all current consumed during the months of May, June, July, and August 3d. and for the remaining months 5d. per unit. For each winter quarter, after 10 units per 8-c.p. lamp have been used, the current to be charged for at 3d. per unit. One of the new engines was started last week by the Mayor (Mr. J. T. Savage). Mr. R. E. Floyd, chairman of the Electric Lighting Committee, and Mr. J. Pilling, the electrical engineer, conducted those assembled to witness the ceremony over the works. Mr. Pilling stated that the original plant comprised five gas-engines, each of 65 b.h.p., driving by belts five dynamos, each with an output of 40 kw. The engines are driven with Dowson gas, manufactured in four gas-producers, which, with two vertical boilers to generate steam for the blast for the producers, are situated in a separate building. The new plant consists of two steam dynamos, for the accommodation of which the engine-house has been extended northwards, and beyond this extension a commodious boiler-house has been erected. There would be two Lancashire boilers 30ft. long and 8ft. in diameter, built for a working pressure of 150lb. to the square inch, the shell being of Siemens-Martin steel plates ¾in. thick. Each boiler would have two internal flues 3ft. 2in. in diameter, each flue containing five Galloway tubes. One boiler which was in position is fitted with Meldrum's forced-draught arrangement. In the main flue is placed an economiser by Messrs. Green and Co., Wakefield, consisting of 96 tubes, and the feed water from the boilers is passed through it, taking up some of the heat of the flue gases, and thus effecting a wholesome economy in fuel. The apparatus for keeping the tubes clear is operated by a small electric motor. The boiler at present fixed is kept supplied with water by a Weir boiler feed pump capable of discharging 2,400 gallons an hour against the boiler pressure, and a Gresham injector with a capacity of 1,200 gallons per hour; and another feed pump can be fixed when the second boiler is in position. The two steam dynamos will have a capacity of 120 kw. and 200 kw. respectively, and it is the smaller of the two which is already fixed and which was set going last week. The engines are of Belliss and Morcom's well-known type, capable of developing 175 b.h.p. and 280 b.h.p. at speeds of 400 and 350 revolutions per minute respectively. The cylinders are compound, and will work either with or without condensing apparatus. The engine started the other day has a stroke of 9in., the high-pressure cylinder being 10in. and the low-pressure cylinder 17in. in diameter. The dynamos, which are coupled direct to the engines, are of the six-pole type, made by Messrs. Laurence, Scott, and Co., of Norwich. A Worthington jet condenser, capable of maintaining a vacuum of 26in. when both engines are working, has been fixed in a well at the north-east corner of the engine-room. The first boiler and the pipe work, pump and condenser, have been fixed by Messrs. Yates and Thom, of Blackburn; and the necessary extensions to the switchboard were carried out by Messrs. Lewis Bayliss and Co., of Wednesbury. The only alterations in the street works necessitated by the extension is the provision of the new feeder mains. These were supplied by Messrs. Callender and Co., of Erith, and have been laid by the Corporation's own employés. The effect of the additions when complete will be to considerably more than double the generating capacity of the works. The five gas-engines are sufficient to supply 5,800 8-c.p. lamps simultaneously, and the one large steam dynamo will produce exactly the same amount of current, whilst the smaller one will be capable of lighting 3,500 8-c.p. lamps at one time. One advantage claimed for the steam plant is the small ground space which it occupies, this being only one eighth of that taken by an equivalent amount of power in gas-engines; and another good point is its almost noiseless running, which greatly impressed those who were present at the ceremony. The new plant has been installed under the supervision of Mr. J. Pilling, and the addition to the buildings was designed and superintended by Mr. H. J. Weaver, the borough engineer.

PROVISIONAL PATENTS, 1901.

APRIL 2.

6851. **Improvements in or relating to electric lamp-shade holders.** Clifford William Kemp, 24, Temple-row, Birmingham.

6862. **Improvements in apparatus for generating electric current and in means for registering its consumption.** Sydney Holmwood Holden, 24, Arthur-road, Erdington, Birmingham.

6870. **Coin-controlled apparatus for telephones.** Edward Gardner Lewis, 55, Chancery-lane, London. (Complete specification.)

6884. **Improvement in protecting covers for steam-pipes, water-pipes, rods, chains, wire ropes, or electric wires for ship purposes.** Charles Edwin Hudson, Billiter House, Billiter-street, London. (Complete specification.)

6898. **An electric racecourse.** Walter George King, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Eugène Piatti dal Pozzo, France.)

6910. **Improvements in or relating to starting and controlling electromotors.** Wilfred Swanwick Boult, 111, Hatton-garden, London.

6933. **Improvements in or relating to prepayment electrolytic electricity meters.** Barker North, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6935. **A new or improved method of and means for passing a known fraction of an electric current through an electrolytic meter.** Barker North, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6946. **Improvements in automatic telephone exchanges.** Herbert John Haddan, 18, Buckingham-street, Strand, London. (The Strowger Automatic Telephone Exchange, United States.) (Complete specification.)

6949. **Improvements in audible electric telegraphy.** Robert Oxlade and William Joseph White Richardson, 22, Southampton-buildings, Chancery-lane, London.

APRIL 3.

6998. **Improvements in the method of and apparatus for adjusting the points of electric tramway lines or the like.** John Thomas Noble, 8, Quality-court, Chancery-lane, London.

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7013. **Improvements in and relating to arc lamps and the like.** Walter Rowbotham and Kate Amelia Rowbotham, 307, Gillott-road, Edgbaston, Birmingham.

7015. **Improvements in the suspending mechanism for electric arc lamps.** The Jandus Arc Lamp and Electric Company, Limited, Bernard Mervyn Drake, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

7016. **Improvements in or relating to electric arc lamps** The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

7040. **Improvements in or relating to safety devices applicable to overhead trolley wires for electric railways and tramways.** Charles Hyde, 6, Lord-street, Liverpool.

7054. **Improvements in systems of electrical distribution.** Norman Wilson Storer, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents etc., Act, 1883, Sec. 103, Sept. 6, 1900, being date of application in United States.)

APRIL 4.

7067. **Electro-mechanical interlocking apparatus for the safe operation and control of railway signals and points** William Robert Sykes, Winfrith, The Avenue, Bickley, Kent.

7076. **Improvements in time switches for electric signs.** Samuel Fildes, 4, Corporation-street, Manchester.

7086. **Improvements in electro-dynamic equipments.** Charles Ashley Carus-Wilson and James Sutherland Warner, 41, Old Queen-street, Westminster, London.

7112. **Improvements in apparatus for rectifying alternating electric currents.** The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Charles M. Green, United States.) (Complete specification.)

7114. **Improvements in electric regulators.** The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Augustine R. Everest, United States.) (Complete specification.)

7115. **Improvements in trolley stands for electric railways.** The British Thomson-Houston Company, Limited, and Frederick Samuelson, Bush-lane House, Cannon-street, London.

7116. **Improved electric motor.** Frederic de Mare, 72, Cannon-street, London.

7126. **Telephone metering system.** Donald McQueen Bliss and Newman Henry Holland, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

7150. **An improved electromagnet motor.** Louis Henry Engelhardt, Harry Merle McNolly, and Mark Gallert, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7196. **Improvements in electromagnetic devices for controlling the rotation of shafts.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Paul Victor Avril and the Société Marinier Navoit et Jeanson, France.)

APRIL 6.

7224. **Improvements in apparatus employed for covering telegraph cables and wires with lead, or other metallic substance for electric purposes, or for manufacturing metallic pipes or tubes or like uses.** Ernest Alexander Claremont and John Stratton, 4, St. Ann's-square, Manchester. (Complete specification.)

7243. **Improvements in and in the method of and apparatus for the manufacture of air-damping appliances for electric measuring instruments and the like.** Alexander Melville Clark, 53, Chancery-lane, London. (The firm of Hartmann and Braun, Germany.)

APRIL 9.

7270. **The production of white lead by the electric arc.** Ernest Bailey, 13, Baile-hill-terrace, York.

7284. **Improvements in pulleys for trolley heads, applicable to electric traction.** John Aspinwall, 24, Oxton-street, Walton, Liverpool.

7285. **Improvements in electric meters.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles D. Fuller, United States.)

7288. **Improvements in and relating to electric furnaces.** Charles Prosper Eugène Schneider, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 10.

7306. **Improved means for connecting electric wires and cables.** Andrew Wilkes, 120, Hart's-hill, Brierley Hill, Staffs.

7371. **Improvements in terminals or bolts and nuts for use in electric batteries as connectors.** Herbert William Butler, 4, Great Winchester-street, London.

7374. **Improvements in electrically-illuminated letters.** Theodor Well, 72, Cannon-street, London. (Complete specification.)

7397. **A new or improved process for the electrolytic production of caustic alkalies.** André Brochet and Georges Ranson, 70, Chancery-lane, London.

APRIL 11.

7438. **Electrically-controlled targets for use with rifles or other firearms.** William Walter Gerald Webb, 9, Coppenhall-terrace, Crewe.

7459. **Improvements in or relating to electric tramways or railways on the overhead system.** Emanuel Cervenka, Joseph Bernt, and Gustaf Meyer, 111, Hatton-garden, London.

7462. **A new or improved apparatus for automatically charging accumulators.** Béla Klein, 13, King-square, Goswell-road, London.

7490. **Improved guard or structure for protecting overhead wires.** William Bracegirdle Whittaker, 6, Bank-street, Manchester.

7492 **Improvement in winding for electromagnetic inductive apparatus.** Henry Heileman Wait, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 12, 1901, being date of application in United States.) (Complete specification.)

7497. **Improvements in contact boxes for the distribution of electricity.** Baptistin Cruvellier, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act 1883, Sec. 103, Nov. 21, 1900, being date of application in France.) (Complete specification.)

APRIL 12.

7524. **Improvements in electric heating and in apparatus therefor.** John Robert Quain, Royal Colonial Institute, Northumberland-avenue, London.

7539. **Improvements in and connected with the electrical transmission of images and in the recording of images.** William Friese-Greene, 55, Chancery-lane, London.

7547. **Improvements relating to incandescence electric lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London (Christopher Dunkin Smithers, United States.) (Complete specification.)

7548. **Improvements relating to dynamo-electric machines.** Louis Maiche, 45, Southampton-buildings, Chancery-lane, London.

7553. **Improvements in electric alternate-current meters.** Silvanus Phillips Thompson, Moriand, Chiselett-road, West Hampstead, London.

7557. **Improvements in electric cables.** Willis Nelson Stewart, Clun House, Surrey street, Strand, London.

7558. **Improved means for insulating electric conductors.** Willis Nelson Stewart, Clun House, Surrey-street, Strand, London.

7565. **Improvements in and relating to systems of electric power transmission by overhead conductors.** Edward Rotter and Thomas Harison Jones, 18, Southampton-buildings, Chancery-lane, London.

7576. **Improvements in electric signalling.** Arthur Thomas Milnor Thomson and the Thomson-Davis Telephone System, Limited, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 13.

7584. **Improved method of obtaining electrical vibrations.** Frederick Thomas Trouton, "Caerleon," Killiney, co. Dublin.

7601. **Improvements in and relating to electric glow lamp holders.** Charles Edward Knowles, 70, Market-street, Manchester.

7617. **Improvements in electric meters.** Charles Orme Bastian and John Vaughan Sherrin, 77, Chancery-lane, London.

7619. **Improvements in signalling on electric traction systems.** Edward Rotter and Thomas Harison Jones, 18, Southampton-buildings, Chancery-lane, London.

7629. **Improvements in and relating to secondary batteries.** Ippolito Celestre and Francesco Gondrand, 322, High Holborn, London. (Complete specification.)

7641. **Improvements in and relating to telephone exchange systems.** William Frederick Smith, 45, Southampton-buildings, Chancery lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on May 4.

1900.

3481. **Resistances for electric circuits.** Newitt.

6871. **Machine for filling accumulator plates with active material.** Franke.

6761. **Process of electrolytically preparing metals or alloys for lithographic purposes.** Strecker.

7777. **Apparatus for wireless telegraphy.** Marconi and Marconi's Wireless Telegraph Company, Limited.

8241. **Electricity meters.** Kallmann.

8361. **Apparatus for switching electric currents on and off, especially suitable for lighting telephone switchboards.** Gill, Gilmour, and Claxton.

9058. **Electric brakes for electric railway vehicles.** Newell.

9760. **Electrical maximum demand indicators.** Hookham.

10662. **Caps for glow lamps.** Halford.

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16875. Construction of plates for accumulators or secondary batteries discharging heavy currents. Garassino.

19437. Electrodes for batteries. Mackenzie.

11571. Electric battery compounds. Blumenberg.

11588. Electric railways on the sectional conductor system. Kent.

19686. Accumulators. De Sales and Gruegnon.

20967. Incandescent electric lamps. Lake. (Pinckard.)

22273. Electrical plug resistance boxes and like apparatus and switches therefor. Gambrell and Gambrell.

1901.

3026. Closed-conduit electric railways. Dion.

5247. Switch for controlling electric motors. Bloxam. (Helios Electricitäts-Aktiengesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Apl. 13	633	621	+ 12	—	—
Birmingham Trams.	,, 13	4 845	4,251	+ 594	60,572	—
Blackburn Corp'rat'n	,, 12	688	496	+ 192	6,310	5,430
Blackpool Corporatn.	,, 11	1,091	231	+ 860	1.242	360
Blackpool-Fleetwood	,, 13	706	488	+ 218	2 973	2 767
Bolton Corporation..	,, 14	1,471	1 336	+ 135	19,916	12,509
Bradford City Trams	Mar. 24	800	350	+ 450	9,167	4,189
Bristol Tramways Co.	Apl. 12	5,050	3,033	+2,017	—	—
Carlisle Tr'mw'ys Co	,, 6	169	—	—	—	—
Central London Ry.	,, 6	5,654	—	—	84 889	—
City & South London	,, 14	1,946	1,159	+ 787	30,090	18,478
Cork E. T. and L. Co.	,, 11	438	349	+ 89	5,059	4 476
Dover Tramways ...	,, 13	262	210	+ 42	2 472	2,239
Dublin & Lucan E.R	Mar. 30	78	73	+ 5	923	763
Dublin U.T., elec. cars	Apl. 12	3 824	3,934	* - 110	—	—
Dublin S.D. Electric	,, 12	1,212	1,167	*+ 45	—	—
Dundee Tram Co. ...	,, 3	532	369	+ 163	21,608	17,164
Glasgow Corporation	,, 8	8,790	9,029	- 239	—	—
Halifax Corporation	Mar. 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	Apl. 13	1,003	672	+ 331	1 772	1,469
Hull Corporat'n E.S.	,, 13	1,739	—	—	3,801	—
Liverpool Corporat'n	,, 6	8,605	7,204	+1,401	110,338	94 487
Liverpool Overhead	,, 14	1,871	1,351	+ 520	22,684	20,305
Portsmouth Corpn...	,, 13	724	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 14	3,670	—	—	—	—
Southampton Trams	,, 11	807	373	+ 434	—	—
Southport Corporat'n	Mar. 30	a405	—	—	7,416d	—
Swansea Tramways.	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. b Since April 1, 1900. d From July 18, 1900.
* Easter week and Spring Show, 1901; Queen's Visit, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Barcelona, £170 increase.
Barcelona Ensanche y Gracia, £53 decrease.
Brisbane (Feb. 20), £107 increase.
Buenos Ayres and Belgrano Electric (week ending March 10), £795 increase; (week ending March 17), £423 increase.
Calcutta (April 13), £123 increase.
Cape Town (month of February), receipts, £13,594; expenditure, £5,712.
Mexico Electric (month of March), receipts, £17,150; expenditure, £9,900.
Perth Electric, £379 increase.
Port Elizabeth (month of February), receipts, £3,043; expenditure, £1,803.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Railways.—		
Central London, Ordinary	10 —	9-9½
—— Pref. Half-Shares	5 —	4½-5½
—— ,, deferred	5 —	4-4½
City and South London, Consolidated Ordinary	100 —	46-50
—— Ordinary	10 —	4-5
—— 4 per cent. Debenture Stock	100 —	113-118
—— 5 per cent. Pref. Stock '91	100 —	132-137
—— ,, ,, '96	100 —	122-127
—— ,, ,, per cent. Pref.	— —	13-13½
Liverpool Overhead, 5 per cent. Pref.	— ..	7½-8
—— Ordinary, 1-50,000	— ..	10½-104
—— 4 per cent. Mortgage Debentures, Red., 1-1,760 ..	100 —	94-97
Waterloo and City, Ordinary		
Telephones.—		
National Telephone, Ordinary	5 —	3½-3¾
—— 6 per cent. Cum. First Pref.	10 —	11-12
—— 6 per cent. Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non-Cum. Third Pref.	5 ..	4½-4¾
—— 4 per cent. Deb. Stock, Red.	100 —	96-98
—— 3½ per cent. Deb. Stock, Red.	100 —	89-92
Oriental Telephone and Electric Company	1 —	1-1½

Name.	Amount paid.	Last price.
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	⅞-1
British Electric Works, Ordinary, 50,001-95,000	1 —	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 —	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	100 —	85-90
British Insulated Wire, Ord., 1-70,000	5 —	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6½
—— 5 per cent. Mortgage Debentures	100 —	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 —	4½-5
Brush Electrical Engineering, Ordinary	2 —	1½-1⅞ xd
—— Non. Cum., 6 per cent. Pref.	2 —	2-2½ xd
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 —	101-103
Callender's Cable, Debentures.	100 —	109-113
—— Ordinary	5 —	15-16
—— 5 per cent. Pref.	5 —	5½-6
Crompton and Co.	2 —	2½-4
—— 5 per cent. Debentures	— —	100-106
Edison and Swan United, Ordinary	2 —	1½-2
—— 5 per cent. Debentures	5 —	3-4
—— 4 per cent. Deb. Stock, Red.	100 —	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	— —	94-96
Electric Construction, Limited, Nos. 1 to 112,100	2 —	1½-2½
—— 7 per cent. Cumulative Pref.	2 —	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-130,000	1 —	0-¼
W. T. Henley's Telegraph Works, Ordinary	5 —	15-16
—— 4½ per cent. Preference	5 —	5½-6
—— 4½ per cent. Debentures	100 —	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 —	21-22
—— 4 per cent. Debentures	100 —	101-104
Telegraph Construction and Maintenance	12 —	36-40
—— 5 per cent. Bonds	100 —	101-104
Telegraph Manufacturing, Ordinary	5 —	10½-11½
—— 5 per cent. Cum. Pref.	5 —	5½-6
Willans and Robinson, Ordinary, 1-80,000	5 —	11-12
—— 6 per cent. Cum. Pref., 80,001-90,000	5 —	6½-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅞-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75 ..	70-75
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 —	10-11
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 —	7¾-8¼
—— 7 per cent. Preference	5 —	8¼-8¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	6¾-7¼
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 —	5-5½
Chelsea Electricity Supply	5 —	5½-6¼
—— 4½ per cent. Debentures	100 —	109-112
City of London, Ordinary	10 ..	8½-9½
—— 6 per cent. Cumulative Pref.	10 —	12-13
—— 5 per cent. Debenture Stock	100 —	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	— ..	101-103
County of London and Brush Provincial, Ordinary	10 —	8-9 xd
—— 6 per cent. Cum. Pref.	10 —	11-13 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 —	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 —	5-5½
—— 6 per cent. Cum. Pref.	5 —	5½-6
—— 4½ per cent. First Mort. Deb.	100 —	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p c. Cm. Pf., 1-20,000	5 ..	4¾-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5 —	5½-6¾ xd
Hove Electric Lighting, Limited, Ord., 1-11,000	5 —	7-8 xd
Kensington and Knightsbridge and Notting Hill	100 —	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9½-10½
London Electric, Ordinary	2 —	1½-1⅝
—— 6 per cent. Pref.	5 —	3½-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	98-101
Metropolitan, Ordinary	10 —	11½-12½
—— ,, 85,001-98,769	5 —	9-10
—— 4½ per cent. First Mortgage Debenture Stock	100 —	110-113
—— 5 per cent. Mortgage Debenture, Red	100 —	97-100
Notting Hill Electric Lighting	10 —	15½-16½
Oriental, 1879.	1 —	1-1⅛
—— £5 Shares	5 —	7-7¼
—— £4½ Shares, New	4½ —	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 —	5½-6¼
River Plate Electric Light and Traction, Deb.	100 —	65-75
Royal Electrical Company of Montreal	$100 —	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100 —	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 —	2-2½
—— 4 per cent. Debenture Stock	100 —	80-90
South London, Ordinary	5 —	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5 —	13½-14½
—— 7 per cent. Pref.	5 —	3½-4½
—— 3½ per cent. Deb.	100 —	98-101
Westminster, Ordinary	5 —	11½-12½
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 —	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-3½
—— 5 per cent. Cum Pref., Nos. 1-75,000	5 ..	4½-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 —	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 ..	10 ..	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40 ..	98-100 xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 —	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 —	119-122
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5½-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 —	104-107
—— Prov. Cert., all paid	100 —	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1 —	1½-1⅝
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	98-102
Kidderminster and District Lighting and Traction, Pref.	5 —	3½-4
London Street Tramways, Nos. 1-31,000	4 —	1-1½
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	103-104
New General Traction, Ordinary	5 —	2¾-3½
—— 6 per cent. Cum. Pref.	10 —	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 —	11½-12¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	11-12 xd
—— 5 per cent. Cum. Pref., 1-20,000	16 —	10-11
—— 4½ per cent. Debenture Stock	100 —	107-109

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NOTES.

Tramways and Light Railways Association.—We have received the official circular for April of the Tramways and Light Railways Association, in which mention is made of the proposed change in Standing Order No. 22, to which we refer elsewhere in these columns. A reprint of Mr. A. N. Connett's paper on "Combined Trolley and Conduit Tramway Systems" will also be found in this issue.

Visit from Glasgow.—A number of students from the Glasgow University Engineering Society visited London last week in order to inspect the principal factories and electrical works in the Metropolis. During the visit a party of about 50, including professors and students, visited, among others, the works of the Robertson Lamp Company at Hammersmith, and viewed the various operations with great interest.

Personal.—Once lecturer on electro-technology at Liverpool University College, Mr. Alfred Hay has just been appointed professor of the same subject at the Royal Indian Engineering College, Cooper's Hill. Dr. Hay (for he has recently received the D.Sc. degree in engineering science from Edinburgh University) was one of Prof. Andrew Jamieson's old students and assistants at the College of Science and Arts, Glasgow. He was also at one time closely in touch with Mr. M'Whirter, having served his apprenticeship at the Faraday Works, Govan. We wish Dr. Hay every success in organising the electrical engineering department at Cooper's Hill.

Municipal Electrical Association.—We are pleased to see that the Municipal Electrical Association is now incorporated. The object of the society is to promote the interests of municipal electrical engineers, to bring municipal electrical engineers and chairmen and members of municipal electrical committees together, to hold meetings for the discussion of subjects germane to municipal electrical undertakings, to establish a reading-room, library, collection, etc. The word "limited" is omitted from the title by license of the Board of Trade, the intention being not to confine the membership roll to any specified length. The registered office of the association is at St. James's Hall, Piccadilly, W.

Wireless Telegraphy for Lightships.—There can be no doubt that the system of electrical communication round our coasts for live-saving purposes has been vastly improved during the last year or two, and this was fully acknowledged by the meeting of the governors and friends of the Royal National Lifeboat Institution last Saturday. Regret, however, was expressed that the Government had not yet seen their way to utilising wireless telegraphy for lightships. It was pointed out in the annual report that the Borkum light-vessel, some 20 miles off the German coast, had been in successful wireless telegraphic communication with the shore for nearly a year, and the committee trusted that the full advantages of the discovery would ere long be secured for this country also.

Tunnelling Construction.—Following on the reading of a paper on "Iron-Lined Tunnelling Construction" by Mr. P. Marshall, a number of members of the Institution of Junior Engineers recently paid a visit to the Great Northern and City Railway works. The line now runs from Moorgate-street to Finsbury Park, and consists of 5½ miles of double tunnelling. The party, having first inspected the surface machinery, proceeded to the working face, where they were shown the shield under actual driving conditions. The outside diameter of this shield is 17ft. 4½in., and it is driven forward by 16 hydraulic rams, each 7in. in diameter, the working pressure being two tons per square inch. The various operations of tunnelling with this machine was the feature of the afternoon. We understand that the work will be completed by September next.

A New Magnetic Observatory.—In a new observatory which has recently been built at Cheltenham, in the United States, special precautions have been taken to avoid any disturbing influences on the magnetic instruments. Of course, no ironwork is used in the buildings, being entirely replaced by copper and brass. The stoves, which are designed to burn only wood, in case there should bo any iron in the coal, are built of soapstone. Precautions are also made to keep the magnetic standard instruments always at constant temperature, which will be about 65deg. F. This is done by means of a series of thicknesses of paper round the walls with air-spaces in between. When going into the room containing the instruments no less than four doors have to be opened and closed one by one in order to prevent an inrush of air, which would be hotter in summer and colder in winter than that inside the standard laboratory.

National Electric Contractors' Association.—Some few weeks ago we referred to the movement which has been inaugurated with a view to forming a National Electrical Contractors' Association. Of necessity the progress of the provisional committee is slow, as one of the duties laid upon it was to foster the formation of local associations in London and the provinces, with a view to their future affiliation with the proposed National Association. With regard to London, however, steps are now being taken to form four local associations—one each for the eastern, western, northern, and southern districts; and we are asked to suggest to London electrical contractors who are in sympathy with the movement the desirability of at once communicating with Mr. Thomas Guthrie, the convener of the provisional committee, 46, Queen Victoria-street, E.C., for the purpose of arranging for meetings in the several districts as early as possible.

Pole-Setting.—The use of the water-jet as an aid in sinking piles for such structures as piers, jetties, and wharves is now generally recognised, the earliest records of its use dating back so far as 1852. Writing in the *Electrical World* on the subject, Mr. Walter O. Pennell calls special attention to the usefulness of the water-jet in setting poles for ærial lines, especially if the soil is soft or sandy. In a hard soil very good results are obtained by first excavating the hole to the proper depth by means of the water stream, and then placing the pole in it. As a rule, however, especially in softer soils and with large spars, it is easier to use the method of applying the jet to the base of the pole and letting both nozzle and pole sink together. The water-jet particularly adapts itself to the seting of poles in marshes and inlets which are submerged, by which means a pole may be placed within a very short space of time. The greatest saving, however, is effected in towns where the hydrant water can be used.

British Exhibition in St. Petersburg.—An exhibition confined solely to the manufacturers and producers of the British Empire is to be held in St. Petersburg this year, under the patronage of her Imperial Highness the Princess Eugenie of Oldenburg and administered by a distinguished committee of the Russian nobility. Her Imperial Majesty the Empress Alexandra Feodorovna has lent for the purpose the beautiful Touride Palace and grounds, where preparations for the event are vigorously going on. This exhibition of the arts, manufactures, products, and inventions of the British

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Empire will be opened on Nov. 14 next, and will remain open till Feb. 14, 1902, and it is hoped that the effect of it will be to do much to put an end to the condition of things which at present exists in our commercial intercourse with Russia. All particulars in regard to the arrangements for intending exhibitors may be obtained from Messrs. S. Corer and Son, of 170, New Bond-street, W., who have been appointed official agents for the exhibition.

British Industrial Supremacy.—The May number of *Cassier's Magazine* contains a letter from Mr. T. Westgarth, of Middlesbrough, in which he complains that the British workman does not fully appreciate the seriousness of the coming struggle for industrial supremacy, particularly in the engineering industry, between England, America, and the Continental countries. He, therefore, suggests that masters and workmen should combine and send a strong committee of *bonâ fide* working-men, selected from all trades, to America, to Germany, Belgium, and perhaps France, to see for themselves and report to their fellows. This, Mr. Westgarth points out, would give them the same insight into what is being done abroad that the majority of their masters have obtained. The scheme appears to have met with the approval of the majority of engineering firms in London, Manchester, Leeds, and other places, many of whom have undertaken to contribute to the fund which will be collected for the purpose. A meeting of manufacturers will shortly be held, at which the various details of the scheme will be gone into.

Gas versus Electricity.—Competition between gas and electricity has up to the present proved exceedingly good for both undertakings when carried out in the same town, and it is only recently that the Board of Trade have granted any provisional orders to gas companies. The reason for this has been the fear that gas companies would take electric lighting orders, not to work them on commercial lines, but as means of preventing competition with gas lighting. Even now when a provisional order is granted to a gas company, care is taken to ensure that the gas company really does mean to supply electrical energy at reasonable rates throughout the area over which such powers are granted. We note that recently in the Massachusetts Legislature a Bill was introduced to prevent combinations between gas and electric lighting companies, on the ground that any such combination was against public policy. The idea is right, but there are towns in which the combination, if properly controlled, is an advantage. We particularly refer in this to small towns, where the saving in establishment charges by having only one company for the supply of both gas and electricity is often commendable.

Consumption of Coal Dust.—A German Imperial Commission has of late been carrying out some experiments on the question of the consumption of coal dust in fire furnaces, and in the report which has recently been issued special mention is made of the Schwarzkopff apparatus. Some of the conditions peculiar to this arrangement are given in the *Journal* of the Society of Arts. In the first place, it is stated that a highly heated fire chamber is necessary for the ignition of the coal dust, for the higher the temperature, the quicker and more perfect will be the combustion. Contact with the boiler walls must be guarded against, as it interferes with ignition, and a fire chamber lined with fireproof material has also to be provided, because only such a chamber can be kept constantly at the required high temperature. It is pointed out that a fire chamber is not an inconvenience, but rather a special advantage in coal-dust firing, because it ensures a perfect combustion, a high temperature of the gases at the start, and protection against the formation of needle flames. Further, such a chamber offers for boiler firings, in case of stoppage, the advantage that by the heat stored in the fireproof walls the steam pressure is longer maintained. The apparatus seems also to ensure a smokeless combustion.

Compulsory Purchase.—A curious dispute is taking place between the Bombay Corporation and the Bombay Tramway Company over the compulsory purchase clause in the tramway company's agreement. The Corporation has issued notices to the company that it proposes to buy up the undertaking under this clause, and the company is objecting on the ground that the Corporation is not intending to work the lines, and hence has no right to purchase. The idea, we presume, is that they are only purchasing as agents for a third party, to whom they would resell the undertaking. We are afraid that if the agreement is drawn up in the usual way, the right to purchase is quite independent of what the Corporation intends to do with the system after the purchase has been effected. The dispute, however, raises the question as to how far the electric light companies in England will stand at the expiration of their provisional orders. It would almost seem as though the corporations would have the right to buy up the undertakings at the then value of the plant, and to immediately resell them to the companies again at their then value as going concerns. When looked at in this light, it is clear that the action of the Bombay Corporation, if it be as represented, is not morally right, and, in any case, is not in the interests of the inhabitants.

Submarine Cables.—One of the first matters which occupied the attention of the House of Commons on the resumption of business after the Easter recess last week was the question of the safety of submarine cables in war time. Sir J. Colomb asked the Under-Secretary of State for Foreign Affairs whether he was yet in a position to give any information to the House respecting the code of law issued by the Navy Department and signed by the President of the United States concerning matters relating to the cutting of submarine cables in war. Viscount Cranborne's reply was confined to a reference to Article V. of the Naval War Code for the use of the United States Navy, which reads thus: "The following rules are to be followed with regard to submarine telegraphic cables in time of war irrespective of their ownership: (*a*) submarine telegraphic cables between points in the territory of an enemy, or between the territory of the United States and that of an enemy, are subject to such treatment as the necessities of war may require; (*b*) submarine telegraphic cables between the territory of an enemy and neutral territory may be interrupted within the territorial jurisdiction of the enemy; (*c*) submarine telegraphic cables between two neutral territories shall be held inviolable and free from interruption."

Electric Tramways in New Zealand.—Heretofore all the tramways in New Zealand have been worked by either cable or horse traction, but the popularity of electric traction has become so general that the Dunedin City Council have decided to make an initial outlay of some £250,000 in buying up and electrically equipping the undertakings of the local tramway companies. This resolve has not been come to without a fairly sure sign that the scheme is likely to bear good fruit, in view of the great success which has attended the conversion of the Roslyn Tramway Company's system to electric traction. It is interesting to note that just 20 years ago this enterprising company were the first to introduce cable tramways into the Australasian Colonies, and now they have the addi-

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tional satisfaction of being the pioneers in electric traction in New Zealand. The new line, the conversion of which, as well as the construction of the overhead system and the power-station equipment, was carried out by the British Westinghouse Company, commenced running for public service last October. During the first five weeks of electric operation an increase of 96 per cent. over the previous five weeks' traffic on the old system was shown, which appears to afford ample justification for the resolve of the local authority to introduce and maintain a complete system of electric traction in the city.

Torpedo Control. — Since the perfection of the Marconi telegraph a good deal has been written in the untechnical Press as to inventions which have been made by numbers of experts for the steering of torpedoes, without providing any connecting wire between the torpedo and the ship which has dispatched it. We do not suggest that the inventors have not given thought to the question, but we do not think the public properly understand the real difficulties in the way. The difficulty is not so much in the steering of the torpedo—which has already been done through a wire trailed behind the same, or paid out from the torpedo as it moves—as in knowing exactly where the torpedo is at any instant in order that the control may be varied to bring the same up to the desired target. When the distance between the torpedo boat and the torpedo exceeds a mile, a large marker on the torpedo projecting above the water-line is required to enable its whereabouts to be determined. Unfortunately, as the torpedo approaches the target, which in war time would be a ship, this marker would be more easily seen from this vessel than it would be from the torpedo boat which is steering the torpedo. The difficulties in the way of a successful solution of the problem are, therefore, exceedingly great, especially when one takes into consideration the action of currents, which varies with the tides. The sending of a signal to alter the position of the helm of a torpedo is an easy matter, but it does not follow that the difficulties in steering a torpedo on a desired course have been overcome in consequence.

"The Scottish Electrician."—The third number of this paper has just reached us, and we notice in it some good information as to the exhibits which are to be seen at the Glasgow Exhibition, now shortly to be opened. The leading article of our contemporary on the vagaries of consulting engineers is somewhat amusing. It suggests that every contracting firm has on its staff an engineer who is quite as capable of doing consulting engineer's work as the consulting engineers whom the contracting firm has to please. The editor also adds that the experience of these contracting engineers is often far greater than that of the experts whose directions they must follow, and whose word is law. The way suggested out of this difficulty by our contemporary, is that five or six of the leading members of the Institution of Electrical Engineers should meet together and draw up model specifications which would please both clients and contractors. From what we know of this class of work, the six members of the Institution could meet every day of their lives without giving satisfaction to either party concerned. It is utterly impossible to draw up standard specifications which would in any way suit the varying conditions which have to be complied with when new plant has to be laid down in different towns. As an example of how disagreements would arise, we might mention that the expert editors of our contemporary have this month reduced the charges to be made by the Glasgow Corporation for electrical energy, but their efforts in this direction have not been ratified by the electrical department of the Corporation.

Shipowners and the Fastnet.—The *Times* publishes a letter, signed by nine of the leading shipowning firms of Liverpool, confirming the statement that was recently made as to the pressing need for the opening of a reporting station on the Fastnet. In fact, they are of opinion that such a station is an absolute necessity for the protection of the great trade route upon which the Fastnet stands; but they have been reluctantly forced to the opinion (the letter runs) that until the public is made alive to the importance of the question nothing will be done. It is to be hoped, however, that the authorities will now give the subject their serious attention in the interest both of the shipowning community and the traders of England. In reference to the above communication, the Marconi Company have written to the *Times* stating that they are now engaged in putting up a station on the mainland of the Irish coast, not far from the Fastnet, for the purpose of reporting ships that are fitted with the Marconi apparatus. It is further stated that the Postmaster-General has arranged to receive a deputation of the directors of the company to-day (Friday), after which the company hope to be in a position to inform the shipping companies the terms on which they, when fitted with the Marconi apparatus, will be able to communicate with the shore. The wide range, it is pointed out, which this station would have, far beyond the Fastnet itself, would render a station on the Fastnet unnecessary. Nevertheless, should it ultimately be considered advisable that a station should be erected on the Fastnet, the company entertain no doubt that it could be carried out in a satisfactory manner.

Protection from Lightning.—A committee, to be known as the Lightning Research Committee, has been organised by the Royal Institute of British Architects and the Surveyors' Institution, with the object of collecting and tabulating information from all parts of the country as to damage resulting to buildings from lightning-stroke. The committee owes its inception to Mr. Killingworth Hedges, who in his paper on "The Protection of Public Buildings from Lightning," read before the Royal Institute in April last year, referred to the difficulty experienced by experts in getting accurate information as to injuries sustained by lightning-struck buildings, and urged the desirability of an enquiry by a recognised authoritative body as to how far buildings are rendered lightning-proof by modern systems of protection. The present enquiry, by the collection of precise data, may serve to test in some measure the results accruing from the rules laid down by the Lightning-Rod Conference nearly 20 years ago. In pursuance of their enquiry the committee seek the co-operation of competent observers in all parts of the country, with a view to obtaining accurate details, noted on the spot, of the effect of lightning-strokes on buildings, whether fitted with conductors or not. Persons willing to assist by their observations are requested to communicate with the secretary to the committee at the offices of the Royal Institute of British Architects, 9, Conduit-street, London, W. The committee includes Mr. John Slater (chairman), Major-General E. R. Festing, C.B., F.R.S., Dr. Oliver Lodge, F.R.S., Messrs. J. Gavey, W. P. Goulding, W. N. Shaw, F.R.S., H. H. Statham, A. R Stenning, Arthur Vernon, and Killingworth Hedges, C.E. (hon. secretary).

Hydraulic Brake.—In a recent issue of the *Scientific American* will be found a well-illustrated description of the Neal-Duplex brake, which is worked by means of hydraulic gear. The characteristics of the brake are not in some respects unlike those of an electric brake, in that there is no possibility of the brakes causing the wheels to skid, because the brake loses its power when the car is at rest. The apparatus required seems to us to involve a considerable number of working parts, but the system is said to be

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the outcome of experience on the Boston Elevated Railway, where the brake has been used in actual service. On one of the axles of the car is mounted a small force pump, which delivers oil to the brake's cylinder. In the normal condition, the oil has a clear way through from the discharge back to the suction, so that there is no work being done by the force pump. A quarter-turn of the brake handle closes the outlet valve of the brake's cylinder, in consequence of which the pressure on the oil rapidly increases, and puts the ordinary slipper brakes on the periphery of the car wheels. The brake's cylinder has two pistons in it, one at either end. The first of these operates the breakes on one axle, while the other piston rod is connected with the brake gear on the wheels on the second axle of the car. The whole of the brake gear is carried in an oil-tight casing, and is, of course, in consequence of the liquid used, quite self-lubricating. The weight is said to be rather less than 500lb., which is a not inconsiderable item in the total weight of the car. While the brake has several advantages over the hand power brake—amongst which is the quickness of action and great power—we do not think that it compares favourably with the latest types of electric brakes.

Conductivity of the Rare Earths.—Prof. Nernst has recently published the results of a long series of experiments which he has made, with the aid of Mr. Reynolds, on the conductivity of mixtures of various oxides at high temperatures. In each case the mixture under examination was a small cube of about 1cm placed in a tube of magnesia heated by means of a platinum wire through which the current of electricity was passed. By altering this current the experimenters were able to vary the temperature up to about 1,400deg. C. The temperatures were measured by means of a thermo-electric couple. The most salient results from the experiments made showed that all the pure substances had a very high resistance. For instance, magnesia, zirconia, and the oxide of yttrium were practically insulators even at 1,000deg. C. All mixtures, however, were found to conduct considerably better than the pure substances from which they were made. But there were one or two exceptions even to this general conclusion. It was also found that the oxides of somewhat similar elements mixed together did not conduct so well as those that were made by mixing oxides and elements farther apart in the scale. Those mixtures of the oxide of thorium, of zirconium, and of cerium are poor conductors, and it is the same with yttrium and erbium. The authors have prepared some interesting diagrams giving the results of their experiments, which we hope to print more fully at a later date. These diagrams show that if one mixes one of the bodies mentioned in the first group above with another of the second group, one gets at high temperature a fairly good conducting substance.

A North of England Tramway Association.—The newly-formed Northern and Midland Counties' Association of Tramway and Light Railway Officials is certainly worthy of every encouragement, as affording an opportunity of inter-communication between officials engaged in similar work in towns in the North of England, which is an all-important factor in the development of the tramway industry. A most successful inaugural meeting of the members of the association was held last week at Sheffield, the gathering numbering some 130 influential tramway people. After the business matters of the meeting had been disposed of, Mr. Fell, appropriately enough, read a paper dealing with the leading points of the Sheffield tramway system. The feature of the day, however, was a visit to the Hecla Works of Hadfield's Steel Foundry Company, the specific purpose of which was to inspect those parts of the works that are devoted to the manufacture of tramway materials and specialities. Many of the visitors were largely interested in the manufacture of points and crossings, and the moulding of these castings attracted special attention. The subsequent processes of annealing, fettling, and straightening were fully explained and practically demonstrated right up to the finishing touches, when a large number of points and crossings intended for various corporations in England were subjected to inspection. A visit was also made to the Globe Steelworks of Messrs. Ibbotson Bros. and Co. in the course of the day. The favourable nature of this, the inaugural meeting of the society, is a good omen of future prosperity, and, in the words of the Lord Mayor, who welcomed the members to Sheffield, we wish the association a successful career.

The Conduit System for Massachusetts.—We gather from a note in the *Western Electrician* that the Massachusetts Legislative Committee on Mercantile Affairs are considering a Bill by which the towns and cities of that State, with the exception of Boston, will be authorised to construct and maintain conduits for electric wires, cables, and conductors. The Bill, which closely resembles one passed by the House of Representatives, but thrown out by the Senate last year, purposes to enable towns and cities to get rid of overhead wires, trolley and long-distance telephone wires excepted. The cost of construction is proposed to be met by the proceeds of conduit loans outside the debt limit, and the rentals received will be devoted to the cancellation of the bonds. Thus, it is believed by the promoters that the building and maintenance of the conduit will entail no financial burden upon the authorities which build them. Each corporation is not to be compelled to remove more than one mile of overhead wire during the first year after the completion of a conduit, nor more than two miles during any one succeeding year. The amount to be charged corporations is not to exceed 12 per cent. per annum of the cost of constructing the conduits, the amount to be apportioned among the affected companies, and the charge not to exceed £70 per mile annually for each duct 2½in. or 3in. in diameter. It is also proposed that the city or town shall pay rental for its own wires. In cases of dissatisfaction in regard to the rental charges, corporations may appeal to the Board of Electric Light and Gas Commissioners. One important provision is that conduits already laid by corporations may be purchased by cities or towns.

Electrical Locking Device for Mail Boxes.—As a means of safeguarding the mails which are placed in the various pillar post boxes in Washington, U.S.A., the Post Office Department have recently installed on one of the busiest routes of the city a number of boxes having their locks electrically controlled. This ingenious arrangement is the invention of Mr. F. Williams, and is just now being subjected to exhaustive tests by the authorities at Washington. The electric cables between the mail boxes and the central station in the post office, from which place the locking device is controlled, are carried in the ducts owned by the United States Electric Lighting Company. At the central station is a clock provided with a mechanism which prints the numbers of the mail boxes when the boxes are opened, and again when they are closed. The postman collecting the mails must invariably visit No. 1 box first, as this controls the operation of the lock of No. 2 box, and so on throughout the route. Having allowed the collector time to reach the first box, the operator at the station presses an electric button, which electrically releases a secondary locking device and permits

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the postman's key to throw back the lock bolt. Another advantage of this system, besides that of ensuring the security of the mails, is that it necessitates the collector keeping strict time. In the event of unlawful attempts to open the boxes, the *Western Electrician* explains, the central station is instantly notified by the ringing of an electric bell, and, again, should the mail collector wish to communicate with the operator, he can do so by pressing a button at any mail box, causing an electric bell to strike at the central, and then by a prearranged code of signals he can send a few important messages. The experiments at Washington have so far proved satisfactory, and the permanent introduction of the device would by no means come as a surprise. It is asserted that the system has been introduced in Boston, New York, and Philadelphia with every success.

Electric Lighting in St. Marylebone.—The correspondence columns of the *Times* are still being used largely in the discussion of the electric lighting in St. Marylebone. Up to the present, however, the letters have been chiefly concerned with the dispute between the Metropolitan Electric Lighting Company and its consumers as to whether this company has fulfilled in the right way its obligations to those consumers, as well as to its shareholders. We should like to see more space devoted to the question as to which of the two applicants for a provisional order has really the most right to receive one. The great supporter of the application from the St. Marylebone Borough Council is Dr. J. Fletcher Little, but even he has not, so far as we have seen, put forward any conclusive reasons why Parliament should allow his Council to compete with the Metropolitan Company. It must be remembered that this company commenced working in the very early days of electric lighting, and that practically all of the plant which they started with has now become obsolete, and in many cases has to be replaced by new. The company has also been exceptionally unfortunate in the fires which have occurred in its central stations, which have hampered it in giving an efficient and continuous supply. It would, therefore, be exceedingly hard if this pioneer company should now have as a competitor a council which is able to borrow all the money it requires at somewhere about 3 per cent., and while allowing itself a free hand in the laying of mains, can harass, and has harassed, the company in small details connected with extension of their mains. The policy of Parliament in granting a competing order in the city of London has been quoted as a reason why the order of the Borough Council of St. Marylebone should be confirmed; but the cases are not alike, as the competition between two companies is much more equal than between a company and the local authority.

Reconstructed Granite.—We have just received a new issue of the *Journal* of the Franklin Institute, in which is a report by the committee appointed to consider the advantages of reconstructed granite as an insulating material. An outcome of this report was that the John Scott legacy premium and medal was awarded to Messrs. T. W. Blakey and W. Courtenay for their invention in connection with this insulating material. The committee describe reconstructed granite as a manufactured product, in which natural granite chips are calcined by being brought to a high temperature and afterwards pulverised. It is then thoroughly mixed with pulverised felspar and kaolin in definite proportions; enough water is added to make the mixture plastic, and it is then moulded into the desired forms under heavy pressure. After being dried it is subjected to a temperature of about 3,000deg. F., at which temperature it is fused into a homogeneous mass. When used for electrical purposes, the surface is given a vitrified glazing, which aids in increasing its insulating properties, by rendering it less porous. The committee found after experimenting that the material was practically fireproof, and that it resisted the action of all solvents and acids except hydrofluoric. They also found that it was practically non-porous. The increase in weight of a sample after being immersed in water for almost a year was only ·2 of a grain on 1,706·4 grains. As regards the mechanical strength, three samples were tried, the crushing force required varying from 5,300lb. up to 12,000lb. per square inch. The tensile strength of the material was found to vary from 667lb. to 1,005lb. per square inch. The insulating properties, also, were found to be exceedingly high, even when the glazed surface of the material had been removed. With this glazed surface on, the insulation resistance of the samples tested could not be measured on the megohm-voltmeter employed, but without more details one cannot tell the sensibility of the instrument in question. The report is of special interest in view of the use of this reconstructed granite for insulating third rails of heavy electric railways, where great mechanical strength has to be combined with high insulation resistance.

Standing Order No. 22.—Referring to the proposal to so amend Standing Order No. 22 as to deprive local authorities of the absolute power of veto at present vested in them to quash any tramway scheme in their particular district to which they do not choose to give their consent, the following is the wording of the existing Standing Order, with the proposed alterations in brackets: "In cases of Bills to authorise the laying down of a tramway [proof shall be given before the committee on the Bill that the promoters have either obtained] the consent of the local authority of the district or districts through which it is proposed to construct such tramway, and where in any district there is a road authority distinct from the local authority, the consent [also] of such road authority in any case where power is sought to break up any road subject to the jurisdiction of such road authority [or that the consent of such local or road authority has been withheld, and if in the opinion of the committee such consent has been unreasonably withheld and ought to be dispensed with, the committee shall report accordingly with the reasons and facts upon which their opinion is founded. Any such local or road authority shall be entitled to petition and be heard against the Bill]." It is, however, sought in consideration of this amendment to insert a clause in the order giving to county councils the right to be heard against any Tramway Bill, the provisions of which may be alleged to injuriously affect them. It was at first intended to bring forward the above amendments some five weeks ago, but owing to pressure of business the consideration of the matter by a House of Lords Committee is at present postponed. We believe that the London County Council were responsible to a certain extent for the introduction of these proposals, and that the reason for it was because of the trouble which this Council had had in getting the consent of local authorities to their own tramway undertaking. It is, however, a change which is undoubtedly to the interest of all, as it will prevent local authorities acting in the arbitrary way which they have done in the past in these matters. It is only too often that they refuse consent to a company, and have no idea of undertaking a tramway scheme themselves. The power of veto which they at present hold in regard to the introduction of tramways is in our opinion altogether excessive, and we therefore think that the proposed alterations to the Standing Order in question will be most beneficial to the country at large.

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GLASGOW ELECTRIC TRAMWAYS.

Formal Opening of the Pinkston Power Station.

The formal opening of the electric tramway system took place on Wednesday, the 24th inst., and the Glasgow Corporation maintained their reputation for hospitality by inviting a large number of guests to be present on that occasion. A small fleet of open carriages and char-a-bancs conveyed the party—which numbered nearly 400—from the City Chambers to the main power station. The station lies on the small estate of Pinkston, an estate from which one of our most distinguished generals—General French—takes one of his family names. After a pleasant drive of about half-an-hour the guests reached their destination, and proceeded to have a general look round the premises. The station is as yet in less than a half-finished state, and it was rather incongruous to see a crowd of frock-coated and silk-hatted citizens worming their way between a bare brick wall and a rough wooden balustrade. Arriving at the engine-room floor, however, it was found that the work here is in a rather

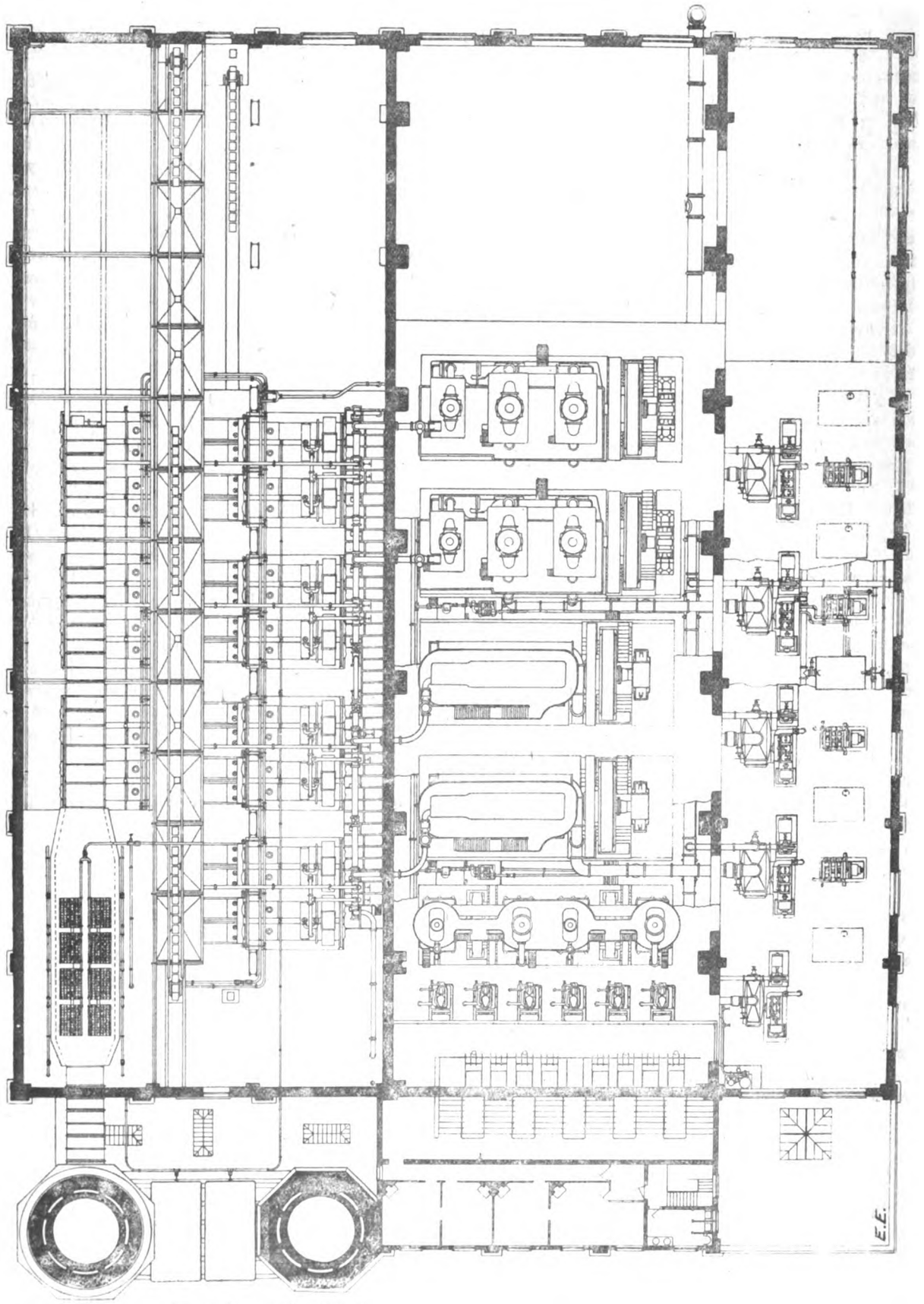

Fig. 1.—General Plan of the Generating Station for the Glasgow Corporation Tramways.

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more forward state than it is down below. The auxiliary switchboard is practically complete, and is now available for controlling the exciters and the motors driving the auxiliary pumping machinery, stokers, economisers, and coal conveyers, as well as for the night and emergency loads. The two 800-i.h.p. Stewart engines and British Thomson-Houston direct-current generators were running at very little below their normal speed, but the large 4,000-i.h.p. Allis engines were standing when the guests reached the engine-room, and a short interval was allowed for inspection of the station and plant. Most of the guests expressed astonishment at the size of the engines and alternators, and at the massiveness of the machinery in general. We do not propose to say much at this point about the plant itself, as this will be dealt with in detail later on, but we could not help being struck with the peculiarly massive appearance of the two Allis engines, which look more like units of 10,000 h.p. than of 5,000 h.p., which is their maximum rated output.

However, to return to the formal proceedings, a halt was called to the inspection process, and on the party gathering round the leaders of the expedition, the convener of the Tramways Committee, Bailie Walter Paton, a veteran in the service of the community, referred to the object for which they were gathered together, and asked the Lord Provost to perform the service of turning steam on to the first Allis engine. In doing so, Bailie Paton said that the request was made partly as an appreciation of the great services which Lord Provost Chisolm had rendered to the city of Glasgow, and partly as showing the great esteem in which he was personally held by all who came into contact with him. The Lord Provost was moving to do as requested, when someone called a halt, and informed him that an interpolation was about to be introduced into the day's arrangements. Mr. Rosenthal, of the Babcock and Wilcox Company, here stepped forward and mounted the engine steps, which made a very appropriate platform.

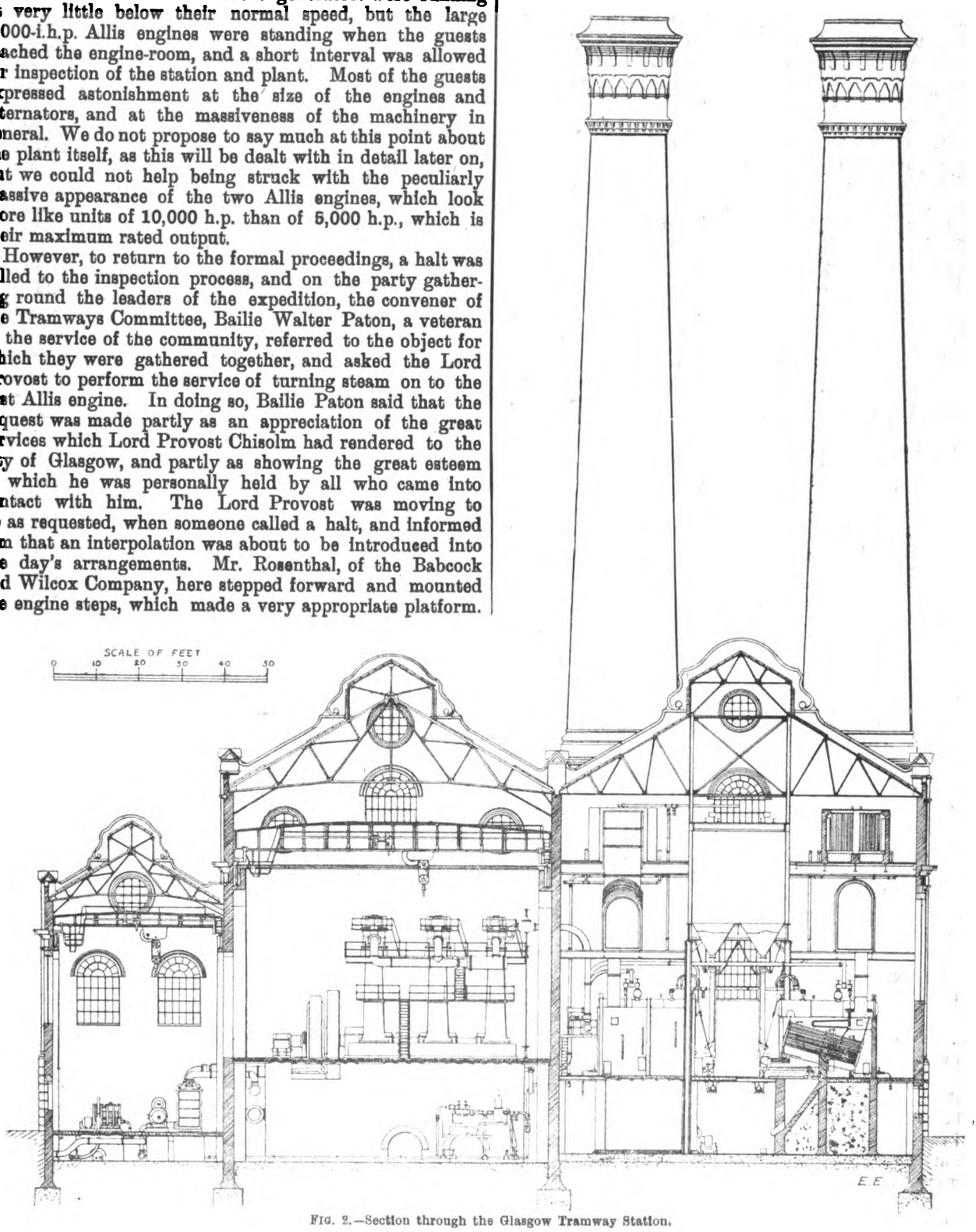

FIG. 2.—Section through the Glasgow Tramway Station.

He referred to the magnitude of the scheme and the admirable planning of the whole undertaking, and then asked leave, on behalf of the contractors, to present to the Lord Provost a "loving cup." The said cup took the form of a bowl of chased silver, gilt inside, about 18in. high and 2ft. in diameter, bearing a suitable inscription. The Lord Provost, who seemed quite taken by surprise, said that he had first of all to thank the Town Council for doing him the high honour of asking him to turn on steam to the first engine, but as a recognition of the great services which had been ungrudgingly performed by the convener of the Tramways Committee in pushing on the work, he would ask as a personal favour that Bailie Paton should turn on steam to the second engine (a request which was greeted with cheers). Referring to the handsome presentation which had been made by the contractors, his Lordship expressed himself as being quite taken aback, alike by its unexpectedness and by its munificence, and humorously observed that the proportions of a bowl were generally considered to be in proportion to the "drouth" of the recipient. He was quite unable to state the exact proportion, but he would leave each member of the company to work it out for himself. He then proceeded to the starting wheel, and turned on steam to the first engine. The turning of the huge flywheel, 24ft. in diameter, was greeted with loud applause. Bailie Paton then turned on steam to one of the Stewart engines amid cheers.

Mr. Duncan Stewart, of Messrs. D. Stewart and Co., Limited, expressed the satisfaction which his firm had in

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placing two Glasgow-built engines in the station. Bailie Paton complimented Mr. Stewart's firm on the excellent and expeditious way in which they had carried out their contract, and mentioned that it was gratifying that the engines were ready before they were wanted. We may state here that the opening run was really made by the Stewart engines, as the main engines are not yet in a condition to take up the work of the station. It is expected, however, that the three-phase plant at Pinkston and at the various sub-stations will be working within a week's time. Presentations were the order of the day, as after Bailie Paton had performed his part of the starting ceremony, Mr. John Young, the general manager of the Corporation tramways, was made the recipient of a handsome silver flower bowl, presented by Mr. Phillips, of the Mirrlees, Watson, and Yaryan Company, Limited, on behalf of the contractors. Mr. Young suitably acknowledged the gift, and a fourth bowl (one facetious gentleman was heard to remark that it was a "bowling match") would have been presented to Mr. Clark, the chief engineer of the tramways, had that gentleman's modesty not prevented him being in the neighbourhood in time to accept the gift.

A rapid adjournment was then made to a temporary erection outside, where a series of photos were taken of the visitors. The guests included the Lord Provost, magistrates, members of the Corporation, Sir James Bell, Sir David Richmond, Sir Charles Cameron, the Provosts of Paisley, Govan, Pollokshaws, and Renfrew, and a large number of gentlemen representing the various industries and institutions in Glasgow and district, and the managers of the Edinburgh, Dundee, Aberdeen, Huddersfield, and Sheffield tramways. Representatives of the various contractors and of the leading electrical papers were also present, while the electrical industry was represented by Dr. Magnus Maclean, of the Glasgow Technical College, Messrs. H. A. Mavor, E. G. Craven, T. C. Fulton, and others. After the company had been photographed, a scramble was made for the conveyances which took the party to the east end of Sauchiehall-street, where nine of the new exhibition electric cars were in readines for the trial run. This run was successfully made, the route being along Sauchiehall-street, past the exhibition (of which an excellent view was obtained), and back by way of Argyle-street to the City Chambers, where the guests were entertained to luncheon in the banqueting hall.

The Lord Provost presided at the luncheon, which was excellent, and at which about 300 guests were present. The croupiers were Bailies McCutcheon, Graham, Stevenson, Ferguson, King, McFarlane, and Dallas. The loyal toasts having been duly honoured, Sir JAMES BELL gave "The Tramways Committee, and Success to their New Departure." In giving this toast Sir James referred in very complimentary terms to the work which had been so successfully done by the tramways department in connection with the new scheme.

Mr. PATON, convener, replying on behalf of the Tramways Committee, stated that Glasgow's good example in municipalising the tramways had caused many towns to follow. He stated that since 1894, when the Corporation took over the running of the tramways, the service had increased 100 per cent., 140 millions of passengers being carried annually, against 50 millions eight years ago. He stated that the station opened that day would cost £500,000, and in putting it down on Mr. Parshall's advice the Corporation felt that they were doing right. At present there were 44 miles of double track in Glasgow, but when the extensions were completed the system would be equivalent to 150 miles of single track. Mr. Paton, in closing, thanked the committee and the Corporation for their loyal support, Mr. Young and his assistants for their administrative work, and Mr. Parshall for his unwearied attention.

Sir CHARLES CAMERON then proposed "The Corporation of Glasgow" in a few well-chosen words. He referred to the municipal reputation held by Glasgow all over the world, and, in referring to the Lord Provost, remarked that all who knew him were proud of him.

The LORD PROVOST, in reply, said the Corporation were not afraid to attack any position if they thought its capture would be for the public benefit. It was in this spirit that they had taken over the tramways.

The remaining toasts were "The Guests," "The Tramway Officials and Engineers," "The Contractors," "The Chairman," and "The Croupiers." All these toasts and the replies thereto brought out some very interesting remarks, but as the speeches were not of a technical nature we do not think it necessary to reproduce them. The Corporation is to be complimented on providing such an interesting and enjoyable function, and we wish them every success with the new scheme started under such auspicious circumstances.

HISTORICAL.

Before giving a detailed description of the Glasgow electric tramway system in its "electrified" state a short historical statement showing the growth of the undertaking, from its very modest commencement in 1872 to its present outstanding position among the tramway undertakings of this country, ought to prove of interest. Having obtained powers to construct tramways, under the Glasgow Street Tramways Act, 1870, the Corporation constructed about 2½ miles of double track (from St. George's Cross to Eglinton Toll) in 1872, and leased the working of these to the Glasgow Tramway and Omnibus Company for 23 years from July 1, 1871. This lease covered the various extensions which were carried out from time to time by the Corporation under various Acts passed subsequent to 1871, and in 1888 the mileage stood at about 31 miles, almost all double track. As the period of 23 years conceded to the company drew to a close, the Corporation opened negotiations with the lessees with a view to arranging a new lease, but a satisfactory agreement was not arrived at; and as the general public showed themselves at the municipal elections in 1890 and 1891 to be strongly in favour of a Corporation tramway service, the Town Council decided in November, 1891, to take over the working of the tramways on the expiry of the company's lease. It was, perhaps, not surprising that the company could not meet the Corporation's offer regarding the taking over of the lessees' buildings, rolling-stock, and horses at a valuation, and consequently the Tramways Committee had to face the problem of providing an entirely new equipment, with the exception of the permanent way itself, to be ready to take over the complete system on July 1, 1894, the day after the company's lease expired. After much practising in side streets to break in horses (new, and in some cases spirited) and men to the work, the running was taken over without a hitch, with the exception of an occasional car off the rails, due to the horses' desire to take a run up some side street where no tramway rails existed. These little incidents, however, only helped to make the citizens of Glasgow patronise the cars—now "their own"—to an extent which was quite undreamt of in the days of the tramway company. The Corporation's policy of reducing the fares appealed to the Scotsman's proverbial love of economy, and this, combined with a very frequent service of cars, has caused a most decided increase in the traffic. Having been approached by the local authorities of the neighbouring districts for extensions of the tramways to serve these districts, the Corporation obtained powers in 1899 to construct about 38 miles measured as single track, about half of this extension being outside the city boundaries, and including extensions to Paisley, Cathcart, Rutherglen, Tollcross, and Shettleston. These extensions are now being carried out.

At present the Corporation owns about 80 miles of track, and after the extensions under the Act of 1899, and further extensions for which powers are at present being sought, the total length of track will be about 137 miles. This will include extensions to Renfrew, Clydebank, Bishopbriggs, and Cambuslang. The Corporation also operate the Govan and Ibrox lines, the property of the Govan Commissioners, and comprising about eight miles of single track. These lines will be electrically equipped by the Corporation, and operated under an extended lease as part of the system.

ELECTRIC TRACTION DECIDED UPON.

Although the Corporation took over the running of the tramways by providing a completely new horse system, it must not be inferred from this that no other means of

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traction had been considered prior to the expiry of the company's lease. As a matter of fact, powers were obtained in 1890 to use mechanical haulage, and from that date (and even before it) till 1898 various systems were examined by the Tramways Committee and Mr. John Young, the general manager of the Corporation tramway system. Cable and conduit systems, accumulator systems, both in Europe and America, and oil motors were examined and reported upon, and finally it was resolved to put down an experimental route on the trolley system, from Springburn to Mitchell-street, a distance of 2½ miles. This route was chosen owing to the steepness of its gradients, and the working of the line proved a complete success, both from an engineering and from a financial point of view.

Our readers are doubtless familiar with the equipment of this route, and it may be remembered that the station is equipped with three McIntosh and Seymour horizontal compound tandem engines, coupled direct to three 200-kw. generators of the Westinghouse Company's standard traction type. These engines obtain steam from Babcock and Wilcox boilers. This equipment and the overhead work was carried out by the Westinghouse Company, but the cars were designed and constructed by the Corporation in their works at Coplawhill. This experimental route has been twice extended, and now comprises a through route from the north to the south of the city, five miles of double track.

The Springburn route was opened on Oct. 15, 1898, and after the line had been working satisfactorily for about two months the general manager reported to the committee on the working of the route, with the result that it was decided to recommend the general adoption of the trolley system. The Town Council approved of this recommendation on Jan. 5, 1899, and also recommended that everything should be done to have the system working electrically in time for the Glasgow International Exhibition, which opens next month. Although an enormous amount of work had to be got through in a limited time, we are pleased to see that all the most important routes, so far as the exhibition is concerned, are now complete, and that sufficient of the generating plant for immediate requirements is working satisfactorily.

General Plan of Distribution.

The scheme as it now stands was designed by Mr. H. F. Parshall, M.I.C.E., M.I.E.E., who was appointed consulting engineer to the Corporation in April, 1899. Previous to this Mr. Parshall had been asked to report on the whole question of generating and distributing the current, and an important decision was arrived at on March 16, 1899—namely, that energy for the cars should be supplied from a totally different station than that supplying the lighting. This decision created a good deal of discussion at the time, but it is now pretty generally conceded that the Corporation adopted a wise policy under the circumstances. Mr. Parshall recommended the adoption of one main generating station supplying three-phase high-tension alternating currents, to be transformed into continuous current at 500 volts by transforming apparatus situated in five sub-stations situated in suitable parts of the tramway area. This recommendation was approved of by the committee and adopted by the Town Council, and steps were immediately taken to have the work commenced with the least possible delay. When it was decided to go ahead with the present scheme, there were about 400 cars running on the lines then in use, and Mr. Parshall prepared a scheme capable of dealing with 600 cars, and capable of extension to deal with 900 cars. The Springburn route showed an average requirement of 7·2 kw., or 9·65 e.h.p. per car, and this figure was taken as a basis in working out the extended scheme.

The Generating Station.

The site of the main generating station is on the north bank of the Forth and Clyde Canal at Pinkston, where an area of 18,997 square yards was acquired in May, 1899. Although towards the northern confines of the city, the site is fairly central, the four outlying sub-stations being practically within the same radius. The site is very near the Port Dundas power station of the electric lighting department, but on the opposite side of the canal, which, of course, necessitated leading the main cables under the canal, all the sub-stations being on the opposite side from the generating station. The lines of both the Caledonian and the North British Railway Companies are branched into the coal bunkers.

The first sod was cut on Sept. 1, 1899, and the excavations for the foundations were done by the staff of the department. Over 50,000 tons of material had to be removed, and in some places a depth of 28ft. had to be reached to get down to the solid rock upon which the foundations are built. The framework of the building is of steel, about 1,300 tons having been employed in its erection. The contractors for this work are the Riter Conley Manufacturing Company, Pittsburg, U.S.A. This firm's contract covered the construction, delivery, and erection of the framework, also the columns, trusses, rafters, floor beams, coal and ash bunkers, and the beams and girders for carrying the economisers, flues, bunkers, and coal conveyors. All the steelwork is the best open-hearth steel. The walls and partitions are built of Glasgow plastic clay brick clothing the steel frame, and have been erected to a great extent by the staff of the tramways department.

The following are the main particulars of the station buildings: length, 224ft.; breadth, 200ft.; height from basement to lowest member of roof girders, 88ft. The station is divided into three sections—viz.: boiler-room, 224ft. by 84ft.; engine-room, 224ft. by 75ft.; auxiliary plant room, 224ft. by 40ft. The height of the boiler-room is 70ft., engine-room 64ft., and auxiliary room 52ft. There are two chimney stacks of brick, with ornamental stone and terra-cotta mouldings. The height of the stacks is 263ft., the pedestals being octagonal and carried to a height of 103ft. above ground level, above which the section is circular. The internal diameter is 16ft., and the width across the base at the foundations is 50ft.

(To be continued.)

THE COMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

With the object of enabling our readers to form a preliminary idea of the nature of the works and central stations which are to be visited by the Institution of Electrical Engineers next June at Berlin, we intend, as suggested in the preliminary notice which appeared in these columns on March 1, giving a series of brief illustrated descriptions of these works as far as possible in the order in which they will be taken in the programme. We therefore give in the first instance a sketch of one of the most important places to be visited—viz., the machine and apparatus works of the Allgemeine Elektricitäts-Gesellschaft, Berlin.

The Machine Factory in the Brunnenstrasse.

The rapid development of the business of the Allgemeine Elektricitäts-Gesellschaft made it necessary for the company in the year 1895 to consider the question of obtaining larger premises to cope with the increased volume of work, and it was eventually decided to remove the machine shops from the Ackerstrasse factory to a new site acquired near the Humbolthain, in the Brunnenstrasse, several streets removed from the Ackerstrasse.

The building of the new factory was commenced in 1895, being laid out on liberal lines, and having in view the experience gained in the Ackerstrasse shops it was boldly decided to adopt the system of separate motors for each machine tool, and time has proved how wise was this decision. No money was spared to make the equipment perfect in every respect, and the Allgemeine Elektricitäts-Gesellschaft can now fairly boast of possessing one of the finest factories in the world (Fig. 1). No one can fail to be impressed after a visit to these new works with the wonderful cleanliness and order everywhere prevailing, and the entire absence of overhead shafting and belting, and the resulting good illumination, gives an appearance which owners of older shops with their masses of belting and shafting, must surely envy.

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The total ground covered by the manufactory is 125,000 square yards (Fig. 2). The principal building is the machine shop, which occupies a ground area of nearly 25,000 square yards. This shop is divided up into 14 parallel bays, each 16 yards in span. Each of these divisions is served by an electric crane, while in both of the two larger divisions, where the biggest generators are built, there are two cranes, each capable of lifting 20 tons, and thus weights up to 40 tons can be transported. The cranes in the other bays are of 10 tons capacity. All the cranes are operated by

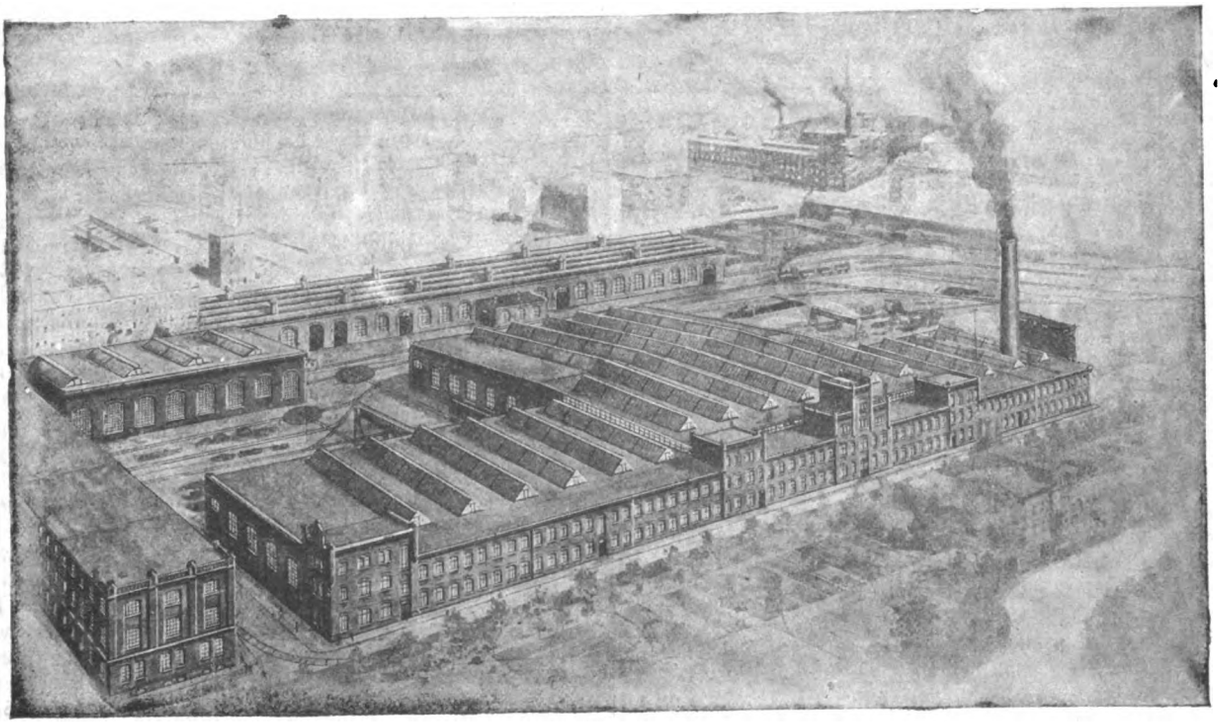

FIG. 1.

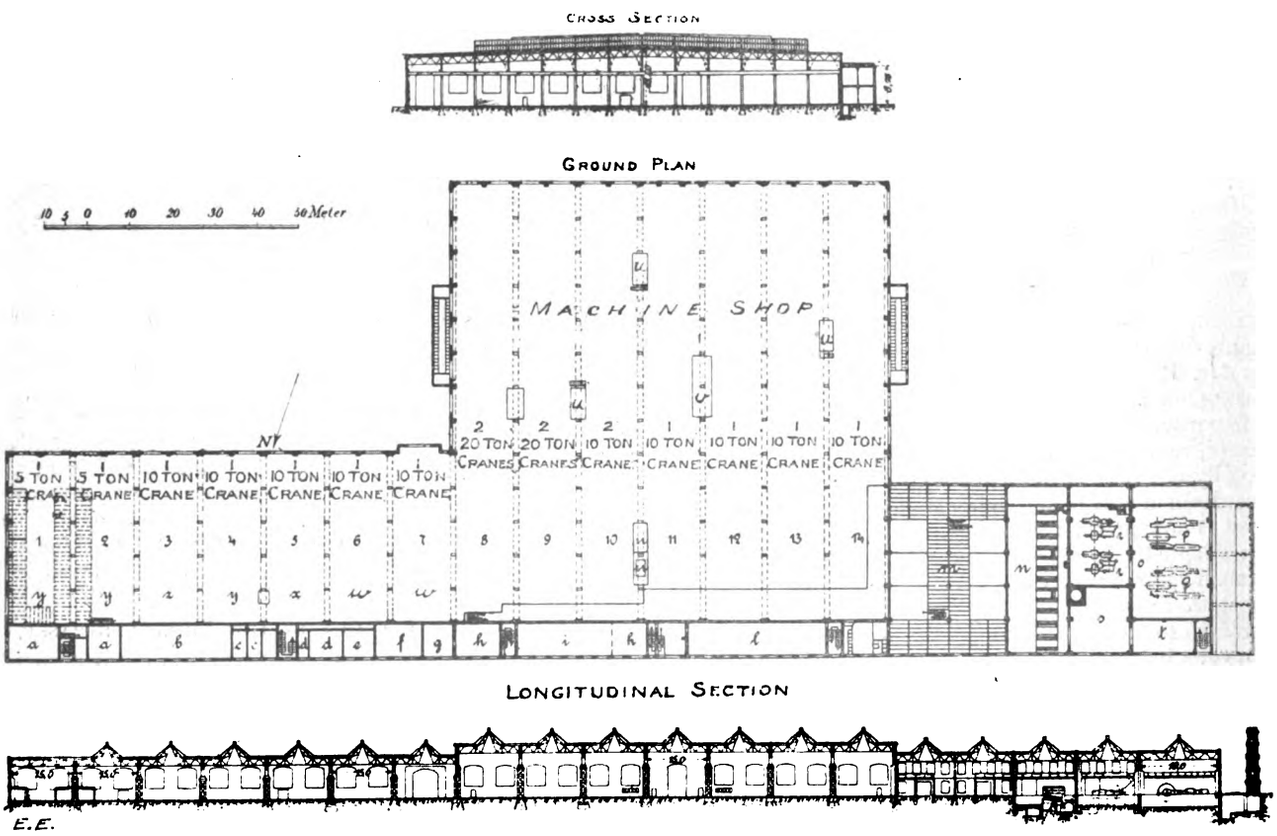

FIG. 2.

	Ground Floor.	First Floor.	Second Floor.
a	Engineer's offices	Engineer's offices	Engineer's offices.
b	Clerical staff's offices	" "	—
c	Business manager's offices.	Chief engineer	—
d	Chief electrical engineer	Manager	—
e	Laboratory	Works manager's offices	—
f	"	" " "	—
g	Drawing office	" " "	—
h	Transformer-room	" " "	Porter.
i	Tool making shop	Estimating department	Drawing store.
l	Drying-oven	Winding shop	Tracing, photographing, and lithographing department.
m	Boiler-house	—	—

	Ground Floor.	First Floor.	Second Floor.
o	Engine-room	—	—
p	1,200-h.p. steam dynamo	—	—
q	1,200-h.p. proposed extension set	—	—
r	500-h.p. ditto	—	—
s	Experimenting department	—	—
t	Smithy	Winding shop	—
u	Foreman's room	—	—
v	Tool store	—	—
w	Testing station	—	—
x	Varnishing-room	—	—
y	Machine store	—	—
z	Packing and export dept.	—	—

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three-phase motors, three being fitted to each crane for the lifting, longitudinal, and cross traverse motions. The motors for the first two motions are provided with rheostatic speed controllers, by means of which as fine a speed regulation as can be desired is obtained. Every bay is laid out for a particular class of work. In division No. 14 (Fig. 2) transformers are built, and from Nos. 13 down to 8 progressively larger generators are

Fig. 3.

constructed. In the last division may be found the largest types of machines, sometimes of over 4,000 h.p. After passing through these shops, the machines come into the erecting and testing bays 7 and 6 respectively, and after testing they are given their complete outfits in bays 5 and 4, and, finally, in divisions 3 to 1 they are packed, stored, and sent away.

The interior of the large hall is divided by a normal gauge railway line into two parts. The southern half of

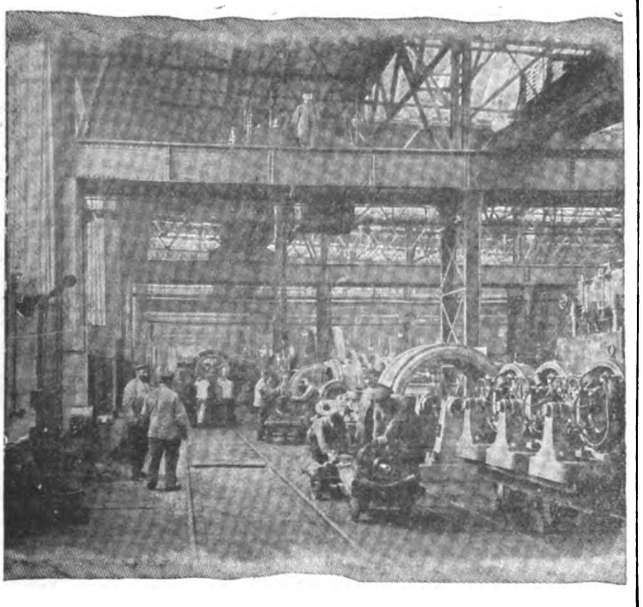

Fig. 4.

the hall is kept entirely for the metal-working machinery and all mechanical work, and the northern half is devoted exclusively to electrical work, such as armature and field-magnet winding and commutator building. This separation of the mechanical part from the electrical was especially arranged to prevent any possible injury to the insulation of the windings, which might by chance arise from the presence of metal-working machinery. All armature and field coils are wound in separate departments. This careful division results in all work being carried out in a systematic fashion. Ample means of transport are provided in the way of cranes and accumulator wagons, but transportation in the shops is rendered unnecessary to a large extent by its methodical arrangement. Castings and other raw materials enter the factory by rail at the south-east wall, and after passing the marking-off table, progress from machine tool to machine tool through all the advancing stages to completion until they reach the fitting shop, where they are assembled ready for testing.

In the main workshop of the machine factory (Figs. 3 and 4) there are 500 machine tools, each of which is driven by a separate three-phase motor (Fig. 5). The three-phase system was decided upon after a careful consideration, which showed that in comparison with the continuous-

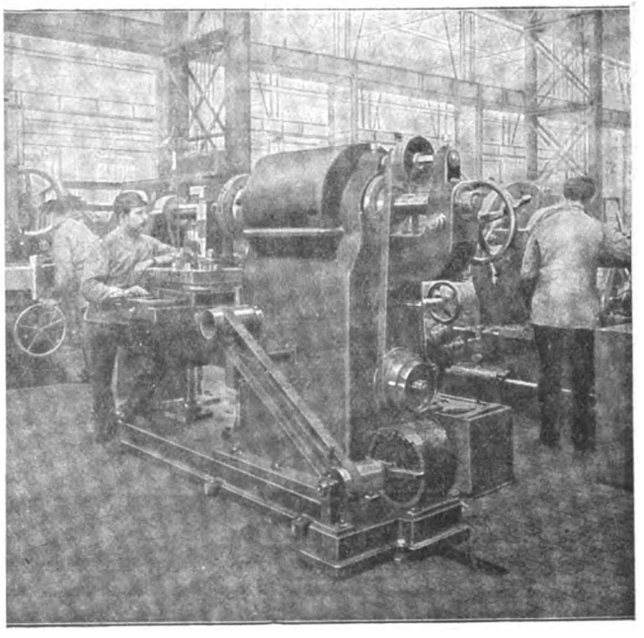

Fig. 5.

current system the motors were cheaper to construct, smaller, more compact, and lighter, they required little or no attention beyond a periodical oiling of the bearings, and the absence of commutators, especially with so many and such small motors, was an especial point in their favour. The adoption of separate motors for each machine tool simplifies greatly the whole arrangement and organisation of the shops. Tools can be laid down in the most advantageous positions, and the addition of further tools when

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the need arises is a very easy matter. Among the tools driven by separate motors are many of considerable dimensions, including planing machines with a stroke of 20ft.,

FIG. 6.

horizontal surface lathes which will take stationary armature frames from 20ft. to 36ft., automatic wheel-shaping machines, multiple boring machines, slotting machines, etc., all of which are placed in the most convenient positions.

Another striking feature in this factory is the extensive and increasing use of transportable electrically-driven tools, which are brought up to the work as required. As many as eight can be seen sometimes at work on one casting (Fig. 6). The great saving of time and labour in shifting heavy work will be readily appreciated. There are over 50 portable tools of all descriptions now in use, and the fact that they are becoming more popular every day shows that a still more extensive use will be found for them in the future. All these tools have been specially designed by the Allgemeine Elektricitäts-Gesellschaft from the experience gained over many years.

To illustrate the magnitude of the work now being carried out in the factory, we may mention the large three-phase generators, type G.D.M. 83/3,000, which many of our readers may have seen in the German Annexe at the Paris Exhibition. Six of these machines are now at work in the central stations of the Berliner Elektricitäts Werke (Fig. 7), and 15 more are in course of construction. Each of these generators is directly coupled to a four-cylinder steam-engine running at 83 revolutions per minute, and will have an output of 3,000 kw. at a terminal tension of 6,000 volts and a frequency of 50 cycles per second. The armature winding consists of solid copper bars, insulated with micanite and sunk into separate slots, and held securely in position by wooden wedges. The revolving magnet inductor has 72 poles, which are dovetailed into the rim and rigidly secured by means of patent double wedges. The diameter of the stationary armature frame is over 28ft., and that of the inductor over 24ft. The total weight of the finished machine is 160 tons, of which 80 tons are in the frame, 70 tons in the revolving field, and the remaining 10 tons in the foundation plates, etc. To transport this huge machine to Paris, 11 specially-designed double bogie trucks were employed.

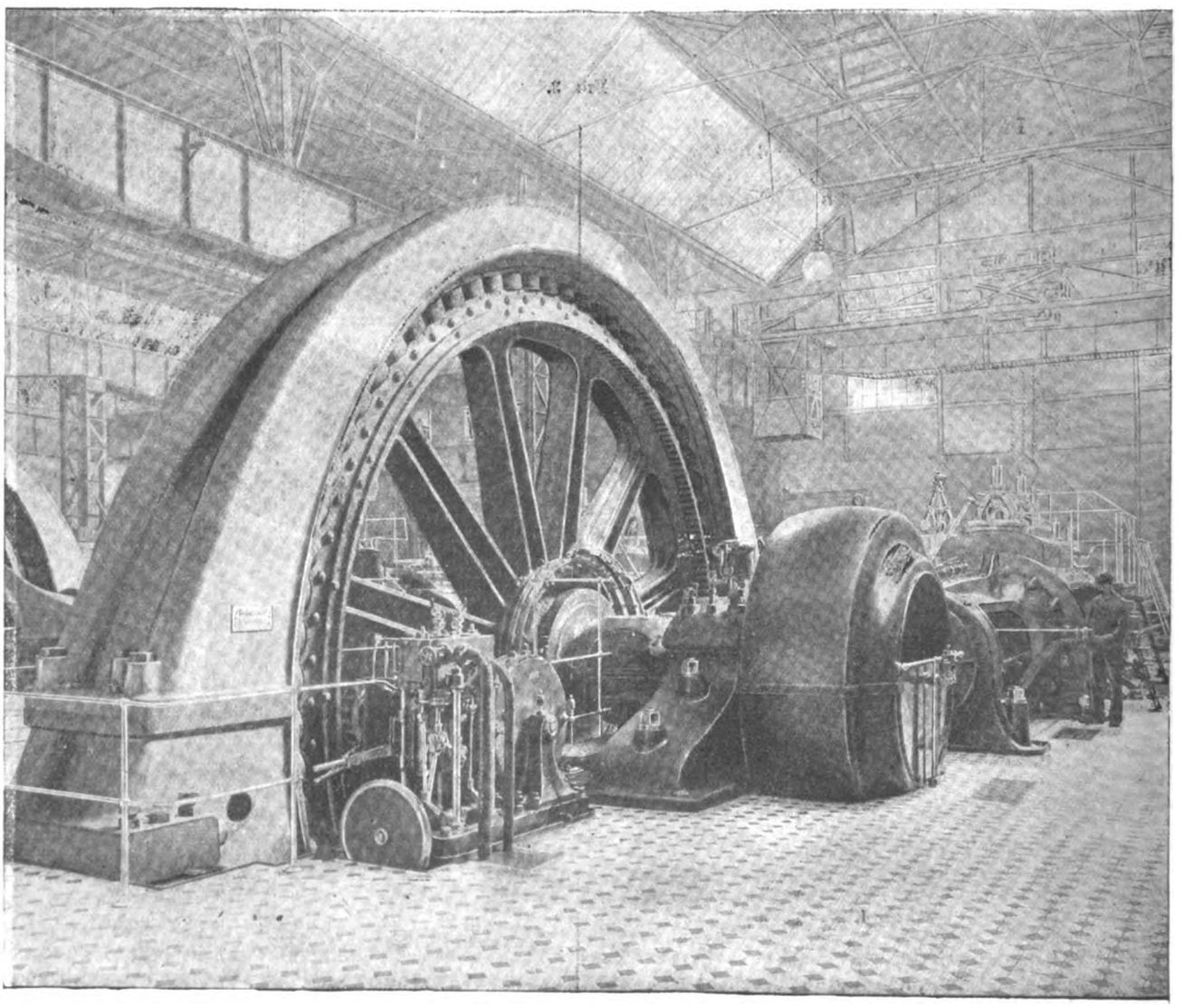

FIG. 7.

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Returning to our description of the factory, we have yet to mention the following buildings, which, though adjoining the main factory, are separated from it. The foundry, which is situated at the north-west wing, and occupies a ground area of nearly 3,500 square yards, calls for no special remark. It is provided with a 20-ton travelling crane, having a traverse of 63 yards and a span of 22 yards. Near to the foundry is the pattern shop, where railway locomotives and carriages are modelled, and the blacksmiths' shop, where the locomotive frames are constructed.

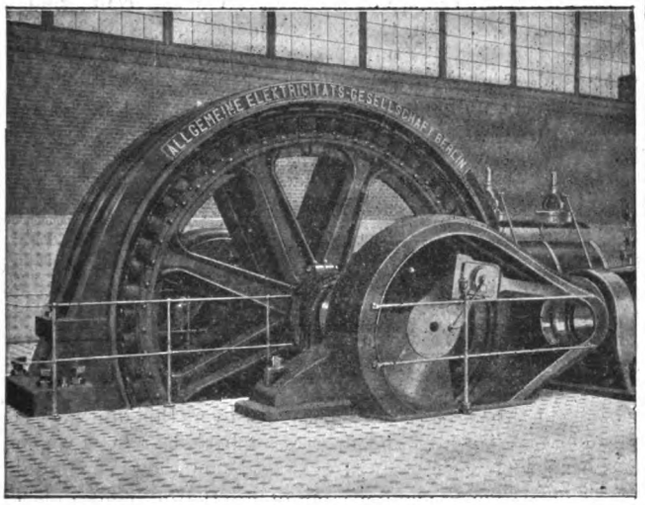

FIG. 8.

The central station (Fig. 8), which supplies the necessary energy for the operation and lighting of the factory, is in itself larger than many a town supply station in this country, and by its general internal appearance sets a good example which could well be imitated. The main load is taken by a 1,200-h.p. horizontal triple-expansion four-cylinder Görlitz engine, with Collman trip gearing, coupled directly to a three-phase alternator, and running at 107 revolutions per minute. A second set of similar dimensions is now being erected in an extension of the engine-room, and there are also two smaller but similar sets of 400 h.p. running at 150 revolutions per minute.

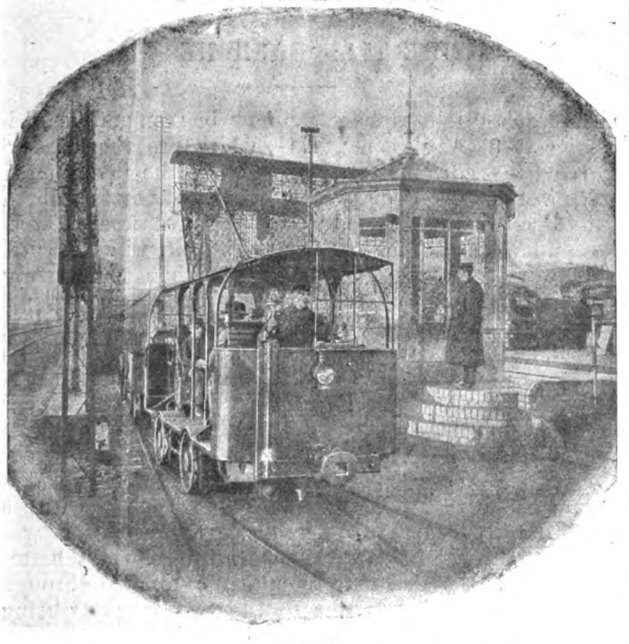

FIG. 9.

The current is generated at a tension of 3,000 volts, and transformed down to suitable pressures for the operation of the various motors. The machines are controlled from a handsome marble switchboard placed in a gallery. The boilers are of the water-tube pattern, generating steam at a working pressure of 140lb. per square inch, which is afterwards superheated. A conspicuous feature in the landscape is the large cooling tower for the condensing water.

The Brunnenstrasse manufactory is reached from the Ackerstrasse works by an underground electric railway (Fig. 9), which was the first to be tunnelled in Berlin. The tunnel, which is 300 yards long, is 10ft. 4in. in height, and its roof 21ft. 3in. below the level of the street. Three sharp curves had to be made in it to avoid the foundations of adjoining houses, 62ft., 82ft., and 98ft. in radius. The stations at each end are above ground, and the gauge of the line being normal it connects directly on to the factory rails and on to the railway siding, which runs right into the goods yard of the factory. In this yard the castings are stacked with noticeable orderliness, and a 20-ton travelling crane is provided for their unloading and loading. Before passing on to describe the apparatus factory in the Ackerstrasse, we may briefly mention the technical and business offices connected to the machine works. These are situated at the north side of the main building, extending through nearly half its length, and being arranged in three floors. Separate offices, with waiting-rooms, are provided for the director, chief electrician, chief engineer and managers, and large roomy general offices for the business and technical staffs and drawing offices.

(To be continued.)

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Concluded from page 453.)

6.—Street-Lighting.

Owing to the fact that for lighting of streets the maximum amount of light is required at a minimum cost, arc lighting is the only electric lighting possible. Incandescent lighting looks very well in purely residential districts, but is extremely costly. The system of lighting which will probably be mostly used in the near future is that of enclosed arcs, but it is doubtful if these lamps are much more economical than incandescent lamps, when the cost of the lamp and necessary repairs is taken into account. It depends upon the life of these enclosed lamps; they have hardly been on the market long enough yet for anyone to see how long they will last. One would not give them a very long life, owing to the great amount of heat generated, which is so confined. The great beauty of these lamps, however, is that they require so little attention, and providing they last as long as an open-type lamp, the revenue costs are low on this account. The light also is extremely pleasant.

There is very little doubt that in nearly all towns now the street-lighting will have to be done in conjunction with the tramway work, if overhead construction is used; therefore it is necessary for the engineer to so space his tramway poles that they will come in for street-lighting also. As to the distance apart for arc lamps, this, of course, depends upon the type of lamp used, whether opened or enclosed, whether for alternating or continuous current, and the current in amperes to be passed through the lamp. The height of the lamps depends upon the width of the road to be lighted: the wider the road the higher the lamps. The rectified current arc lamp is another type which might be mentioned; but there seems to be little in favour of a rectified system, as if the supply is an alternating one, then excellent results can be obtained from alternating lamps, and, of course, with continuous current nothing need be attempted to better matters. One of the very best installations of public lighting is to be found at Cheltenham, and this is alternating; most of the lamps are of the open type, and take about 660 watts per lamp, including transformer losses during normal running. This installation is supplied also in a very excellent way; the main cables, which are charged at 2,000 volts, are controlled direct from the works; and this ought to be done wherever possible, for more than one reason, one of them being that if the distributors for private lighting go wrong the streets are not in darkness at the same time as the shops. Probably, in all new town installations, cables would be laid to be used only for street-lighting, being fed at some centre feeding point. It is also a very good plan in combined arc lighting and tramway installations to feed the arcs from other cables

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than those supplying the current for traction, even if they are fed from the private lighting mains.

If the supply is high-tension alternating, each lamp may have a separate transformer, or several lamps may be run off one larger transformer; the lamps in the latter case being either in series or parallel, according to the wishes of the engineer. Parallel lighting is probably the most reliable, though excellent results can be obtained from series lighting on continuous-current circuits if automatic cut-in resistances are used.

Two cables will be needed for arc lighting, whichever system is used: one to supply the lamps which are left burning all night and one to be switched off after the streets are practically deserted for the night—say, at about 11.30 p.m.—to supply every alternate lamp. These two cables would have to be used whether a transformer were used to each lamp or not, unless men were employed to go round to switch off every alternate lamp; the money so spent would soon pay for the second cable. It is most likely that the system of a transformer to each lamp comes out much cheaper than the system of using one larger transformer to several lamps, as, in the latter case, if the switching off were done at the works, four cables would be needed—two low-tension and two high-tension—to act as feeders, although with the larger transformer the transformer losses would not be so great. If the system of a separate transformer to each lamp were to be used on a combined arc lighting and traction installation, the transformers would probably have to be placed underground in iron or brickwork boxes on the footway, as it would be almost impossible to design a pole base to surround a tramway pole large enough to hold an arc lamp transformer, which would not be very unsightly because of its enormous size. In the case of poles or posts only for use as arc lamp posts, the column portion need not go right down into the ground, but need only fit into the base by means of a spigot joint, and, better still, could be cast in one piece with the base. All cast-iron lamp posts should be cast in as few pieces as possible, so as to get the finished post as lineable as possible, every joint tending to throw one part of the post out of line with the other parts.

A very excellent alternating arc installation could be got, where the supply is a three-wire one at 400 volts across the outers, by the use of the Lewis transformer lamp, which is an enclosed lamp taking about 6 amperes at 200 volts at the lamp terminals. This lamp is certainly one of the best enclosed lamps on the market, as it is so very simple, and, as its name implies, transforms from 200 volts to a pressure suitable for the arc; one coil of the transformer, being movable and pivoted, works the clutch for raising and lowering the top carbon. The cost for renewal of working parts in this lamp would necessarily be very low, as there are practically no working parts—a very desirable thing, indeed. The price is probably somewhat higher than other enclosed lamps, but it may be taken for granted that an arc lamp, whether open or closed, costing £7 or so, is always worth £2 more than a lamp costing £5. There are, however, many good arc lamps, more especially amongst the open type, one of the best being the Brush-Vienna; others are the Brockie-Pell and the Crompton-Pochin.

Before lamps are placed on the circuit, each one should be separately tested with a wattmeter, and the length of arc adjusted. Many lamps are allowed to burn which do not feed often enough, thus a long arc is formed giving a very purple light; ¼in. is quite long enough for most arcs. A good light also depends very much upon the carbons, and exhaustive tests of these should be made before a quantity of any one make is ordered. The writer once made such tests of about 12 different makes of carbons, all of which were burnt in the same lamp, which was placed in a test-room, and thus shielded from the wind. A note was taken of the length of time each pair of carbons burned, and the variation was from 10 hours to 16½ hours per unit length and diameter. Price was also taken into account, and in several cases those that lasted the longest time were cheaper; in one case by as much as 50 per cent. It will, therefore, be evident that such tests should be made. The two makes of carbons which came out best in the above tests were both supplied by English firms; and in one case made by the firm which supplied them, and in the other made on the Continent.

Cleanliness and good and careful trimming are other essentials necessary if good light is required. An arc lamp can best be cleaned when the trimmer can easily get at it without having to hold on to the post at the same time. To this end, it is very desirable to use the Heathman ladder, unless the lamps are made to lower by means of a winch and wire rope. This wire rope business cannot be confidently recommended, as the rope often breaks; there is also the trouble of the slack cable with this system. When using lamps lowered thus, one would prefer to supply the lamp through a socket fitting fixed to the post, so that slack cable would not be required; but the use of a socket gives bad contact, and so more trouble. In the writer's opinion, the Heathman ladder is the best way out of the difficulty; but the design of the ladder does not seem to be all that it should be. It seems to be much too heavy for its wheels, and yet not heavy enough to stop its being shaken to pieces; it is also very liable to be blown over in heavy wind. Several times the writer has seen as many as three men holding one of these ladders by means of ropes, while the trimmer has been engaged at the top. On macadam roads, the rubber wheel-tyres are another fruitful source of trouble. Of course, if a lamp gets very dirty it must be removed from its post and another clean one substituted. One of the greatest troubles in arc lamps arises from the flexible conductors to the carbon-holders. If these are covered with rubber, the rubber will soon become quite hard, eventually causing the cable itself to break in two. The best way to get over this difficulty is to use flexibles covered with asbestos or bare flexible on which glass beads have been strung; this latter method is a capital one for insulation. The reflectors in alternating lamps, also, often give trouble, through the top carbon rubbing against the side of the hole in the reflector through which it passes. This can be obviated by making the hole in the reflector much larger. It is not required so small as it usually is made, for the simple reason that the sides of the carbon point do all the reflecting necessary for the light rays which pass immediately upwards from the arc.

In concluding these notes, the writer hopes that he has been able to show to some of the younger men employed on mains some of the most important points arising during the practical supervision of a network of electric mains, and while much remains that has not been said, yet a close attention to detail, and a high standard for work, will ensure a reputation for capability.

THE TELEGRAPHONE.

The Poulsen telegraphone can now be seen and heard in London at 2, Angle-court, E.C., which are the offices of the London syndicate organised to work the invention in this country. The Poulsen telegraphone was first exhibited at the Paris Exhibition, and we have several times referred at considerable length to this instrument, which records sound by magnetising steel wire or ribbon transversely. In Figs. 1 and 2 we give reproductions of photographs taken at 2, Angle-court, as they may be of interest to those of our readers who were not able to see the earlier machines at work in the Paris Exhibition. The first form of instrument is shown in Fig. 1, in which a steel wire is wound on a revolving cylinder. A small electromagnet having two projecting poles, which embrace the wires, is used to magnetise the same. The magnet is constructed with independent cores wound with a large number of turns of exceedingly fine wire. It was found that the two independent magnets produce a better effect than if the magnetic circuit is completed through iron. This is obviously due to the two magnets being more susceptible to the exceedingly rapid alterations of magnetic flux which have to be obtained in order to properly record the speech. The handwheels seen in the front of the apparatus can be used to turn the cylinders by hand, but they are only employed to bring the same practically up to the correct speed, after which they are driven by means of motors so as to obtain a constant speed. The electromagnet then moves along the spiral of wire as the cylinder revolves, but the length of conversation which can be recorded on the cylinders in question does not exceed one minute. In order to increase the

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length of the possible record steel ribbons are used in place of a wire wound on a cylinder. Fig. 2 shows one such apparatus. The two smaller wheels seen in this photograph are the driving wheels, worked, as before, from an electric motor. The larger wheels are reels made to contain the steel tape, which is wound from the one to the other over the arched framework, in the middle of which the recording electromagnets are placed. With the type of apparatus shown

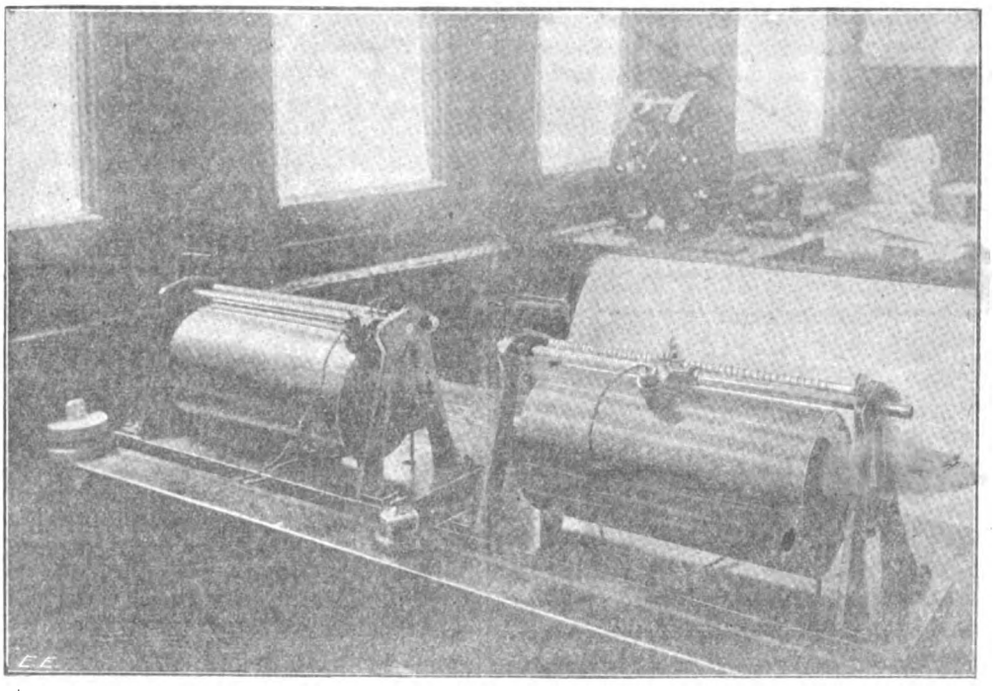

FIG. 1.—View of the Poulsen Telegraphones.

sufficient ribbon can be carried to record about half an hour's conversation. The ribbon, when it has the message impressed on it magnetically, can, of course, be removed and sent away by post if required. The speech given off by revolving these cylinders, thus drawing the tape in front of the small electromagnet, the winding of which is connected with a telephone, is considerably clearer than is obtained from an ordinary phonograph. The tones are much more pure and the reproduction of the inflections of

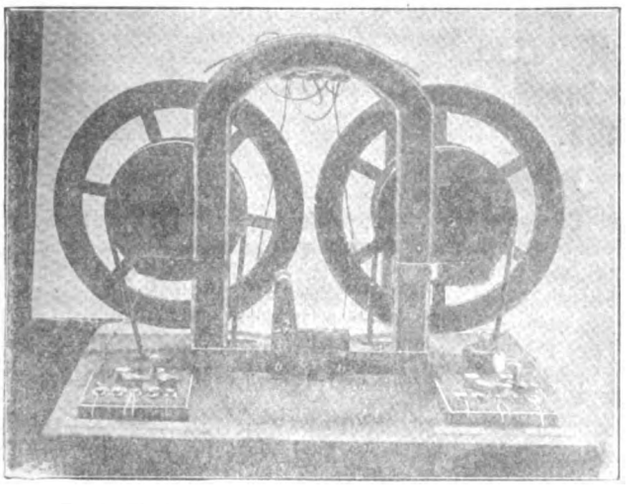

FIG. 2.—The Poulsen Telegraphone with Steel Ribbon Record.

the voice most accurate. As a scientific toy, therefore, the Poulsen telegraphone leaves nothing to be desired. It is however, with the commercial possibilities of these instruments that electrical engineers are concerned, and much has been written as to the possibilities of using them as telephone relays. We regret that there were no experiments of such relay work made at Angle-court for the following reasons: In the diagram exhibited one receiving Poulsen telegraphone is made to pass its record on to a revolving ribbon, opposite which six subsidiary sets of poles are placed. These poles are connected up to the poles of the electromagnets opposite six other revolving ribbons, so that each of the six ribbons would receive a record of the message. These ribbons were shown continuously revolving, and it is presumed that they would be kept practically at the same speed. The record received on them would be carried forward to a second pair of poles in each case. The windings on these secondary sets of poles were shown connected in series, and the current obtained from them in this way is shown going out to the next section of the line. The difficulty which we apprehend from this method would be in obtaining synchronism on the six transmitting electromagnets. It was pointed out to us that this might be overcome by using one broad ribbon instead of six independent ribbons of steel, and it was said that the record could be equally well stored on the small sections of the total breadth of this broad ribbon. Even then the electromagnets would require to be spaced exceedingly accurately in order to keep the currents induced in the sending magnets absolutely in the same phase. Unless this were done we should imagine that the one magnet would generate a current, which would oppose to a certain extent the current from the other magnets. We were told that the experiments so far conducted have, however, shown that it is possible to augment in loudness a record by combining several instruments together, and it would, perhaps, be too critical if we doubted the ingenuity of the inventor in overcoming the difficulties we have indicated. One interesting experiment most successfully exhibited was that of a news distributing telegraphone. At Angle-court a message given down in one telephone was distributed over 10 different circuits, wholly independent the one from the other. This was done by means of a band of steel ribbon passing over two pulleys driven at uniform speed. These two pulleys were mounted on a horizontal base-plate, which was also used to support the impressing and distributing electromagnets. There are 11 of these magnets on the ribbon in question, but obviously their number could be increased without difficulty. One point then on the lower horizontal part of this moving band, when it comes opposite to the first electromagnet, has a permanent magnetic record pressed on it. It then moves over the first of the distributing magnets, in which it induces a current which is quite sufficient to give off a very audible message in the telephone receivers connected thereto. The same portion of steel repeats the same message to each of the sending electromagnets in turn. It then passes over the first pole and back again over the section. Before it reaches the recording magnet the wire is passed between the poles

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of two permanent magnets, which completely wipe off the record, leaving the steel in such a condition as to be able to take up the next part of the message. It will be seen, then, that the record is only maintained for approximately three-quarters of the path over which the ribbon moves, and no permanent record is kept. In the case, however, of a news distributing agency, it would be quite easy to so arrange a long length of steel ribbon on reels that the record is kept for a day or two until all interest in the news ceased. As regards the permanency of the magnetisation of these steel ribbons and wires, we were able to hear a Danish song given off from one instrument. This had been taken down some six months ago and regularly repeated for exhibition purposes ever since without any deterioration. We were also told of a case in which a ribbon had become damp and rusty, and was cleaned up with emery paper before being used again. In spite of the rough mechanical treatment involved, the record was not affected. In conclusion, we must again express our opinion that Mr. Poulsen's invention is one of the most remarkable ever made in connection with telephone work, and the light it throws on molecular construction of steel alone entitles him to the thanks of the scientific world. It would have been a very interesting thing if one could have obtained the opinion of the scientific experts as to the possibility of doing what Mr. Poulsen has so successfully effected. We do not think we should be wrong in stating that they would as a whole have explained that it was utterly impossible that the records would faithfully reproduce the impressed message. We would advise those of our readers who are in London to make a special effort to see these instruments at work at Angle-court.

A RECORD TELEGRAPH SPAN.

We give herewith two illustrations of a long span which occurs on the system of the American Telephone and Telegraph Company. This span, in which the distance between the support of the wires is 1,300ft., occurs on the line between Boston and New York. It is claimed by the makers of the wire used on this span that it is the longest on record. The river which necessitated this enormous length of wire between two supports is the Connecticut River, which is crossed near Middletown. The tower is constructed to carry 40 line wires, but only 20 of these are now in position. Ten wires are carried on the one arm, being spaced at intervals of 1ft. apart. With such a long length of wire it is of the utmost importance that equal tension should be obtained in all, as otherwise they will be apt to cross each other in high winds. In order to get this equal tension, a straining arrangement is provided for each wire. An iron bolt $\frac{5}{8}$in. in diameter, with a strain insulator at the one end, is used. The screwed end of this bolt is passed through a straining arm, and nuts at the back of which allow for the tension to be adjusted. The tower shown in Fig. 2 was erected on the low bank of the river, and is 182ft. high. It consists of well-braced steelwork. The tower at the other side, standing on a higher bank, is only about 80ft. high. The wire used is called phono-electric wire, the agents for which in this country are Messrs. Maguire and Baucus. We had to refer to it in connection with tramway work a few weeks ago, and pointed out that the characteristics of the alloy is the uniformity of its tensile strength, and also its high elastic limit. The wire used for this long span is of No. 8 B.W.G., the tensile strength being 82,000lb. per square inch. The elastic limit is said to be 40 per cent. higher than that of hard-drawn copper. We have not any information by us as to the sag allowed, but from the illustration (Fig. 1) it can be seen that this is small for such a large span.

FIG. 1.—View of a 1,300ft. Span over the Connecticut River.

BODIES SMALLER THAN ATOMS.

On Friday last at the Royal Institution, Prof. J. J. Thomson delivered a most interesting lecture entitled "The Existence of Bodies Smaller than Atoms." Without diagrams of the various experiments performed we cannot do more than give a very brief *résumé* of the lecture, but we hope at a future time to obtain for our readers a more complete account of the experiments, and of the deductions which Prof. Thomson drew from the facts experimentally

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ascertained. He briefly referred to work which had been done by others, both in theory and practice, in order to determine the size of an atom. One method of doing this was by ascertaining the charge of electricity which an atom carried during the process of electrolysis, and from the charge to calculate the mass. The experiments of the lecturer were made with a view of ascertaining the mass of the small particles which carry an electric discharge through attenuated gases. It was explained that by balancing the deflecting effect of an electrostatic field on the discharge in a vacuum tube by means of an electro-magnetic field, one was able to obtain the velocity of the particles. The deflection produced by the electrostatic field was proportional to Fe, where F is the strength of field and e the charge. This charge moving with the velocity v resembled in some respects a current which could be attracted by a magnetic field, H. The force was equal to evH. If, then, these two quantities were

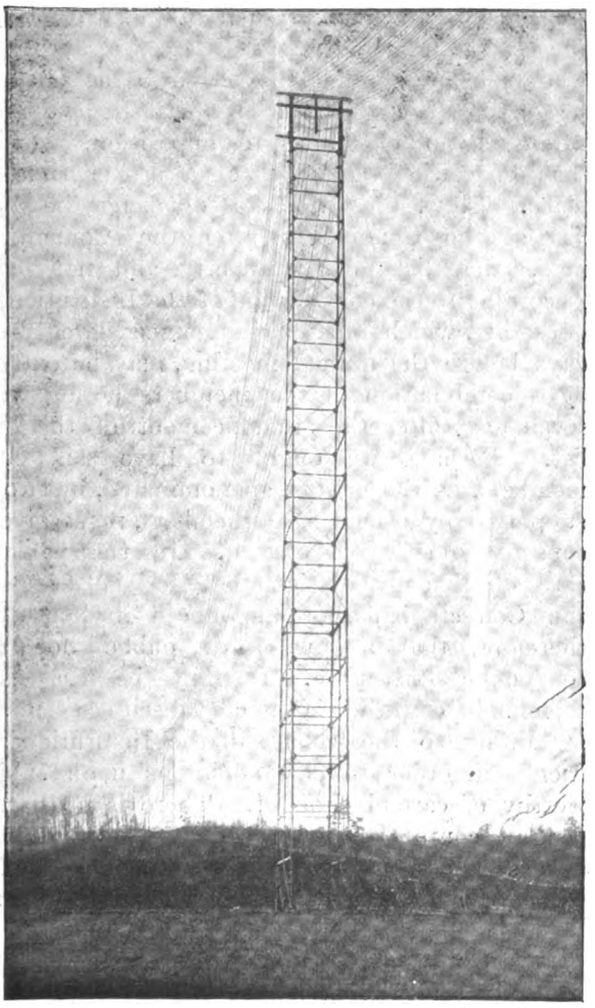

FIG. 2.—Detail of the Steel Tower on the Lower Bank of the River.

balanced the one against the other, the equation obtained would be $Fe = evH$, from which v was found to be equal to $\frac{F}{H}$. From this velocity and the discharge rate one could tell how much electricity was being conveyed at any one instant by the attenuated gases.

The next experiment was made with the object of ascertaining the mass of all the particles used to carry the charge, and also their number. For this purpose use was made of some experiments by Mr. Wilson on the sudden expansion of a gas saturated with moisture. He found that a cloud was not produced by the sudden expansion if the air was quite free from dust. It was also found that if either dust or the charged particles of gas were present a cloud was formed. The total quantity of moisture in the cloud could be calculated from the expansion. Some experiments of Prof. Geo. Stokes could then be employed to ascertain the volume of each particle. These experiments had for their object the careful determination of the rate at which particles of water would fall, the speed being dependent on the dimensions. From the formula obtained Prof. J. J. Thomson was able to ascertain the size of the particles by observing the time it took for the cloud formed in the tube by a sudden expansion to fall. Knowing, then, the size of one particle and the total mass, all the information required had been obtained. The conclusion was that the small particles carrying the charges of electricity were only one-thousandth of the size of an atom. These experiments were all made with discharges of negative electricity. It was also found that these small particles negatively charged were given off from incandescent matter and from radium. Another curious point was that their mass was invariable for all gases. When, however, positively-charged bodies were experimented with, quite different results were obtained, and the results varied with the gases experimented with. The further experiments described by the lecturer with an idea of proving whether the single-fluid theory of electricity could not be got to fully explain all the phenomena, have yet to be brought to a successful issue.

FORTHCOMING EVENTS.

FRIDAY, APRIL 26.

Society of Arts.—At 8 p.m., Howard Lecture. Paper: "Polyphase Electric Working," by Mr. Alfred C. Eborall.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On the Thermodynamical Correction of the Gas Thermometer," by Prof. Callendar, F.R.S.; "On the Production of a Bright-Line Spectrum by Anomalous Dispersion and its application to the Flash-Spectrum," by Prof. W. R. Wood.

Royal Institution.—At 9 p.m., Dr. Hans Gadow on "Colour in the Amphibia."

North-East Coast Institution of Engineers and Shipbuilders.—At 7.40 p.m., general meeting at Sunderland. Mr. G. M. Brown will reply to the discussion on his paper on "Some Attempts to Increase the Efficiency of Marine Boilers." Mr. Walter Scott will also reply on his paper "The Commercial Organisation of Shipyards." The discussion on Mr. Edwin Griffith's paper on "Water-Tube Boilers" will be resumed. Paper on "A Simple Method for Preventing the Corrosion of Tail Shafts," by Mr. James M. Thornton.

SATURDAY, APRIL 27.

Institution of Electrical Engineers—Students' visit to the works of Messrs. Easton, Anderson, and Goolden, Erith.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section).—General meeting at Newcastle-on-Tyne.

MONDAY, APRIL 29.

Society of Arts.—At 8 p.m., "Alloys," by Sir William C. Roberts-Austen, K.C.B., F.R.S. (Lecture II.).

TUESDAY, APRIL 30.

Institution of Civil Engineers.—At 8 p.m., annual general meeting.

WEDNESDAY, MAY 1.

Royal Institution.—At 5 p.m., annual meeting.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "The Application of Power to Machine Tools," by Mr. C. B. Nixon.

THURSDAY, MAY 2.

Rontgen Society.—At 8 p.m., ordinary meeting. Paper by Dr. Hugh Walsham on "X-Ray Diagnosis of Aneurism," with lantern demonstration.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Papers: "An Instrument for Measuring the Permeability of Iron and Steel," by Mr. C. G. Lamb and Mr. Miles Walker; and "A Watt-Hour Meter," by Mr. Frank Holden.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper on "The Storage of Electricity," by Mr. A. H. Allen.

FRIDAY, MAY 3.

Society of Arts.—At 8 p.m., Mr. A. C. Eborall on "Polyphase Electric Working" (Lecture II.)

Royal Institution.—At 9 p.m., Mr. Chas. Mercier, M.B., on "Memory."

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. The Northcott Prize paper on "How may the best efforts of Employers and Employed be exerted for their mutual advantage and for the national benefit?" by Mr. William Powrie, will be read and discussed.

SATURDAY, MAY 4.

Institution of Electrical Engineers (Students' Section).—Visit to the Davies-street works of the Westminster Electric Supply Corporation.

Automobile Club of Great Britain and Ireland.—Third annual exhibition opens, Agricultural Hall, Islington.

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DIVULGENCE OF CONFIDENTIAL MATTERS.

Who divulged the proceedings of the Institution Council last week to the newspapers? Whoever the members of Council were, they are not fit to sit longer upon the Council, and we trust the strongest possible means will be taken to reject those men as unfit representatives of a body of gentlemen. With every society there is an unofficial method of communicating matters of importance to the Press. It is seldom that journalists break the honourable record for reticence, thus we assume that the comments made by a contemporary upon the house list of the Council were made because of the personal representation of parties claiming to be in the know. The house list is presumed to be secret till made public at an ordinary meeting of the Institution, but it is perfectly clear to everybody who read the comments referred to that for some reason or other the house list was to be opposed. There is no objection to opposition, providing that opposition is made at a proper time and place. Now, the time for opposing the house list of the Council is after the Council has made that list public property, and not before. According to the constitution of the Institution, the house list, which must be announced twenty-eight days before the annual meeting, may be extended by a combination of ten members acting within seven days after the announcement of the house list. Perhaps we ought to have said eleven members, as the gentleman nominated, by two and supported by other eight members, must give his consent to serve if elected. In the particular case under consideration the fact is clear that the Council had not announced its house list; therefore, that list was not public nor open to public discussion. It may be that some members of the Council discussed matters pertaining to the welfare of the Institution with friends in order to elicit opinions upon subjects worthy of careful thought. There is no harm in such a course—in fact, it is to be commended, always reserving the point that such verbal or written communications are confidential. It may be that some hot-headed, impetuous, inexperienced young men forgot the "confidential," and in their ardour to make running for their friends committed acts deserving of the severest censure. Whatever excuse can be found for members or their friends, none can be found for the journalists who comment upon a confidential document. Fortunately, perhaps, the matter is less serious as the culprit journal is generally supposed to regard flippancy, cynicism, and sneering as the analogues of generosity, knowledge, and experience. We are not in a position to say why the Council did not announce the house list last week, but it is an inconvenient matter. The annual general meeting is fixed for May 23 next, and as twenty-eight days must elapse between the ordinary meeting and the general meeting the imbroglio involves further change. The house list will be looked for with some curiosity, as the reasons for the premature campaigning may then be understood. When the names of the officials are

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public property, then will be the time to discuss their merits. To do so earlier is a gratuitous insult to the Council as well as to the gentlemen whose names are mentioned; and the attempt to influence by premature newspaper criticism the decision of a duly elected Council, not having lost the confidence of the members, is a course to be most strongly condemned.

ELECTRICAL ENGINEERS R.E. (VOLUNTEERS).

Regimental Orders, April 23, 1901.

1. **Change of Address.** — The new headquarters are now occupied, and in future all correspondence affecting the above corps should be addressed,

"The Officer Commanding
Electrical Engineers R.E. (Volunteers),
Regency-street, Westminster."

2. **Recruit Drills.**—Drills for this year's recruits will take place at headquarters on Tuesdays and Thursdays, at 6 30 and 7.30 p.m.

3. **Uniform.**—All members not yet measured for uniform are requested to communicate with the Sergt.-Major at once.

4. **Training for 1901.** — The dates and places for annual training, 1901, will very shortly be published. Those members of the corps who have not yet replied to camp circulars should do so at once.

5. **Medals.**—The War Office have called for lists of all members of the 1900 detachment of the Electrical Engineers entitled to the South African War Medal. This is being prepared.

6. **South African Detachment, 1901.**—This detachment, under the command of Major A. Bain, which sailed from Liverpool in the ss. "Bavarian" on March 25, 1901, arrived at Cape Town all well on April 16. It is believed their destination is Norvals Pont.

(Signed) R. S. ERSKINE, Major,
O.C.E.E.R.E.(Vols.).
C. T. RUSE, Sergt.-Major.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

VENTILATION OF UNDERGROUND RAILWAYS.

SIR,—This subject has had my attention for some years, because I have had large experience in mines. The problem of removing dangerous gases and supplying pure air is identical in the two cases, with the added difficulty in the tunnel railways that there is a probability of noxious germ life taking up a permanent abode in them and spreading serious disease among those who travel by them.

The immediate cause for my writing to-day is to refute a false statement on p. 544 of your current issue, that the "Central London line offers a clear atmosphere and clean rolling-stock."

I am one of those who abandoned the Inner Circle at the opening of the Central London line, and from that day to this I have never found a healthy atmosphere in the tunnels. One day last summer at the Bank the atmosphere in and around the subways was so atrociously foul that I made enquiries of the company's official as to its cause, and was informed that some pumps were stirring up the drainage which had accumulated during the construction of the tunnels.

Since then I have studied the shape of the tunnels, and it is evident that where trains pass from one small tunnel to another they do so in a tunnel whose diameter is double that of the small tunnels, and that beneath the rail level there must be a very large space, which, from what is visible, seems inaccessible, and, at least in the instance mentioned, was an old cesspool, stirred up during the busiest part of the day, and unquestionably doing serious injury to the health of every passenger and servant of the company. At the entrance to the gentlemen's lavatory in Bank Station there is a grating from which the foulest smells arise at times.

The remedy must be sought, and sooner or later, if the company neglects its obvious duty to its passengers, an investigation such as was necessary on the Circle will be instituted by the same authority. Let us hope that more rapid progress will be made than has been the case on the Circle.

In my opinion the cesspools in the large exchange tunnels should be kept as clean as any part of the railway where passengers go. It is most difficult to efficiently put pure air into these tunnels, because they have been constructed without the slightest forethought on this subject. Much has been said and written about the piston action of each train being a powerful ventilating agent. Whoever thinks so does not know what ventilation means. The most economical arrangement possible, now that it is too late to make the tunnels suitable for directing air currents, is to close in all shafts at the stations, as in mine ventilation, and force in an enormous volume of air at *alternate* stations, and run equally large exhausting fans at the remaining stations.

In future tunnels for railway work, the exchange of trains from one line to the other should be provided for in the station tunnels, thus reducing the number of cross passages, and putting those that are unavoidable where they can have, in easily accessible positions, the usual light doors that we put in mines to direct the currents of air. With such a plan carefully laid out, the piston action of the trains could be utilised for efficient ventilation, and supplementary power would be unnecessary.

I shall be one of the first to return to the Circle when that line is electrically equipped, because the Central London does not offer a healthy atmosphere.

The "note" under criticism also comments favourably on the uniform 2d. fare. In my opinion this is an importation from the land of the mighty dollar, that shows clearly that whoever is responsible for its introduction here is unable to understand the temper and education of the English, which is expressed in "Save the pennies, and the pounds will take care of themselves." If the idea is to keep away 1d. passengers for short distances, it simply means reducing the earnings. English men and women will accept a 3d. ride for 2d., but they will not pay 2d. for a 1d. ride. The suggestion I read in the daily Press of putting a turnstile in the carriage door with a penny-in-the-slot lock on it is also absurd. Surely there are railway servants enough standing about to save the first-class passengers the trouble of finding change and of working a turnstile. L. D. C.

London, April 20, 1901.

CENTRAL LONDON RAILWAY BOILER PLANT.

SIR,—The letter in to-day's *Electrical Engineer* on this subject, in my opinion, occupies space that could have been better used, because the writer continually informs us of his ignorance of the facts of the case.

I have heard it stated several times that experiments in dust destruction have been running for a number of months on this plant, with results which satisfy those responsible for the work. This accounts for the necessity for more grate area, and will probably be news to "Ajax."

Yours, etc., C. R. ALFORD.

Heath House, Ealing, W., April 19, 1901.

ACCUMULATOR TRIALS.

SIR,—Your criticisms of the tests made by the *Automotor Journal*, or, rather, the methods of making the tests, of our Rosenthal battery, are somewhat ungracious, and we submit you should support a genuine attempt to ascertain facts. Why not make the test yourselves? We will gladly send you a cell for the purpose.

Your conclusions as to the efficiencies are made without considering the tests. It is obvious that the *Automotor Journal* expert purposely overcharged the cell as part of his test, and the amount of charge put into the cell was no guide as to its efficiency.

The efficiency obtained with this cell (see *Electrical Review*, April 12) was 89 per cent.—a very high efficiency—and we obtain 80 per cent. in everyday use.—Yours, etc.,

HENRY F. JOEL AND CO.

[Truthful criticism is apt to be considered ungracious, but we cannot accept figures such as were obtained for

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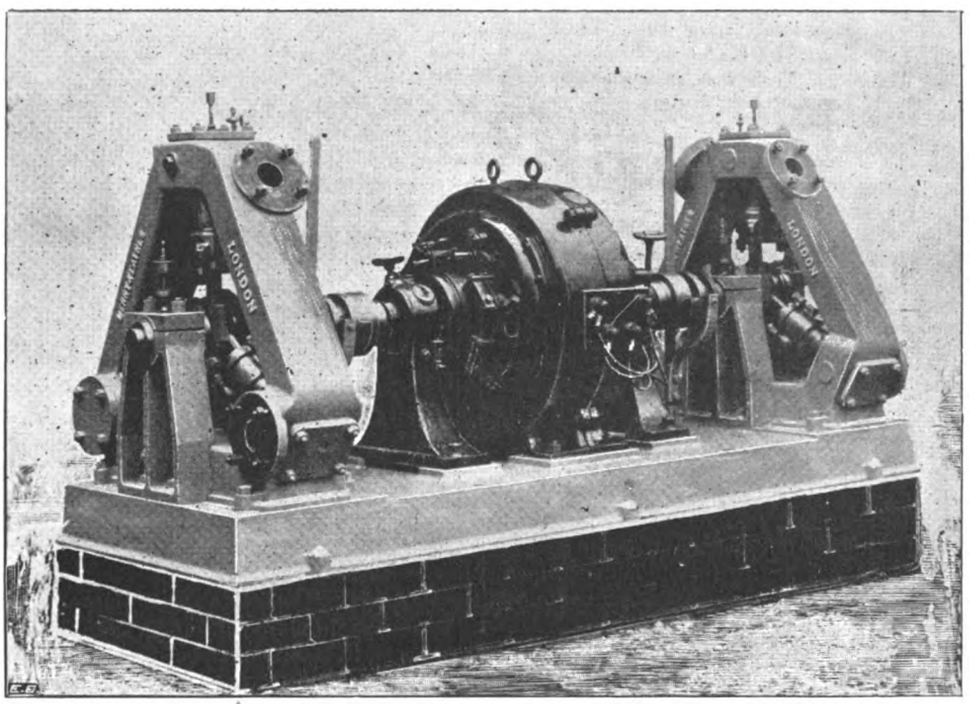
the Rosenthal battery without comment. The expert who made the tests did so in such a way that the results were valueless, and this we had to state. The remarks as to efficiency in the last part of above letter are also inconclusive, as here again current efficiency, and not energy efficiency, is meant. A current efficiency of 89 per cent. is not very high, and for everyday use considerably more than 80 per cent. should be obtained.—ED. *E. E.*]

ELECTRICAL FEED-PUMP.

The illustration which we give herewith is of a feed-pump of the "Hatfield" type, manufactured by Messrs. Merryweather and Sons, of Greenwich-road, S.E. It will be seen that the pump is of the three-cylinder type, constructed much in the same way as the original Brotherhood high-speed engine, with three cylinders spaced at intervals of 120deg. apart. This construction greatly simplifies the details, and permits of high speeds being obtained. Another feature in the construction is that of placing two pumps on the one shaft, with a clutch to connect either one or both on to the motor. This enables a considerable range of output being obtained while still running the working pump at its full speed. The actual pump illustrated was made for the electricity works of the Bristol Corporation. We have received from the manufacturers a few details of the tests which were made after the plant had been installed, but the local conditions prevented a long run being made at full load. The motor in this case was wound for about 590 volts, so as to be driven from the arc lighting machines in the station. The speed of the pump was then about 400 revolutions at the maximum output, but, of course, this speed was reduced by means of regulation in the electrical circuits when required. When working against a pressure of about 130lb. per square inch, good over-all efficiencies were obtained. Thus, even at half load, nearly 60 per cent. efficiency from the input at the electrical terminals and the output at the pumps was found. We understand that the firm are also using this type of electrically-driven pump for fire protection purposes, one being installed in the Stock Exchange, another in the St. James's Hall, and a third in Lord Rothschild's mansion in Piccadilly. In these cases the pumps are used to augment the water pressure from the water company's mains, which is not sufficient to throw a satisfactory jet on to the roof.



The Merryweather "Hatfield" Type of Electrically-Driven Feed-Pump.

INSTITUTION OF ELECTRICAL ENGINEERS.

On the Use of Storage Batteries in Connection with Electric Tramways.

BY G. A. GRINDLE, M.I.E.E.

(*Continued from page 562.*)

Saving in Operating Plant.—The judicious and adequate employment of accumulators will very materially reduce the amount in construction cost of a generating plant—that is to say, the boilers, engines, and the generators at the power station—and also, in consequence, the cost of station buildings. If we take a typical load curve of a power station operating an average sized tramway system in this country, it will be found that the mean load throughout the day approximates very closely to one-third of what may be termed the peak load or line, eliminating from the calculation the abnormal peaks which would occasionally occur. To meet this load fairly and effectively, the plant must, if a battery is not employed, be capable of generating the peak line, or, in other words, three times the mean day load, with the consequent result that, taking the day through, the plant is only loaded to one-third its capacity, a very uneconomical state of affairs, which will not by any means be improved by the varying nature of the load. Diagram No. 11 is an interesting example of this, showing, so far as the upper, or "load on line" curve is concerned, even a more aggravated state of conditions. The generator in this case is steadily doing the mean day load, and the battery is dealing with everything above. These readings were taken every five seconds for a period of five minutes at the time of heavy load at seven o'clock on a September evening. The load variation, you will notice, ranges from 15 to 250 amperes, and that as a matter of fact no part of this extreme variation came upon the generator, the generator output actually falling at the moments of heavy load. Let us for a moment compare the cost of two plants, one operating without and one with a battery, taking, for instance, a system calling for a mean load of 150 kw., representing a moderate sized system of some 20 running cars. Under the typical conditions mentioned above, the maximum load which may from time to time be demanded will rise as high as 450 kw. To deal with this, therefore, in the first instance it will be necessary to instal a plant capable of generating this output, or no less than 300 kw. over and above the mean load, and on taking the cost of a complete installed plant at £30 per kilowatt, which I think will be admitted to be a fair and reasonable figure, this means no less than £9,000 in surplus plant over and above the £4 to £5,000 plant which must of necessity be employed to deal with the mean load. In the second instance, by employing a battery to deal with the demand ever and above the mean load it will require that there should be installed a battery capable of delivering as a maximum 300 kw. The cost of a battery to comply with these conditions would approximate somewhere about £12 per

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kilowatt, including booster and switchboard arrangement, or an expenditure of £3,600 as and against the £9,000 in the first instance, or a clear saving in capital expenditure of approximately £5,400. In both the above instances no allowance has been made for spare plant; this must, of course, be provided in both cases, but the necessary amount will be considerably less in the case where the battery is employed. The above examples apply to the case in which the battery is installed at the power-house. Where the battery or batteries are installed in sub-stations, their introduction will effect in addition a great saving in the cost of feeders, varying, of course, according to the existing conditions of the line, distance from power-house, and

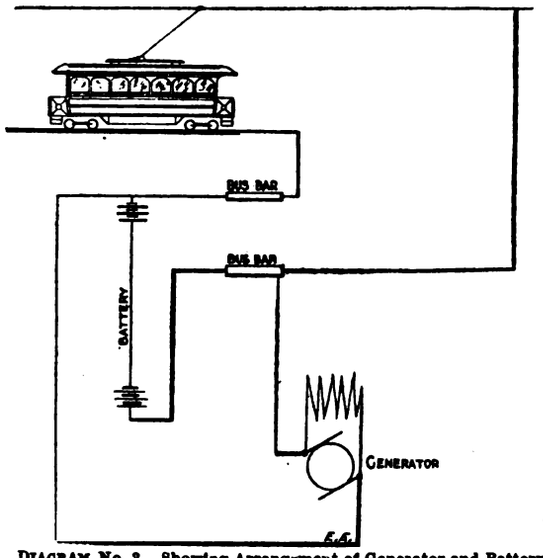

DIAGRAM No. 3.—Showing Arrangement of Generator and Battery (at Power House). No Booster employed.

various other factors. Owing to the number of these factors and the wide variations that may exist in them, it is practically impossible to formulate any idea as to what may be effected in the way of saving, though a rough idea may be easily arrived at if we consider for a moment the work which is usually performed on any traction system by a feeder. This, of course, must necessarily vary considerably in accordance with the traffic upon the line, but it is extremely doubtful if the aggregate of a day's working amounts to more than 10 per cent. of its full capacity. With a battery installed at a sub-station, the full carrying capacity of the feeder can be employed during the whole of the operating hours of the power station. As an

laying, the total cost of battery installation necessary to fully meet all the requirements, while the question of an additional power-house was found to be absolutely out of the question on account of the heavy operating expenses which would necessarily be incurred, apart from the fact that the capital cost of the battery station was considerably less than 50 per cent. of the estimated cost of the power station. These figures are sufficient to show how on the question of cost alone on the first outlay a battery is an undoubted saving.

The Saving to be Made in the Cost of Operation is self-evident, the high load factor on the engine ensuring the highest economy in the cost of production of energy, and if it is possible to

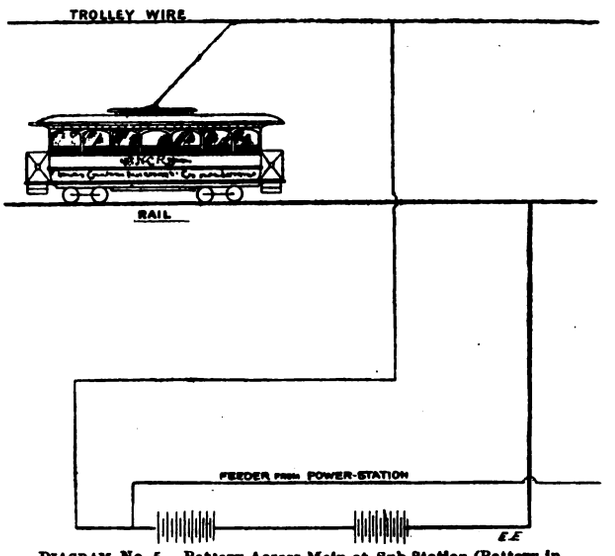

DIAGRAM No. 5.—Battery Across Main at Sub-Station (Battery in Outlying Sub-Station).

reduce, as before mentioned, our coal consumption 75 per cent. almost on this score only the cost would be justified, apart from the saving in many instances of an entire shift and the decreased running hours of machinery. The question will naturally arise here as to what the battery losses will amount to on that portion of the load that is dealt with by the battery. These are very considerably less than are generally estimated to be the case. The actual result of four consecutive months' working of the plant from which the curves on Diagrams Nos. 8 and 9 are obtained show that out of 234,072 units generated 8,240 were absorbed by the booster, or 3·5 per cent., and the efficiency of used to generated units worked out to 91 per cent.

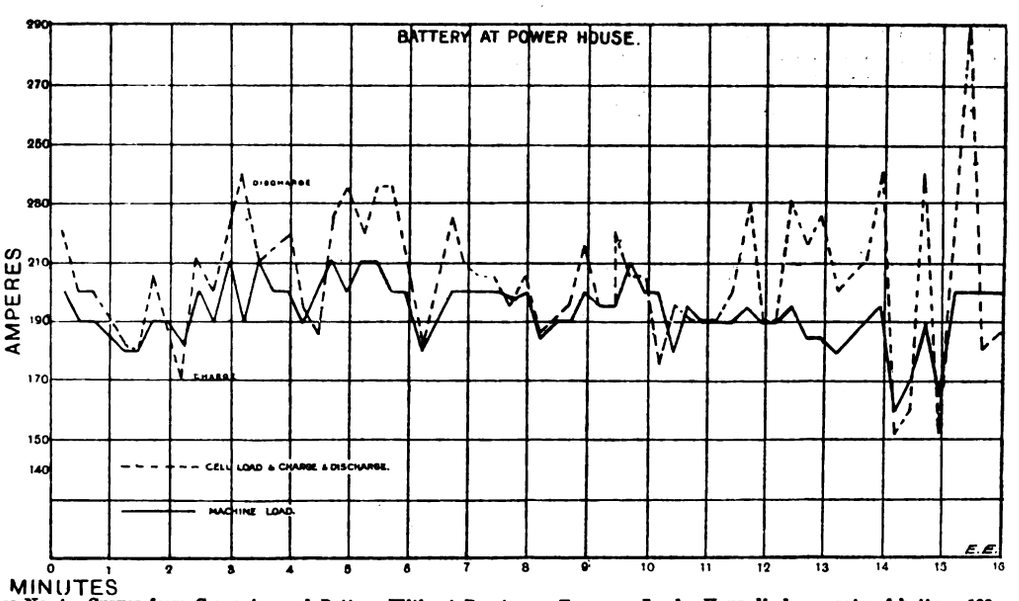

DIAGRAM No. 4.—Curves from Generator and Battery Without Booster on Tramway Load. Hour discharge rate of battery, 190 amperes.

instance of the enormous saving that may at times be effected, the case of the Union Traction Company's system at Philadelphia is a marked instance. The extension of this line was found to be necessary, and the service practically increased to double. It was found that it would be necessary either to build a new power-house or instal a battery sub-station, as to attempt to augment the feeder system to the extent that would be demanded would necessitate such an enormous outlay for copper as to render it commercially impossible. The most carefully made calculations proved that the cost of copper alone would amount to from four to five times, excluding the cost of

Relative Proportion of Battery to Station Capacity.—To effectively instal a battery, this is a point requiring careful consideration, and will vary considerably under different existing conditions. As a general rule it may be taken that the battery should be capable of dealing with from twice the mean load in the case of small stations to half the load at large stations; a very considerable range, it will be noted, due to the fact that with the increase in number of running cars the relative variations of load will decrease, and also to a considerable extent by the size of generators employed in the case of large stations. No more definite rule can well be formu-

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lated to deal with the question, each case requiring to be dealt with on its own merits. The question will be further influenced to a considerable degree by the exact

Method of Employing the Battery.—There are several methods of employment, which may be generally divided into two main heads—namely: (*a*) where the battery is employed at the power station; (*b*) where the battery is employed at an outlying sub-station. Each of these two main divisions can be again sub-divided into: first, where the battery is coupled as a whole

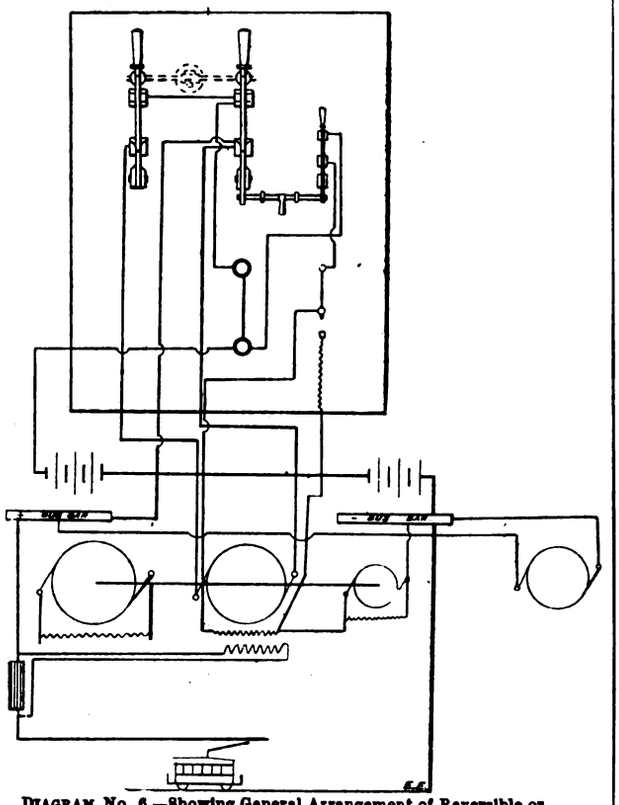

DIAGRAM No. 6.—Showing General Arrangement of Reversible or Differential Booster.

across the mains or 'bus bars; second, as the first, but with a portion of it employed as regulating cells; third, where it is employed in conjunction with an ordinary booster; and, fourth, where it is used in conjunction with a differential or reversible booster. The function of the battery under these different conditions will vary considerably.

Let us in the first instance take the case where a simple battery is installed at the power station without any special apparatus for its control, its two extremities being coupled to the 'bus bars. Under these conditions a certain portion of the fluctuations of load must fall on the generator, and a certain variation of voltage must be permissible at the 'bus bars in order that the battery may take its proportion of the load. This is easily understood if we first consider a condition of no external load. Have the battery standing at a potential of 500 volts, and the potential of the generator at 500 volts; it is now very evident that the two will balance and nothing will result. If, however, by adjustment of the governors of the engine, or by the field windings of the generator, we so arrange that the generator potential shall rise, then, as can easily be followed, the generator will charge into the battery. The load next comes on the line, which should be dealt with by the generator up to the point of its full output being reached, after which should the load still continue to increase the generator voltage should commence to drop, the battery voltage predominate, and the battery commence to discharge to line. As the load falls the reverse conditions will take place. This method of working must of necessity require a certain amount of voltage variation on the 'bus bars, and consequently on the line, and it also requires a very careful predetermination of the precise characteristic of the generator. The results generally obtained cannot be deemed to be satisfactory, though greatly improving matters as compared with the case in which no battery is employed; they are, nevertheless, far behind what can be obtained with other methods of employment. This system has, it is to be regretted, been rather widely adopted not only at home but also abroad, and the modicum of success obtained with it has, I am afraid, resulted in rather discouraging and disappointing those adopting it. Diagram No. 3 shows the general arrangement of a battery employed on this method, and Diagrams Nos. 4 and 12 the results obtained. From these will be noted the extremely small amount of work done by the battery and the wide range of machine load—in No. 4 the machine load varying no less than from 160 to 210 amperes and the battery practically getting no charge at all, with the result that it would either have to be charged by special means during slack time or after running hours. Under these conditions the battery is of little real value, and is certainly working under very bad working conditions to itself. Diagram No. 12 shows very much the same, the generator practically following the load throughout, the battery being induced to assert itself very occasionally. These readings were taken soon after charge, and may therefore be assumed to be working under best conditions. The voltage curve shows a variation of over 50 volts, which cannot be deemed satisfactory. The method of adoption at the sub-stations where the battery is simply placed across the mains, as shown in Diagram No. 5, is possibly the simplest adaptation, but the results are as equivalently unsatisfactory. Here everything does and must depend on the rise and fall of the line voltage. At times of heavy load the volts will go down and the battery discharges, while when the load is light the voltage rises and the battery charges. As can be easily gathered the result cannot give satisfaction, nor is there any possible chance, within reasonable limits of variation of voltage, of the battery ever doing very much, the operation of the battery being entirely dependent on the variations of the line voltage, which must of necessity have a wide range to ensure any effectual work being got out of the battery. To be perfect, a storage battery should be without internal resistance, so that however great the current passing through it the fall or rise of volts across the terminals due to that current, whether charging or discharging, should be negligible—unfortunately, no storage battery has been made which show these qualities, nor, I am sorry to say, does it appear likely there ever will be. In quite a number of cases that have come to my personal knowledge where batteries have been installed under these conditions they simply lie little less than "dead" on the line. A recent instance I have in mind where a battery which had been installed with adequate boosting arrangements at a power station was, on being replaced at the power station by a considerably larger battery, itself removed to an outlying sub-station, and employed there in this way pending arrangements for boosting. The battery, which has a one-hour discharge rate of 150 amperes, under its old methods of working frequently discharged up to 175 amperes and over, while under the new conditions it has never been known to exceed 40 amperes. Diagram No. 4 also demonstrates the same

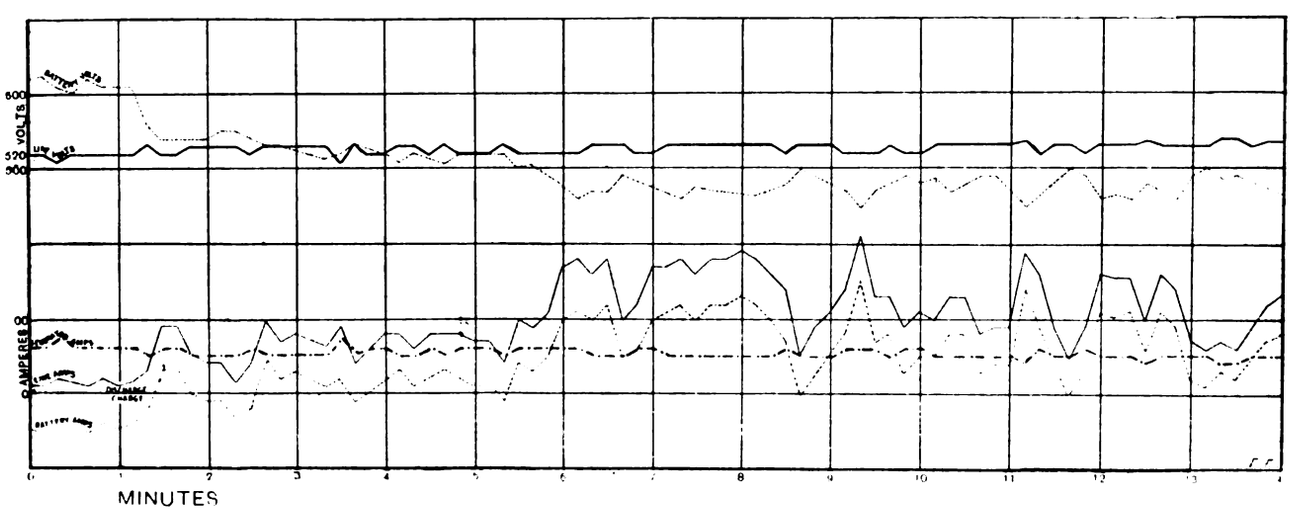

DIAGRAM No. 7.—Curves from Generator, Battery, and Special Booster on a Tramway Load. Eight cars on line, 100-kw. shunt-wound generator. Battery 1 hour discharge rate, 110 amperes.

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poor result. The battery in this case has a one-hour discharge rate of 190 amperes, and it will be noticed that the highest point ever reached is only 90, and that quite an exception. It is certainly not worth while installing a battery under these conditions if an effective result is desired from it, and, further, the working conditions are distinctly detrimental to the battery.

(To be continued.)

CATALOGUES RECEIVED.

The Electrical Company, of Charing Cross-road, have forwarded to us their descriptive pamphlets of testing instruments. The first of these deals with the apparatus for measuring insulation resistance on alternating-current circuits where an ordinary voltmeter reading is not sufficient, owing to the induction and capacity effects. The other pamphlet sent us at the same time deals with a series of dead-beat moving-coil instruments designed for alternating-current working. These instruments are so made that their readings are quite independent of wave-form and frequency. Dynamometer and magnetic damping arrangements are adopted to make the pointer dead-beat. The magnet and disc used for the damping is kept quite independent of the dynamometer, so that no interference between one and the other is possible. We have also received the firm's electrical progress-sheet for April, in which our attention is drawn to the curling-iron heaters with automatic switch, a quantity of which were supplied to H.M.S. "Ophir" for the Royal tour; also to the patent hydrometer, which should prove most useful for the small accumulators used in connection with electrical ignition for motorcars.

The British Westinghouse Electric Company have issued three more circulars, numbered respectively 1,042-3 and 4. The first of these circulars describes the general details of the multipolar generators and motors manufactured by the firm for working with belt transmission. These direct-current machines have all former-wound armature coils, so that standard coils can be obtained to replace any which may be damaged in course of time. These coils are sunk into teeth formed in the laminated cores. Another special point in the design is the ventilation of the armature. The ventilating spaces are so designed that the air passing up through them is projected on to the field windings, and tends to keep the same cool. With these multipolar machines the balancing of the various circuits in the armature which are connected in parallel at the brushes becomes an important consideration. A slight eccentricity is apt to produce heavy circulating currents, which may cause serious overheating. The British Westinghouse Company reduce very largely this effect by cross-connecting a number of points on the armature, which are, or should be, of equal potential. This cross connection is carried out by means of rings of copper, to which each of the potential points are connected. The circular concludes by giving a complete list of the dimensions of the large number of standard machines manufactured by the firm. Circular No. 1,043 deals with generators and rotary converters for electrolytic work. Here again, of course, the machines are all of the multipolar type, but in view of the large outputs required most of them are designed for direct coupling. A series of interesting illustrations are given of important installations carried out by the firm with this class of machine. The last circular before us from the same company deals with their direct-connected railway generators. We notice that in the larger sizes of these railway generators the firm arrange for the engine flywheel to be adjoining the generator, and not on the shaft on the other side of engine crank, as was frequently done by certain American engine builders. The next move in this direction will, we expect, be to make a direct connection between the cast-iron body carrying the armature core plates and the spokes of the engine flywheel. In this way all strain will be taken off the keys of the flywheel and dynamo. Engine builders will find the list of standard machines manufactured by the British Westinghouse Company exceedingly valuable as a reference. In glancing down this list we note that the speed of these large generators is comparatively low to what certain English engine builders are prepared to give. It will, we believe, be found in time that these high speeds are not advantageous with such large generators.

We have received from Messrs. Allan and Adamson, Limited, of Crampshaw-lane, Ashtead, Surrey, lists of their accumulators which are designed especially for electric launches, tramcars, etc. In each case teak boxes, which are lead-lined, are used to contain the plates and solution, and the design is such that the space taken up is exceedingly limited. We gather from the description that the outside dimensions can be varied to a certain extent to comply with the space available on the launch, etc. Another type of cell which the firm are making is specially devised for medical work. It is supplied in five ranges commencing at 4, 6, 8, 10, and 12 volts. The maximum discharge rates for short periods of the various sizes of accumulators made vary from 6 amperes up to 21. The normal rates of discharge are, of course, considerably less than these, but the accumulators will give the amperes mentioned for a short period such as is required when using an electric cautery. From what we can see of the waves given, the output obtained from these cells is good.

LIGHT RAILWAYS.

The Commissioners held an enquiry on Thursday into the expediency of granting the application of the Croydon Rural District Council for an order to authorise the Mitcham light railway.

The Earl of Jersey, G.C.M.G., Colonel Boughey, C.S.I., and Mr. E. S. Bateman held an enquiry on the 18th inst., into the expediency of granting applications made for the construction of an electric tramway or light railway in the township of Clifton, and also the Bolton, Turton, and Darwen Light railway. At the close of the enquiry the Earl of Jersey intimated that the Commissioners would recommend the Board of Trade to grant the order asked for.

The Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the urban districts of Rishton, Clayton-le-Moors, Great Harwood, and Padiham, the rural districts of Clitheroe and Burnley, and the parishes or townships of Read, Simonstone, and Whalley, and (under certain conditions) in the county borough of Blackburn. Objections must be lodged on or before May 17.

HASTINGS ELECTRICITY ACCOUNTS.

From the accounts of the borough of Hastings electricity works department just issued, it appears that the total expenditure on capital account to Dec. 31, 1900, amounted to £102,255. We give herewith abstracts of the revenue account and general balance-sheet, together with the report of the borough electrical engineer (Mr. L. Andrews) thereon to the Sub-Electric Light Management Committee:

REVENUE ACCOUNT.

Expenditure.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£4 623	17	2			
Oil, waste water, and stores	496	18	7			
Wages at generating stations	884	12	2			
Repairs and maintenance: buildings, £9 5s. 10d.; engines and boilers, £307. 12s. 10d.; dynamos, exciters, transformers, motors, etc., £22. 4s. 9d.; other machinery, instruments, and tools, £53. 14s. 10d.	392	18	3			
				6 398	6	2
Distribution of Electricity.						
Wages and other remuneration	10	5	5			
Repairs, etc., of mains	5	17	2			
Repairs, etc., of transformers, etc.	75	18	11			
Repairs, etc., at distributing stations	2	19	3			
				95	0	9
Repairs, etc., of public lamps				206	10	2
Rents, Rates, and Taxes.						
Rents payable	150	19	0			
Rates and taxes	255	9	3			
				406	8	3
Management Expenses.						
Salaries	420	15	4			
Salaries and commission of collectors	147	17	0			
Stationery and printing	43	8	1			
General establishment charges	87	19	8			
				700	0	1
Law and Parliamentary Charges.						
Law expenses				16	6	5
Special Charges.						
Insurances, etc.				164	9	7
Total expenditure				7,987	1	5
Balance carried to net revenue account				3,980	18	7
				£11,968	0	0

Cr.	Income.	£	s.	d.
Sale of current, per meter		8,548	16	7
Sale under contracts		203	10	9
Public lighting		2 650	0	0
		11,402	7	4
Rental of meters and sales and repairs		456	10	8
Rents receivable		109	2	0
		£11,968	0	0

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GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account: Hastings Corporation 3 per cent. redeemable stock, second issue, £6,646. 14s. 4d; third issue, £104,439 11s. 7d.	111,086	5	11
Less discount and expenses third issue, £6,521. 11s. 7d.; and premium less expenses second issue, £224. 5s. 8d.	6,297	5	11
	104,789	0	0
Amount due to borough treasurer	1,937	5	4
Sundry creditors	3,397	8	6
	£110,123	13	10

Cr. Assets.	£	s.	d.
Capital expenditure: amount expended on works, £102,255. 17s. 5d.; less redemption of stock and loans account—balance at credit thereof, £5,272. 17s. 7d.	96,982	19	10
Loans fund for redemption of stock: amount at Dec. 31, 1899, £812. 0s. 8d.; transfer from sinking funds, £2,073. 6s. 7d.; appropriations and interest during year, £2 387. 10s. 4d.	5,272	17	7
Stores on hand: coal, £183. 11s. 11d.; oil, waste, etc., £96. 2s. 4d.; general, £224 3s. 5d.	503	17	8
Sundry debtors for current, etc., supplied, £4,317. 19s. 7d.; rents, materials, etc., £329. 3s. 11d.; suspense accounts, £1,112 3s. 1d.	5,759	6	7
Insurance premiums unexpired	116	8	9
Balance at debit of net revenue account	1,488	3	5
	£110,123	13	10

REPORT OF MR. ANDREWS.

Gentlemen,—In connection with the balance-sheet for the year 1900, I beg to submit the following data for your information: During the past year we have sold (for private lighting purposes) 404,083 units. This is an increase of 122,217 on the previous year. For the four years prior to 1900 the average yearly increase had been only about 35,000 units per annum. The increase, therefore, during the last year alone has been almost as great as in the whole of the preceding four years put together. The average price obtained has been reduced from 7 63d. in 1899 to 5·45d. in 1900. This equals a reduction of 2·18d., or 28½ per cent. This reduction corresponds to a rebate to existing consumers of £3,650 per annum. In spite of the heavy increase in the price of coal, the total works costs have been reduced from 3 63d. in 1899 to 3·51d. in 1900. The only items on the expenditure side of the balance sheet that have been appreciably increased are those of coal, oil, waste, water, and engine-room stores. These items alone have been increased to the extent of £1,999, but about £1 427. 10s. of this increased expenditure has been incurred through the abnormal increase in the price of coal, and owing to difficulties we have had to contend with in maintaining a constant supply during the progress of the alterations and extensions to the buildings. The enormous rise in the price of coal has alone been responsible for an increase of about £600 on our coal bill for the year, and this has been further increased to the extent of at least £827. 10s. owing to the very uneconomical conditions under which the plant has, of necessity, been working due to the roof being off the works for the greater portion of the year, and other losses directly attributable to the building operations. It will be seen, therefore, that the increased cost directly due to the increased output has only been about £572. This equals 1 12d. per unit for the 122,217 extra units that have been sold. This result confirms, I think, the statement I made in my report dated Dec. 5, 1899, that the actual cost of generating current beyond the standing charges should not exceed 1½d. per unit. It also shows that the charge of "10s. per lamp and 1½d. per unit" leaves a very fair margin for profit. Other items of expenditure for the year have been materially reduced. The cost of wages for instance, has been reduced from £982 in 1899 to £864 in 1900. The cost of repairs has been reduced from £491 in 1899 to £392 in 1900. These reductions are the outcome of shutting down the Waterworks-road station, which, it will be remembered, I advised you would considerably reduce the works cost. Other items have also been reduced; for instance, the distribution charges have been reduced from £157 in 1899 to £89 in 1900. (Signed) L. ANDREWS.

APPOINTMENTS VACANT.

Assistant Draughtsman, South Shields. Applications to Mr. J. Moore Hayton, town clerk, Court-buildings, South Shields, endorsed "Draughtsman," by 27th inst.

Improver, lighting station, South of Ireland. Details in our advertisement columns.

Draughtsman for motor and large switchboard work. Particulars in our advertisement columns.

Mechanical Engineer, Victoria Jubilee Technical Institute, Bombay, India, salary, rupees 400, rising to rupees 600, May 28. Particulars in our advertisement columns.

Improver, Doncaster Corporation Electricity Works, 15s. per week, May 1, 1901. Full particulars in our advertisement columns.

Assistant for taking resistances, used to Wheatstone bridge preferred; also youth required as clerk with some technical knowledge, Aron Electricity Meter, Limited. Details in our advertisement columns.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

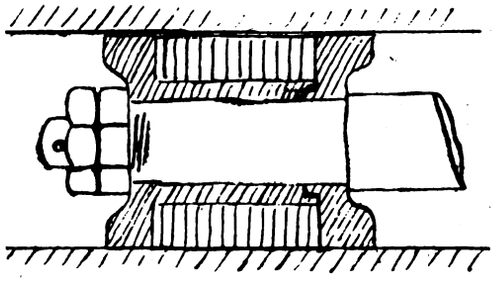
371. It is required that a 500-volt motor be run at a constant speed off traction mains where the pressure varies from 350 to 500 volts. Would a booster in circuit with the aforesaid motor get over the difficulty?—S. B. W.

372. In a central station where turbines are installed to drive the generators the hot-well temperature (owing to the high vacuum) is only 70deg. F. It is not advisable to pump the feed into the economisers so cold as this. What is the best method of warming it up to about 110deg. F.?—C. P.

ANSWERS.

Question No. 365.—Which is the best type of bucket (or piston) for the water end of a boiler feed pump suitable for the pressures used at central stations, etc., and are any such pumps fitted with ebonite packing rings?

Best Answer to No. 365 (*awarded* 10*s.*).—There are several types of water-end pistons for the electrical engineer to choose from in specifying details for new direct-acting boiler feeders to meet the up-to-date requirements of his power station. With increased boiler pressures has also followed many minor alterations in the boiler feeding arrangements, but none more important than the water piston or bucket, which now has to work against pressures varying from 160lb. to 200lb. compared with 60lb. to 80lb. pressure of a few years since. The truck plunger pump has found much favour in almost all large stations, as it reduces to a minimum the risk that attends the pump bucket. However, the pump fitted with the latter commands a large sale, and, therefore, it is necessary to face the trouble and reduce the risk. This has been to a great extent met by the introduction of the vulcanite packed bucket, which is here shown. It consists of a



series of discs or washers of vulcanite placed side by side and held firmly together by the bucket proper, formed of a sleeve plate and junk plate, and these in turn securely attached to the pump rod by a shoulder on the rod at one end and lock nuts at the other. Care has to be taken in turning up the bucket that it fits the liner of pump accurately. An extremely hard polished surface is presented to the face of the liner, and in practice it is found to give excellent results when pumping hot water at a working pressure of 200lb. This test was made with some Duplex boiler feeders made by Hayward Tyler and Co., and fitted by them with the vulcanite-packed bucket. The ring type of bucket is an excellent form of water piston, although in this there is more wear and tear, but providing the metal is of best quality they are not likely to give much trouble. The sketch clearly shows the present form with somewhat broad rings, two

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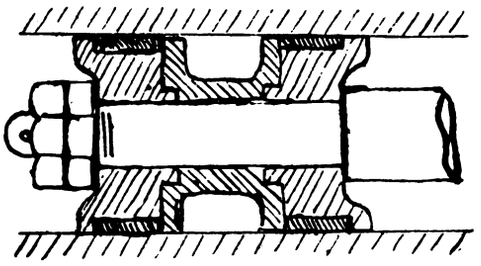
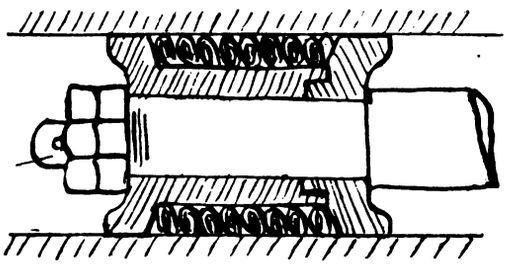
end bucket plates and grooved intermediate piece. This is secured on the piston rod exactly similar to the vulcanite bucket. The hemp-packed bucket is shown on No. 3 sketch, and looking at it from an economical point of view it certainly stands first. With very high pressure, however,



the hemp is likely to get blown out if a little wear takes place, or jams itself between the plates and the liner. For moderate pressures it can be recommended, and the outlay



for renewal is so small that it commends itself at once. No skilled labour is required, merely a piece of plated hemp packing lightly wound on the sleeve plate, and screwed up to the junk plate as shown.—J. R.

Answer to No. 365 (*awarded* 5*s.*).—This question offers a very large scope, as at the present date there is a great variety of such pumps on the market, both electrical and steam driven. The electrically-driven pumps are mostly of the plunger type, with rubber valves. The one advantage of this class of feed pump is that they give a continuous flow of water, as they have three plungers on the one shaft. Should the feed water become hotter than 120deg. at the suction, it will vaporise in the pump chamber, and the pump will then refuse to lift the water. Then, again, we have the steam-driven flywheel plunger feed pump, which will also refuse to pump the water if it should become hotter than 120deg. Then we have the piston feed pump—that is to say, the bucket is fitted with junk ring and packing ring (in the same way as an ordinary steam piston) made of gunmetal or Bull's metal. This class of bucket has the advantage of pumping feed water at a very high temperature, up to 160deg. or 170deg. Then there is the rope-packed bucket. This bucket is made solid, then recessed out about $\frac{3}{4}$in. deep, with $\frac{1}{2}$in. flanges on both ends, packed with manila rope round and round the recess of the bucket, and as soon as it comes in contact with the water the rope swells, and so prevents the water passing from side to side of the bucket. And, again, there is the Weir steam feed pump, which to my idea is the best and most efficient in the market. It is fitted with ebonite packing rings, the bucket is made of gunmetal, with solid packing and flange rings of the same metal, the packing rings are cut and are made of specially manufactured ebonite, suitable for all temperatures and pressures. When the bucket is screwed up, the ebonite rings should be easy enough between the gunmetal supporting rings to be moved laterally by hand. The four first-mentioned pumps will work very badly if they have to lift the water from a depth of 6ft. or 8ft. and deliver it against a boiler pressure of 160lb. I have had a Weir feed pump under my charge that would lift the water from a depth of 16ft. and deliver it against a boiler pressure of 160lb. with the greatest ease. Of course, any pump will give better results if the supply tank is overhead.—TELFORD.

Answer to No. 365 (*awarded* 5*s.*).—For steam pressures up to 120lb. per square inch, the Worthington regular pattern pump will be found most reliable and satisfactory; there is a number of pumps on the market of very similar design (Fig. 1). The double-acting plunger (of which there are two) works through a deep metallic ring bored

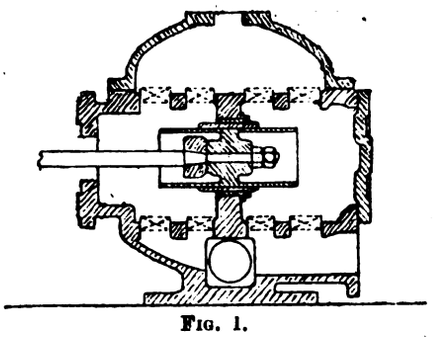


FIG. 1.

to an accurate fit, being neither elastic nor adjustable. Both ring and plunger offer great facilities for repairs or renewal, and if desired to change the proportions between the steam pistons and pumps, a plunger of somewhat larger size or decreased to any diameter can be readily substituted. For boiler pressures above 120lb. per square inch, the writer has found the arrangement shown in

FIG. 2.

Fig. 2 to be more suitable, and has used this type for feeding a boiler working at 200lb. pressure per square inch without experiencing any difficulties. Here the plungers with exterior packings work into each end of a cylinder divided by a partition. They are connected together by yokes and exterior rods (not shown in sketch), which cause them to move as one plunger, so that while one is drawing, the other is forcing, and thus making the double-acting pump.

Referring to the last part of the question, the writer does not know of any boiler feed pump in which ebonite packing rings are employed, although there are low-pressure pumps fitted with a variety of packing rings. In a high-pressure feed pump dealing with hot feed water, any packing whatsoever which is directly in contact with the feed water is objectionable, and would prove unsatisfactory.—R. A. C.

Question No. 366.—Describe the process of making commutators for small direct-current dynamos in large quantities. Are special tools required?

Best Answer to No. 366 (*awarded* 10*s.*).—The manufacture of commutators for continuous-current dynamos and motors is not capable of the same treatment as most other parts of machinery which are required in large quantities, and which may be machined in jigs and by specially shaped tools. Each commutator must be "built up" by hand of alternate strips of copper and mica. The whole is then securely fastened together, and the interior carefully machined. This done, the permanent support is fastened on, and the previous temporary fastening taken off, when the exterior may be machined. Once the permanent support is attached, and the temporary one withdrawn, the commutator should never afterwards be taken apart. It will be seen, then, that there are three principal operations in making a commutator—viz, "building up" the strips, boring and shaping the interior, turning the outside. The details of these three operations are as follows:

Building up.—The usual custom amongst the best makers is to obtain the copper strips ready shaped in the form of a wedge, as in Fig. 1. Other makers prefer to buy their strips roughly shaped, as in Fig. 2. There is very little saving, however, in the time required for machining, whereas this form will generally be found to take somewhat longer to build up. Each diameter of commutator requires a stout "clamp," into which the strips have to be placed. For small sizes this clamp is usually made in two halves; for larger sizes it may be in three, or even more segments.

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In any case, the gaps between any two portions of the clamp should be less than the width of a copper strip, otherwise it may be found that no pressure is being exerted on one strip, and that in boring out afterwards this one may not "clean up." This is an important point, as it is necessary that the holding rings shall bear as evenly as

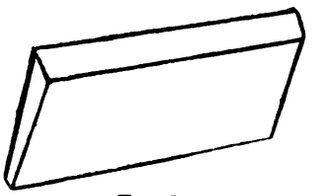

FIG. 1.

possible on each and all of the commutator strips, otherwise sooner or later trouble will arise. Fig. 3 shows the temporary clamping ring with the commutator strips within it.

Boring and Shaping the Interior.—At each end of the interior of the commutator cones must be formed by

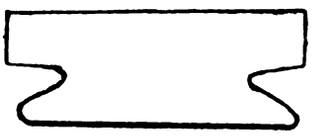

FIG. 2.

which it is ultimately to be held together, so that when finished each strip will have the shape shown in Fig. 2. These cones should all be cut to a standard and uniform shape and size. They cannot be cut at one operation (or one feeding of the tool), as the strips would be strained

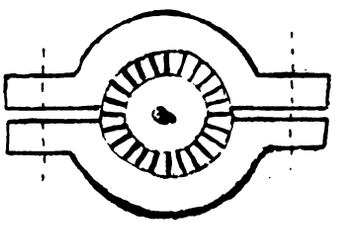

FIG. 3

and jarred loose immediately, so that there is very little room for automatic work or labour-saving appliances. Templates should, of course, be used, which would take the forms illustrated by Figs. 4 and 5. Fig. 4 would be used as a gauge to which to bore one end. That

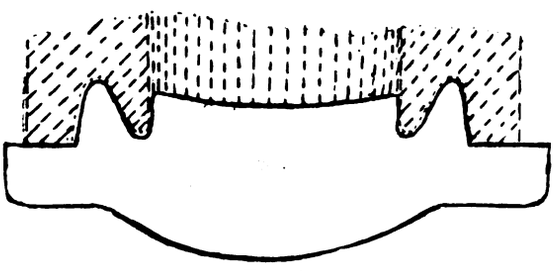

FIG. 4.

finished, and the correct internal diameter carried right through to the back, the gauge shown in Fig. 5 would be used for gauging the cone at the other end. The sliding portion, A, is brought to a mark on the bar for each size of commutator, so that all of one size may fit a

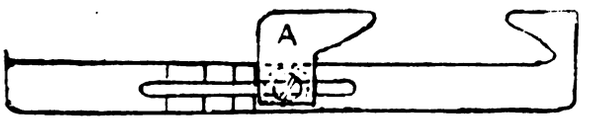

FIG. 5.

standard mounting. Another method which may be adopted for cutting the cone for the second end is as follows: The template shown in Fig. 5 will not be required in this method; instead, that shown in Fig. 4 will be used, but with a "shank" on it which will be long enough to enter for the full length of the parallel part of the bore until it comes against the "pad" shown in Fig. 6. As soon as the first end is finished as described above, the workman takes the commutator out of the machine just as it stands, reverses it, and places it upon a "pad" which is attached to the face-plate of his lathe. That which was the back end is now to the front, and is bored in exactly

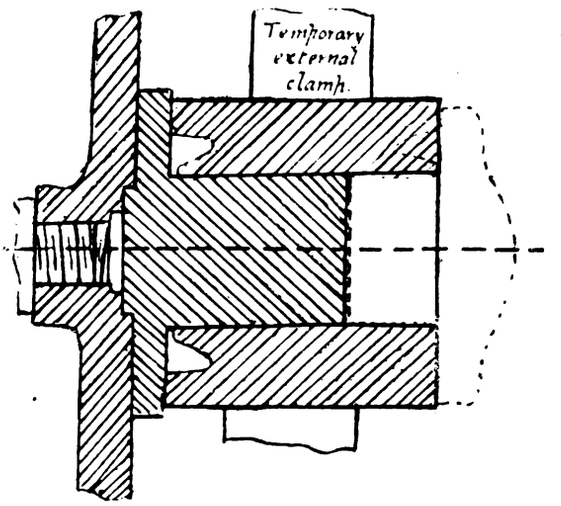

FIG. 6.

the same manner as the first end was. Fig. 6 shows this arrangement on the face-plate of a lathe, and the use of the prolonged "shank" of the template will be understood from the illustration, where it is shown in dotted lines. This second method is the most expeditious, and also tends to the most accurate work. It is given the second place only because the other is more commonly met with. Also, when adopting this method, that portion worked on the pad may be done in a second machine—which may be always ready to receive it—thus saving the time required for taking the pad on and off.

Turning the Outside.—When the interior is finished, the commutator, while still held together by the temporary external clamp, is mounted on its permanent cones. Fig. 7

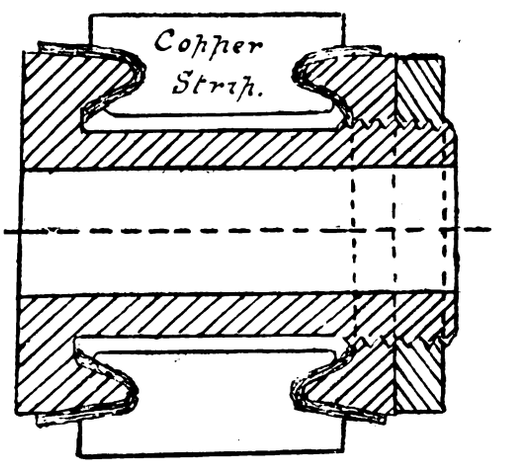

FIG. 7.

shows this clearly; the mounting may be made of any suitable metal. When securely fastened on this mounting the external clamp is taken off, and the outside "cleaned up true" between the centres of a lathe. This last operation may be, and often is, deferred until the commutator is mounted on the shaft, and all its armature connections made and soldered to it. The foregoing is a description of the methods in use in the Westinghouse and Brown-Boveri shops. It must be understood, of course, that at every stage careful tests for insulation must be made, as if this is not done it may sometimes be found that when completed a bad short-circuit has developed, in which case all the labour expended has been lost.

No special tools or machines are required except the gauges mentioned. All the work can be done on an ordinary lathe such as is found in any machine shop.—E. M. R.

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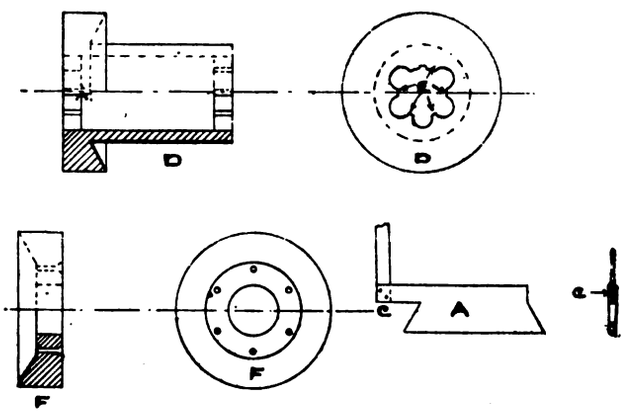
Answer to No. 366 *(awarded* 5*s.).*—Most small commutators are built up and completed ready to slip on to the armature shaft.

To start with the copper segments. These are first cut to the over-all length from copper strip of sufficient width, and thickness rather more than the greatest thickness of the finished segment. They are now taken to a punching machine, and by means of special dies stamped to the shape shown at A. As this operation very often bends them, they are next hammered flat by hand, special men being kept for this purpose. The segments are then clamped in a milling machine vice, which, if of the universal type, is set so as to give the required taper. If the vice is an ordinary one, the segment rests on a steel strip (previously planed) taper. To cut the slot at the end, C, for holding the connecting lugs, the segment is gripped on the sides and a circular saw put in the milling machine. The lugs are riveted and soldered in the slot. The segments, separated by sheet mica, are built up round a mandrel, being held together by pieces of strong wire, which are screwed at the end and pulled up tightly by nuts. The coned ends of the segments are lightly skimmed up in a lathe. This part is now ready. At



D is shown a cast-iron sleeve. Small lugs, E, are cast at the ends to save time in boring out. It will be noticed that one lug is larger than the rest; this one has the key-way cut in it. When a large quantity of the same size is made the machining is done in a hexagon turret lathe, to save frequently changing the turning tools. Where the thick lines are shown in the sectioned half of view D, thin strips of mica are stuck on with shellac varnish. This part of the work is usually done by boys. The end cap, shown at F, is made of cast iron, and also is insulated with mica where the thick line is seen. After the completed segments have been slipped on the sleeve, D, the cap, F, is tightly screwed on with counter-sunk screws. The whole commutator is now heated, as this softens the shellac and allows the cap, F, to be screwed up tighter. It is then turned up in a lathe, and before being tested for insulation it is spun at a rate several times greater than that at which it will eventually run. This is necessary, as the centrifugal force due to the segments sometimes bursts the cap, F. For testing the small-voltage commutators 500 volts are generally used. The commutator is finally ground up after being put on the armature shaft and connected up to the armature.—F. H. PALMER.

Answer to No. 366 (*awarded* 5*s.*).—The most important part in the manufacture of commutators in large quantities is that all the parts should be made to template, then when the number of segments, the depth, and the outside diameter are decided, copper strip of the required shape and size can be obtained from the drawers. These require cutting to the proper length by means of a circular saw, leaving sufficient room to allow of truing-up in the lathe when put together. A good method is to fit the circular saw firmly on a brass chuck in the lathe, and also to make a small saw bench to fit in the whole of the T-rest with an adjustable bracket to form a gauge. The next step is to cut a slot in the end of each segment thus cut off to receive the lug which has to be brazed in. This slot can be easily cut in on a milling machine, but if such is not to hand a cutter may be mounted on a brass chuck in a similar manner, and an ordinary slide rest can be used to hold the copper bars. In the meantime, the lugs should be cut from the copper tape to the required length, and cleaned at one end ready for fitting into the slots made in the end of the segments. No oil should be used in these operations, but soap and water, so as to facilitate the brazing, after which the ends must be filed and the bars straightened, when they will be ready for putting together with the mica insulators, which should be cut to template, and should be as near to the finished size as possible so as not to be cut to waste, and also take the edge of the turning tools. The number of segments which form a commutator should now be put into an easy-fitting ring, in which are fitted set screws equal in number to the commutator segments. The insulation must be fitted in between the copper bars whilst in the ring, when by means of the set screws the segments can be screwed home and held firmly in their place, and in this way passed on to the lathes for the turning and shaping of the ends, which must be done to template, so that the insulating rings can be made in large quantities, also to template. Now, if the mica insulation is made to the proper size so as not to project in the inside, the whole commutator can be forced on to a mandrel and the ends shaped in this position, after which they can be fitted on to the brass sleeves with insulating rings complete and turned true and straight on their diameter. With the exception of the ring with the set screws no special tools will be necessary beyond what will be found in almost any brass-finishing workshop.—K.

LEGAL INTELLIGENCE.

BAKER STREET AND WATERLOO RAILWAY.

In the King's Bench Division of the High Court on Monday last Mr. Justice Bingham gave judgment in the case of May *v.* the London and Globe Finance Corporation. The plaintiff, Mr. Frank Boyd May, a stockbroker, claimed to recover from the London and Globe Finance Corporation £26,600, balance of commission under a commission note dated Dec. 2, 1896, which he alleged to be due to him for introducing to the defendant corporation the Waterloo and Baker-street Railway scheme and its extensions. As the result of a previous action, the plaintiff had been paid £35,000 odd, but he alleged that since that payment the capital of the railway company had been increased by or through the defendant company by £1,330,000, £997,500 being in shares and £332,550 in debentures, the reason for the increase being that powers had been obtained for the extension of the line to Paddington and the Elephant and Castle. It was on that sum that the plaintiff now claimed commission. The defendants' case was that they had fully satisfied and discharged the plaintiff's claim by the payment of the £35,000, and they denied that the increased capital was subscribed by or through them. But even it were, they contended it was outside the commission note, as it was for additional railways and works not included in the original scheme.

Sir R. Reid, K.C., Mr. Rufus Isaacs, K.C., and Mr. Atkin appeared for the plaintiff; while the defendant corporation was represented by Sir E. Clarke, K.C., Mr. Joseph Walton, K.C., and Mr. Bremner.

His **Lordship**, in the course of his judgment, said a great deal of very conflicting evidence had been called to show what was said and done in 1896, when the commission note was given, and what was said in an interview in January, 1897. He did not pretend to say what the truth of those conflicting statements might have been; he thought it probable the desirability of obtaining powers of extension was discussed, and it might be even true, as the plaintiff alleged, that he produced on those occasions a plan on which he had marked in dotted lines the extensions, but he was quite convinced nothing was said or done which could in any way indicate an intention either to claim or pay for the introduction of capital of the then unauthorised line. The scheme mentioned in the commission note consisted of the then authorised line and nothing else, and in his opinion neither the plaintiff nor anyone else connected with the matter imagined otherwise. In his opinion the present claim was without any foundation, and must be dismissed with costs. Judgment accordingly.

WESTMINSTER ELECTRIC SUPPLY CORPORATION.

At the Westminster Police Court on Friday last, Mr. Shell had before him 80 summonses against the Westminster Electric Supply Corporation, Limited, taken out by Messrs. John R. Cleave and Co., owners and occupiers of the Hotel Windsor, Victoria-street, S.W., for wilfully making default in complying with the regulations of the Board of Trade as to the supply of electrical energy. It appeared that under the lighting order of 1889, Messrs. Cleave and Co., as customers of the defendant corporation, were entitled to an electrical supply at a constant pressure of 100 volts, with no variation exceeding 4 per cent. either way. This provision in the order was, however, qualified by a further regulation relied

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upon by defendants, "that no penalties shall be inflicted if default is occasioned by inevitable accident, or is of so unimportant a character as not materially to affect the value of the supply." Under this last clause, the magistrate dismissed several summonses, though Messrs. Cleave had given evidence that their current so fluctuated beyond the limits of allowance that their lamps were either blackened or burnt out by over voltage, or in the other extreme giving but half their proper illumination. Mr. Avory, who appeared for the prosecution, then said he would select a summons for a day in last October when the voltage was over 110 for 40 minutes, and no less than 17 lamps at the hotel were broken and several fuses burnt. Evidence was given bearing out this statement. Mr. Sheil asked questions as to the duration of the current variation, remarking that he should not hold short changes of, say, five or six minutes as offences to be penalised. As to this particular case, Mr. Wallis, for the defence, relied on the words "inevitable accident." Mr. Sheil eventually dismissed this summons also, and suggested the adjournment of the remainder, numbering about 70. This was agreed to.

KILLARNEY ELECTRIC LIGHTING COMPANY.

The case of Callender's Cable and Construction Company, Limited, *v.* Killarney Electric Lighting Company came before the Master of the Rolls in the Chancery Division, Dublin, on Tuesday on the application of the defendants for an order that Mr. Thos. C. Goodman, sub-sheriff of co. Kerry, who was appointed receiver on plaintiffs, should be authorised to collect all sums due to the defendant company, and to pay the wages and other necessary outgoings of the company under the direction of the directors. The defendants it was stated, wanted to do what they could to preserve the property.

The **Master of the Rolls** granted the order asked for, authorising Mr. Goodman to make the necessary payments after conference with the directors.

BRITISH ELECTROZONE CORPORATION.

On the 24th inst., **Mr. Talbot** appeared before Mr. Justice Wright in the High Courts in support of the petition of Messrs. Ede and Allom for the compulsory winding up of the British Electrozone Corporation, Limited. He said there was already a voluntary winding up, but he submitted that the creditors would be prejudiced by its continuance, as the liquidator had not taken efficient steps to get in the assets, which included about £25,000 due on shares issued without any consideration.

His Lordship granted an adjournment for a fortnight, but said that unless further considerations were then suggested to him as against a winding up, he should make the order.

COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION TELEGRAPH.

At the general meeting of the shareholders held at Winchester House, Old Broad-street, on Wednesday, the **Marquis of Tweeddale** stated that the Company, in conjunction with the Great Northern Company, had been enabled to carry out further important work in the North of China during the past six months by constructing land lines between Taku, Tientsin, and Pekin. The "standard revenue" fixed by the Cape-Australian cable agreement for regulating the Australasian tariffs was maintained during the past year, and consequently the tariff was further reduced on Jan. 1 last for telegrams exchanged with South Australia, Western Australia, and Tasmania to 3s. 6d. a word. Since the close of the year the Government of New South Wales had accepted the Cape-Australian agreement, and the reduced rate of 3s. 6d. was therefore applied to telegrams exchanged with that State as from Feb. 1 last. The communication between the Cape and Australia, which the new cable would establish, was expected to be completed and open for traffic before the end of the present year. A contract had been entered into by the Governments interested with the Telegraph Construction and Maintenance Company for the manufacture and laying of the all-British Pacific cable at a cost of nearly £1 800,000, to which had to be added about £200,000 for erecting stations, etc. The cable was not expected to be completed before the end of next year. When it was opened, however, it was not likely that, consisting as it would of a single line of cables, with one unbroken stretch of 3,600 nautical miles, it could effectually compete with the Company's vast network of triplicate and quadruplicate cables. He then formally moved the adoption of the report and accounts.

Mr. J. Denison Pender seconded the motion, which was unanimously adopted.

LONDON ELECTRIC SUPPLY.

The ordinary meeting of the shareholders was held at the Westminster Palace Hotel on Tuesday.

Lord Wantage, V.C., who presided, said that when he addressed them last year they might recollect that owing to the default of the contractors in delivering the additional plant required for the winter of 1899-1900, the existing plant was subjected to such a severe overstrain that it first became inefficient and afterwards broke down. Acting on the consulting engineer's report on the condition of the plant and machinery the station was afterwards shut down for a complete overhaul and to enable the new plant, so long overdue, to be erected. The station was shut down early in April last year, and running was not recommenced until October. During that period they received the whole of their supply from three companies whose mains adjoined this Company's area. They were grateful for this assistance, as it enabled them to retain their customers, but the price charged for the energy so purchased left them no margin of profit. Although it was very disappointing that the directors had had to pass the preference dividend for the year, yet the effect of shutting down the station had been very beneficial. Nearly the whole of the additions and improvements made had been in connection with the steam system, from which cause the troubles which were experienced in the winter of 1899-1900 arose. The only new work mentioned by him last year which was not yet completed was the new well, from which they hoped to obtain the whole of their feed water, which at present cost the Company nearly £2,000 per annum. They recommenced running for part of the supply in October, and for the whole of the supply in December, and up to the present time they had had no trouble of any kind from the plant and machinery. In addition to this the cost per unit, both generated and sold, had been diminished by one half as compared with the corresponding quarter of 1900, and to an appreciable extent when compared with the corresponding quarter of 1899. If the results of the first quarter of the present year were kept up—and he saw no reason why they should not be—he anticipated as the result of this year's working that the payment of preference dividend would be resumed.

Sir William H. Preece seconded the motion, which was ultimately carried unanimously.

ORIENTAL TELEPHONE.

The report of the directors for the year ended Dec. 31, 1900, states that the revenue account shows a balance to credit of £13,456. 4s. 5d. transferred to profit and loss, including £1,507. 16s. 10d. brought forward from 1899, and after deduction of £4,287. 12s. paid as interim dividend on Nov. 1, there remains £10 676. 9s. 3d. for disposal. The directors recommend dealing with this sum as follows: to pay a final dividend of 3½ per cent., free of income tax, making, with the interim dividend of 2½ per cent. already paid, 6 per cent. for the year; to transfer to reserve £2,000, and to carry forward £2,673. 16s. 6d. The electric lighting branch of the Company's business shows an increased surplus over that obtained in 1899, and the current year has opened with a fair amount of business on hand. The dividends declared by the Indian subsidiary companies have, as usual, been included in the revenue accounts, and the amounts have been duly remitted. Both these companies have again paid 6 per cent. for the year, and have carried forward substantial sums for future contingencies. The Telephone Company of Egypt, Limited, has declared a dividend of 7½ per cent. on its preferred shares, against 6 per cent. in former years, and has also transferred a considerable sum to reserve for further developing the business. The China and Japan Telephone Company has paid its debenture interest and makes fair progress, but the accounts for the past year have not yet been presented to the shareholders. A small exchange has been opened at Johore during the year, which is in direct communication with the Company's system in Singapore. The company has also been granted a license by the Government of India to open an exchange at Mandalay. The directors to retire at the present meeting are Sir Auckland Colvin and Mr. H. Johnstone Grewing, who, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and offer themselves for re-election.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The third annual general meeting of the proprietors was held on Friday last at River Plate House, Finsbury-circus.

Mr. J. B. Concanen presided, and, in moving the adoption of the report, said that on Sept. 10 last electric traction over the whole of the lines was inaugurated, and the net results for the three months ended Dec. 31 last showed receipts aggregating £38,320 and expenses equal to about 55 per cent. of that amount. This would give some idea of what the results of electric traction might be. The receipts for the first three months of this year came to £35,980, as compared with £29,030 for the corresponding quarter of the previous year, but they could not expect this ratio of increase to continue throughout the whole of 1901. On the whole, he thought that the shareholders would agree with the directors in considering the result obtained as satisfactory. He believed that they might confidently anticipate, in respect of this year, being able to pay the dividend on the A and B preference shares, and to wipe off a certain portion of the arrears on the latter, now amounting to about £20,000, or 14½ per cent. While not wishing to be too sanguine, he expressed the hope that in three years the whole of the arrears on the B preference shares would be liquidated, and that there would then be a nice surplus available for the ordinary shareholders. The contemplated work in connection with the outer loop to Belgrano and the repayment of temporary loans would necessitate the issue of about £50,000 of the second debenture stock authorised a year or two ago.

Mr. H. Brown, who seconded the motion, regarded the prospects of the Company as very satisfactory.

The report was adopted, and a vote of thanks to the chairman concluded the proceedings.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Dundee.—The Town Council invite tenders for the supply of copper bonds. Tenders by May 1. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the twelve months' supply of electricity meters. Tenders by May 6. Details in our advertisement columns.

Stirling.—The Town Council invite tenders for extensions to steam, drain, feed pipes, and feed heater. Tenders by May 1. Details in our advertisement columns.

Motherwell.—The Electric Light Committee invite tenders for cast-iron lamp columns, arc lamps, switches, fittings, etc. Tenders by May 18. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and erection of two-phase motor-alternators and switch gear. Tenders by May 15. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for electric wiring and fitting of the courts and offices at the Guildhall. Specification, etc., can be obtained at the Guildhall. Tenders by May 3.

Bristol.—The Electrical Committee invite tenders for steam and other piping, low-tension switchboard, 210-kw. continuous-current dynamo. Tenders by May 9. Details in advertisement columns.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the annual supply of stores and materials. Tenders by May 14. Details in our advertisement columns.

Wells.—The City Council are desirous of absolutely disposing of their electric lighting order, 1896, and invite offers for the purchase of the same. Offers by May 1. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of main switchboard and instruments and battery of accumulators and accessories. Tenders by April 29. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for the supply and erection of main switchboards, sub-station switchboards, transformers, arc lamps, and arc lamp pillars. Tenders by June 3. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for poles, bases, refuge pillars, etc., brackets, feeder and section pillars, etc., trolley and other wire, and insulators and line suspensions. Tenders by April 30. Details in our advertisement columns.

Ashton-under-Lyne.—The Electricity Committee invite tenders for two continuous-current generating units, each of 250 h.p. to 300 h.p., with double-acting enclosed engines. Tenders by April 29. Details in our advertisement columns.

Alloa.—The Electric Lighting Committee invite tenders for insulated cables, joint-boxes, etc., public arc lamps, lamp pillars, etc., and sub-station equipment and sundry connections. Tenders by April 30. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for the supply and erection at the electrical power station, Dudhope-crescent-road, of one 700-h.p. triple-expansion steam engine and dynamo. Tenders by May 11. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of permanent-way construction over three miles of tramways. Specification, etc., can be obtained from Mr. Wm. L. Macindoe, town clerk, Kirkcaldy. Tenders by May 13.

Nottingham.—The City Council invite tenders for the construction and erection of a new tramway depôt near the Trent Bridge. Drawings, etc., may be seen by applying to Mr. Arthur Brown, M.I.C.E., city engineer, Guildhall, Nottingham. Tenders by May 6.

Fulham.—The Council invite tenders for the supply of materials and goods required in connection with their electric light and dust destructor station at Townmead road, Fulham, for the period ending March 31, 1902. Tenders by May 15. Details in our advertisement columns.

Turkey.—The following works will shortly be taken in hand: (1) renewal of submarine cables between Galata and Stamboul; (2) new telegraph line between Bassora and Nedsch (in the interior of Arabia); (3) new telegraph line from Lohya to Lith (along the coast of the Red Sea, about 650 miles).

Madrid.—Tenders are invited by the Spanish Post Office for a concession for the establishment and working of a telephone system at Denia. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by May 10.

Madrid.—Tenders are invited by the Spanish Government for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by June 3.

Madrid.—Tenders are invited by the Municipality of Lopera (Jaen) for the concession of the exclusive right of lighting the town by electricity for 10 years. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m., or at the office of this journal. Tenders by April 28.

Poplar.—The Guardians invite tenders for the provision and carrying out of the necessary steam, exhaust, hot and cold water piping, valves, water-meters, etc., at their new works adjoining the union buildings in High-street, Poplar. Tenders by May 1. Details in our advertisement columns.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the supply of 6,250 tons of steel girder tramway rails and 190 tons of steel fishplates, and points, crossings, and filling pieces. Specification, etc., may be obtained from Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S.W. Tenders by May 13.

Middlesbrough.—The Electric Lighting Committee invite tenders for boiler-house plant—one 30ft. by 8ft. 6in. Lancashire boiler and accessories; engine-house plant—one 300-kw. high-speed steam dynamo and accessories, together with steam, exhaust, and feed pipes, etc.; condensing apparatus—ejector condenser, with circulating pumps. Tenders by April 30. Details in our advertisement columns.

Battersea.—The Borough Council invite tenders for the carrying out of work in connection with the supply of water for condensing purposes to their central electric generating station, Lombard-road, adjacent to the River Thames, as follows: electric pumps, pipework, etc., for condensing water; river work, pipes, and pits for condensing water supply. Specifications, etc., may be obtained on application to the Town Clerk, Municipal Buildings, Lavender-hill, S.W. Tenders by April 30.

Portsmouth.—The Corporation invite tenders for supplying and laying telephone conduits and cables, copper wire, iron and steel stay wire, insulated wires, lightning and high-tension guards, arm bolts, nuts, and washers, miscellaneous ironwork, insulators, switchboards, batteries, telephone instruments, fixing subscribers' instruments, creosoted poles, oak arms, erecting poles, arms, stays, insulators, wires, etc., and silicium bronze wire. Tenders by April 30. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (Specification No. 1) water-tube boilers; (No 2) plant of 15,000 i.h.p. in generating and sub stations; Sections A, B, and C) steam-engines, with condensing and auxiliary plant; (D) three-phase generators; (E) motor-transformers. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by May 7.

Plymouth.—The Plymouth, Stonehouse, and Devonport Tramways Company invite tenders for the reconstruction of the existing tramway lines in Plymouth, Stonehouse, and Devonport, and the reduction of the gauge from 4ft. 8½in. to 3ft. 6in., and the bonding of the rails for electric traction. The rails, points, crossings, tie-bars, fishplates, fishbolts, copper bonds, and any granite setts that may be required will be supplied by the tramways company. Particulars can be obtained on application to Mr. John Glen, C.E., engineer, 11, Queen Victoria-street, London, E.C.

Ludlow.—The Corporation invite tenders for the supply and erection of one water-tube boiler to be erected and fitted for connection with a refuse destructor, with electric motor, injector, etc.; one ditto, ditto, for a coal-fired boiler, and furnace connected therewith; two quick-revolution compound two-crank self-lubricating engines, coupled direct to compound-wound dynamos, equal to an output of 35 kw. each, with motor-transformers and accessories; steam, exhaust, and feed pipes; overhead travelling crane (six tons); switchboard and instruments; accumulators; electricity supply mains; and public arc lighting and glow lamps, the latter on existing pillars. Tenders by May 20. Details in our advertisement columns.

Tonbridge (Kent).—The Urban District Council invite tenders for the supply and erection of (Section A) boiler-house plant—two Lancashire boilers and accessories, steam pump, injector, and economiser; (B) engine-house plant—two 50 kw. steam dynamos, motor-transformer, and accessories; (C) condensing apparatus and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) electricity supply mains; (H) public arc lighting; (I) house meters; (K) public incandescent lighting, for the municipal electricity works. The whole bound up in one specification. Specifications, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders by May 30.

Battersea.—The Borough Council are prepared to consider schemes for the wiring of consumers' premises for electric lighting, free of all initial cost to the Council or the consumer. The wiring rules and the general conditions under which the work would have to be carried out can be obtained on application to Mr. W. Marcus Wilkins, town clerk, Lavender-hill, S.W., upon the deposit of £1. 1s., to be returned on the receipt of a bona fide tender. The conditions admit of payment to the contractors for the work carried out by them in one or more of the following ways: (*a*) by one cash payment by the consumer; (*b*) by the easy payment system; (*c*) by a fixed rental per annum; (*d*) by a small extra charge per unit supplied to the consumer, to be collected by the Council and paid by them to the contractors. Tenders by May 14.

RESULTS OF TENDERS.

Stirling.—The Town Council have accepted the tender of W. Arnott and Co., Coatbridge, at £1,280, for supply of two boilers.

Ayr.—The contract for balancers and boosters for the Council's electricity station has been placed with D. Bruce Peebles and Co. at £625.

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Luton.—The Town Council have accepted the following tenders for wiring: Taylor and Co., Rose-grove, Ardwick, Manchester, town hall, £55. 0s. 6d. and £35. 2s. 6d.; D. Firth and Sons, 14, Cannon-street, Manchester, free library £27. 11s., corn exchange £23. 10s. 11d.

Buxton.—The Urban District Council have accepted the following tenders: Electric Construction Company, Limited, 250-kw. dynamo coupled to a Belliss T.C.T. ·4 engine, £2,825; Sunderland Forge and Engineering Company, Limited, two 43-kw. dynamos coupled to a Belliss E.C. ·6 engine, £1,269.

Hackney.—The Lighting Committee recommend the Council to enter into an agreement with the National Electric Wiring Company, Limited, Connaught Mansions, 34, Victoria-street, Westminster, S.W., for the free wiring and fitting of consumers' premises, at a rate of 2s. per lamp per annum installed (for any lamp up to 50 c.p.); agreement to be terminable by six months' notice on either side.

Tonbridge.—With regard to municipal telephones, tenders have been received for the local "house" services as follows: S. E. Haward and Co., £14. 10s.; National Telephone Company, £12. 10s.; Corporation of Tunbridge Wells, £11. 5s. 6d., as compared with the present sum of £15. 7s. paid to Mr. E. Powell. The tenders received for the main line service, for which a sum of £27. 7s. is now paid, are as follows: Municipal main line service, the Corporation also supplying the local service, £21. 14s.; Municipal main line, with local service supplied by the National Telephone Company, £22. 8s. 6d.; National Telephone Company's system, with local service supplied by municipal authorities. £24. 5s.; municipal main line, with local service supplied by Haward and Co., £24. 8s. 6d.; National Telephone Company's main line, with local service combined, £25; municipal system, with Mr. E. Powell's present system, £25. 5s. 6d.; National Telephone Company's main line system, with local service supplied by Haward and Co., £27; present system, being National Telephone Company's main line connection and local service, supplied by Mr. E. Powell, £27. 17s.; present system, with the addition of the Tunbridge Wells municipal main line service, £37. 15s. 6d.

BUSINESS NOTES.

TRACTION.

Cork.—The extended electric tramway to Blackrock is now open to the public.

Brighton.—The amended plans of the proposed tramway offices will entail an expenditure of £10,228.

Pontypridd.—News has been received that the District Council tramways scheme has been sanctioned.

Leeds.—The Meanwood and Elland-road sections of the city tramways are now run by electric traction.

Hull.—The salary of Mr. McCombe, the manager of the tramways, is to be increased by £50 per annum.

Steyning.—The West Rural District Council have passed a resolution in favour of acquiring at a reasonable rate the rights of the tramways within their district.

Blackpool.—The Blackpool Corporation are hurrying forward with the completion of the new tramway round Marton, and May 20 is the date named for the cars to run.

Haslingden.—No further steps have yet been taken with reference to the acquirement of the tramways. A joint arrangement with the corporations of Accrington and Rawtenstall is talked of, however.

Hereford.—The County Council have adopted resolutions in favour of the registration of motorcars and of limiting the speed to 12 miles an hour. A memorial of protest from the Automobile Club was referred to the Roads Committee.

Birkenhead.—In a letter to the *Birkenhead Advertiser* Mr. G. C. Bell urges the necessity for an extension of the electrical tram service within the borough, with the object of making Charing Cross one of the chief centres of the system.

Glasgow.—The generating station at Pinkston was opened on Wednesday, the conversion of the tramway system from horse haulage to electric traction being almost completed. Electric cars are now running on some of the principal routes.

Belgium.—The Belgian Government has appointed a commission of expert engineers to proceed to this country to investigate the uses of electricity as a motive power for railways. The commission will make a stay of some three weeks in England.

Whitworth.—At the last meeting of the District Council a letter was read from the Whitworth Ratepayers' Association protesting against the proposal of the Council to take up the existing tramlines. A meeting is to be convened to consider the matter.

Newcastle.—The proposal that the Corporation trams when ready should be run from Scotswood-road up Benwell-bank to Fenham is again the subject of discussion, the idea being that such a route would form an important section of a circular service.

Edinburgh.—The Town Council have decided that a notice be served upon the National Electric Traction Company requiring them to transfer to the Corporation the powers granted by the Portobello and Musselburgh order for the construction of the tramways.

Private Bills.—In the House of Lords on Tuesday the West and South London Junction Railway and the City and North-East Suburban Electric Railway Bills were read a second time. In the Commons on Monday the Bury Corporation Tramways Bill was read a third time.

Wembley.—The District Council have consented to the application of the Middlesex County Council for permission to extend their light railway within the Council's district, along the Harrow-road, as far as their generating station, upon the stone bridge and the roadway being widened.

London Underground Railways.—On Tuesday a select committee of five members of the House of Commons was nominated to join with the Committee of the Lords on London Underground Railways, as follows: Sir W. Arrol, Mr. Ashton, Mr. Cawley, Sir M. Foster, and Sir J. Dickson-Poynder.

Merthyr Tydfil.—At a meeting of the Lighting Committee of the Urban District Council on Tuesday extracts from a report submitted by Messrs. Hancock and Dyke upon the system of energy adopted by the Merthyr Electric Light and Traction Company were ordered to be sent to the Board of Trade.

East Molesey.—The District Council have received an amended plan of the proposed tramway route through the district from the London United Tramways Company. It is stated that single has now been substituted for double lines over certain portions of the route, thus giving 9ft. 6in. between rail and kerb.

New Issue.—The Merthyr Electric Traction and Lighting Company, which has a share capital of £100,000, divided into 10,000 5 per cent. cumulative preference shares of £5 each and 10,000 ordinary shares of £5 each, announces an issue at par of 6,000 5 per cent. cumulative preference shares of £5 each.

Batley.—Major Druitt, Local Government Board inspector, has heard the Corporation's application for sanction to borrow £52,451, the estimated cost of laying and equipping seven miles of electrical tramways in the borough. The Inspector said he had no doubt electric trams would pay in Batley. There was no opposition.

Bournemouth.—A deputation from the Corporation of Bournemouth, which is about to spend £250,000 in providing tramways within the borough and in the new districts to be added next November, has visited Sheffield with the special object of discovering and reporting on the most suitable road material. The deputation has also paid visits of inspection to London, Liverpool, Southport, and Manchester.

Finchley.—A meeting of ratepayers has passed a resolution in favour of the Urban District Council applying to Parliament for additional provision to be inserted in the Finchley and Hendon Tramways Bill to enable the Council to themselves construct so much of the tramways as are situate in the urban district and to borrow the necessary money.

London United Tramways Bill.—This Bill came before the Examiner of Standing Orders on Friday last. It is understood that the net result is that out of about 45 miles of line as originally scheduled in the Bill the Company will proceed with a little over 33 miles, in regard to 30 miles of which they have already the consents of the local authorities.

Shildon.—The scheme of the United Kingdom Tramway Company for the laying down of some 20 miles of electric tramways, at an estimated cost of between £100,000 and £150,000, in the Shildon and Bishop Auckland district of Durham, is to be the subject of consideration at a conference of the local authorities concerned within the next few days.

Dublin.—The Great Northern Railway Company's electric tramway from Sutton round the Hill of Howth is rapidly approaching completion, and it will probably be open for traffic towards the end of May. The portion of the system from Sutton to the summit of the Hill is already complete, and the Board of Trade inspection of this section of the line is expected to take place during the next few weeks.

Wolverhampton.—Every effort is being made to push forward the work of tramway extension in the borough, the Tramways Committee being exceedingly anxious to have the line in thorough working order in time for the opening of the art and industrial exhibition next year. No decision, it is said, has yet been come to in regard to whether the overhead trolley or the conduit system will be adopted, but the matter is occupying the attention of the committee.

Dundee.—At the last meeting of the Works Committee it was stated that as the result of a conference between the convener of the Tramways Committee and the district manager of the Telephone Company, the latter would recommend the company to place underground all overhead open wires which crossed existing or projected tramway routes, with the exception of a few open wires in the outskirts of the burgh, which he would recommend should be replaced by covered wires.

Leamington.—A special meeting of the Town Council was held last week for the purpose of affixing the seal of the Council to the agreement between them and the British Electric Traction Company. The Board of Trade have struck out the "overhead" clause, but the Mayor explained that they had only left the matter open to them for further consideration and there was no reason why they should not adopt the overhead system just the same. The motion was then put, and carried unanimously.

Hastings.—At the meeting of the Town Council on Friday the Tramways Consultative Committee made a long report on the Hastings tramways and Bexhill and St. Leonards light railway schemes, in which mention was made of various points, including an agreement into which the promoters were prepared to enter in order to meet certain demands of the Council not provided for in the Tramways Bill. The Council's seal was affixed to the agreement. The report was eventually adopted by 18 votes to 14.

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Personal.—The salary of Mr. Chas. Revill Bellamy, general manager of the Liverpool Corporation tramways, has been increased by £200 per annum, while Mr. P. M'Cullough, assistant manager, has been appointed to take up the duties of electrical equipment engineer, with an increase of £50 per annum. The salary of Mr. C. W. Mallins, traffic superintendent, has also been augmented by £50 per annum.

"Tube" Vibration.—No more witnesses are to be called before the Board of Trade Departmental Committee on Vibration in connection with the Central London Railway. In view of the investigations to be carried on before the Joint Committee of Parliament respecting the Bills promoted for the construction of other underground electric lines, the committee intend to proceed with the preparation of their report as quickly as possible, and a meeting will shortly be held, at which such report will be put into form.

Pontefract.—The granting by the Board of Trade of the West Riding Tramways Provisional Order, 1901, brings an important project within the range of practicability. A circular route will be traversed, the tramways going through the districts of Pontefract, Castleford, Whitwood, Normanton, and Featherstone. There are 20 different sections, representing a total length of 12½ miles, and the estimated cost is £130,000. An extension of seven or eight miles is contemplated next year. It now only remains for a confirmation Bill to pass through Parliament.

Clifton.—The Earl of Jersey and Colonel Boughey have heard, on behalf of the Light Railway Commissioners, an application promoted by the Barton-on-Irwell District Council for an order to construct a light railway or electric tramway in the township of Clifton. The estimated cost of the scheme is £11 433, plus an expenditure of £6,466 for electrical and overhead equipment, and exclusive of rolling-stock and generating station. The principal object of the scheme, which was practically unopposed, is to secure a through service from Bolton, where electric traction is at work, and Salford, where a similar system will shortly be completed, including running powers to Pendlebury.

West and South London Railway Bill.—This Bill came before the Standing Orders Committee of the House of Commons on Tuesday. The Bill seeks to authorise the construction of an electrical underground railway, extending from a connection with the Great Western Railway at Paddington to near Kennington Park. The promoters, whose measure had been reported for non compliance, were now prepared to undertake to insert the usual clause for the protection of cellars under streets not referenced; and, in addition, a clause protecting the sub-soil under such cellars or vaults. It was decided to dispense with the Standing Orders on the conditions agreed to by the promoters.

Bath.—The City Council have sealed a supplemental agreement with the promoters of the electric tramway, covering points agreed to between the authority and the promoters, but not embodied in the order which the Light Railway Commissioners are about to issue. It appears that the Commissioners declined to ratify the agreement that the promoters should pay wayleave to the amount of £500 per annum, ordering, instead, that the promoters should make a capital payment to the authority of £5,000, the whole of which shall be spent in street improvements on the line of route. The authority and the promoters, however, agreed that the amount should be fixed by an actuary.

Baltimore.—The British Consul at Baltimore states in his last report that the Baltimore and Ohio Railway Company have lately entered into negotiations for the erection of a large electric storage battery for the traction of trains through the tunnel at Baltimore. The building in which the battery is to be placed will be 145ft. long and about 45ft. wide. The tanks are to be of hard wood and will number 320. Each will contain 10 negative and 20 positive plates, and when the battery is in operation it will have a capacity of 1 200 h.p. It is said that when the third-rail system is in operation the company will have one of the most modern systems of electrical traction in the world.

Huddersfield.—At the last meeting of the Town Council the Tramways Committee reported a deficiency for the year ended March 31 of £13,600. 4s. 8d., including £3,500 for depreciation. They recommended that no appropriation be made this year for depreciation; that £5,000 be taken from the depreciation fund; and that the remainder of the deficiency—£5,100. 4s. 8d.—be carried to an open account. The Town Council also adopted the recommendation of the committee that the Board of Trade be requested to sanction the borrowing of £60,000 for not exceeding 30 years. A fresh poll of the ratepayers is to be taken on the question of the running of Sunday trams on the electrical sections of the system.

Liverpool.—The tramways traffic returns for the fortnight ending April 13 show that 3 761,555 passengers have been carried by the electric trams, as compared with 1 502,648 in the corresponding fortnight of last year. There were 286 electric cars running during the fortnight ending on the date named and seven horse vehicles, which had carried 30 684 passengers. Total receipts for the fortnight amounted to £17.753. 14s. 8½d., only £159. 17s. 8d. of this being receipts from horse vehicles. The income for the corresponding period of last year was £14,744. 5s. 1d., nearly half of which was revenue from horse vehicles. Next week, it is hoped, the belt line running along Shield-road, which will relieve the Old Swan penny stage distance, will be opened to the public; and a fortnight after that the Tunnel-road belt route will provide a similar additional facility for Smithdown-road and Wavertree-road routes.

Halifax.—The Tramways Committee at their last meeting had before them reports of the borough engineer (Mr. Lord) and of the electrical engineer (Mr. Street) with regard to the cost of working the tramways. In these reports the committee are recommended to set apart a sum over and above the amount hitherto allowed of £425 per fortnight for depreciation. Hitherto the committee have estimated that the cars, motors, and track had a life of 20 years. The engineers advise that the rails and cars will require renewal every 10 years and the motors every seven years. The consideration of the matter was deferred to a future meeting of the committee. The extensions to Luddendenfoot, Shelf, and Queensbury are now completed, and the official inspection on behalf of the Board of Trade was announced to take place yesterday, and it was hoped the inspector would sanction the running of the electric cars that day.

Bolton-Darwen Scheme.—An enquiry, conducted on behalf of the Light Railway Commissioners by the Earl of Jersey and Colonel Boughey, has been held into the application of the Lancashire Light Railways Company for powers to construct a line 6¼ miles long in six different sections, and known as the Bolton, Turton, and Darwen electric tramway or light railway scheme. The general effect of the scheme is to connect the existing systems of Darwen and Bolton. An interesting point in connection with the overhead trolley system of electric traction was the request for the insertion of a new clause in the agreement with the National Telephone Company. In effect, it was asked that owing to possible accidents from the contact of the telephone wires and the live trolley wire, a guarantee of indemnity for such accidents should be given to the promoting company by the National Telephone Company. This was strongly opposed. The Commissioners intimated their intention to advise the Board of Trade to grant the order asked for.

LIGHTING AND GENERAL.

Goole.—The electric lighting order has been granted by the Board of Trade.

Boston.—The cost of lighting the town by electricity is now estimated at £30,000.

Llandilo.—The Urban District Council have sealed a loan of £4,000 for electric lighting purposes.

Tickhill.—The Urban Council have passed a resolution in favour of the Yorkshire Electric Powers Bill.

Newton Abbot.—We understand that a site has been approved for the proposed electric lighting station.

Grimsby.—New electric light consumers are coming in rapidly, and 440 yards of cable are to be purchased.

Runalet.—The Rural District Council have decided to support the Yorkshire Electric Power Company's Bill.

Liverpool.—The salary of Mr. Arthur Bromley Holmes, city electrical engineer, has been raised by £200 per annum.

Mirfield.—The whole of the Council has been appointed as the Gas, Highway, Sewerage, and Electric Lighting Committee.

Wakefield.—Consideration of the South Yorkshire Electric Power Company's Bill has been referred to a sub-committee.

Keighley.—The Rural District Council have decided to petition in favour of the Yorkshire Electric Power Company's Bill.

Southwell.—The Parish Council have signed petitions in favour of the Derbyshire and Nottinghamshire Electric Power Company's Bill.

Hackney.—The General Purposes Committee recommend that the salary of the borough engineer be increased by £50 per annum.

Hoylake.—The electric lighting works to be carried out in the urban district of Hoylake and West Kirby are now estimated to cost £12,000.

Thornhill.—The Yorkshire Electric Power and the South Yorkshire Electric Power Bills are being discussed by the District Council in committee.

South American Cables.—The rates for telegrams to the Argentine Republic, Bolivia, Chili, Ecuador, Paraguay, Peru, and Uruguay have been reduced.

Alloa.—The Electrical Committee have been empowered to ask Mr. Yuill, the gas manager, to act along with them in carrying out the electric light installation.

Rotherham.—Mr. John Williams, Halifax, has been appointed assistant electrical engineer, and Mr. J. R. Lilliker, of Sheffield, mains foreman to the Corporation.

Castleford.—The Urban District Council have appointed Councillors Beevers, Masterman, and Cheesbrough as the Electric Lighting Committee, with Council's powers.

Limerick.—The Shannon Bill is still being discussed by the Council, the main difficulty being the price to be charged for current, as to which the company still hold out.

Wellingborough.—The order authorising the Urban District Council to supply electricity for the lighting of any street, public building, or place within their area, has passed the Examiners of the House of Commons.

Stoke Newington.—The Board of Trade have informed the Council that they do not propose to proceed with the application of the North Metropolitan Electrical Power Distribution Company for the provisional order.

Todmorden.—At a meeting of ratepayers on Monday resolutions were passed granting the Town Council power to oppose the Yorkshire and South Yorkshire Companies' proposal to introduce an Electricity Bill for Todmorden.

Hull.—The Works Committee have accepted the offer of the Electric Lighting Committee to erect 12 electric arc lamps in the

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new street from Whitefriargate Bridge to Prospect-street. The cost per lamp will be £22 per annum.

Driffield.—At a meeting held on Monday to consider the practicability of establishing telephonic communication between Driffield and Hull, and there with a trunk system, the requisite 10 guarantors of £10 each for seven years were obtained.

Fulham.—At the meeting on April 17 the Resident Engineer reported that since the last meeting applications equivalent to 288 8-c.p. lamps had been received, making the total applications received 181 in number, equivalent to 12,630 8 c.p. lamps.

Cleveland and Durham County Electric Power Bill.—Consideration of this Bill was begun by a committee of the House of Commons, consisting of Sir Wm. Houldsworth (chairman), Mr. Crombie, Mr. Gerald Loder, and Mr. Russell, on Wednesday.

Share Market.—During the week there was hardly anything dealt with in electric shares beyond Charing Cross debentures. There were, however, some deals in Metropolitan, British Electric Traction ordinary, Belgrano trams, and London Electric preference.

London Gazette.—A receiving order has been made out *re* J. Brown, 278, High-street, West Sunderland, on debtor's petition.—An adjudication order has been made out in the estate of G. J. Lloyd (trading as G. J. Lloyd and Co.), 109, Chesterfield-road, Bristol.

Aberdeen.—The electric light is to be introduced into the grammar school at a cost of £225, exclusive of cables, etc. The annual expenditure is calculated at £68. It is also proposed to supply electricity to the new post-office buildings in Crown-street for light and power purposes.

Balderton.—The Parish Council have signed a petition in favour of the Derbyshire and Notts Electric Power Company's Bill, under which the company propose to supply electricity for Notts and a part of Derbyshire, excepting the High Peak Division and that south of the River Trent.

St. James's and Pall Mall Electric Light Co.—The amount of electricity sold by the Company for the quarter ended Lady Day, 1901, is returned at 1,778,340 units, estimated to produce £31,121, as against 1,599,768 units, which produced £28,062, for the corresponding period of last year.

River Tyne Commission.—The River Tyne Commissioners have acceded to an application from the Postmaster-General for permission to lay a submarine telegraph cable on or across the bed or foreshore of that portion of the Tyne known as The Narrows, the total distance to be traversed being 1,150ft.

Bedford.—We understand that the Corporation intend to proceed with the proposed telephone license. An expert has been engaged who will shortly report upon the scheme. The Urban Sanitary Authority have decided to obtain one dozen five-ampere meters at the price of £3. 15s. each.

Bromley.—The Beckenham Council have declined to agree to a proposal made by the Bromley Urban Council for taking steps to secure a municipal telephone service, on the ground that there would be no connection with the National Telephone service and that proposed to be instituted by the Post Office.

Beverley.—At the last meeting of the Town Council the Town Clerk stated that since the Electric Light Committee sat he had received the Act forming the electric light order. Only one clause had been deleted, which the Local Government Board considered was covered by the Electric Lighting Act of 1882.

Brighton.—The Corporation have resolved to establish a municipal telephone exchange, and to seek the sanction of the Local Government Board to borrow £45,000 for the carrying out of the undertaking. The system will embrace a service to Shoreham, Hurstpierpoint, Rottingdean, and other outlying districts.

Clay Cross.—A deputation, composed of Prof. Lupton, Mr. Swanwick, of the firm of Davis, Saunders, etc., and Mr. Branham, architect, Clay Cross, waited upon the Urban District Council last week to obtain their support for the electric power scheme. The Council decided to hold a special meeting to consider the matter.

West Bowling.—Some time ago a petition was presented to the postal authorities asking them to open a telegraph office in Bowling Old-lane for West Bowling. The Postmaster-General, in his reply, says he has to regret that the circumstances of the case are not such as to justify him in opening a telegraph office at the place suggested.

Hammersmith.—Since the last meeting of the Council eight additional consumers have been connected, representing a maximum of 945 8-c.p. lamps; these added to the number previously reported show a total of 855 consumers taking current from the mains. The tender of Messrs. Boult Bros. for supplying lubricating oils is recommended for acceptance.

Edinburgh.—It is stated the ash plant to be provided at Dewar-place station at a cost of £600 will, in the opinion of the chief engineer, save the labour of two men—equal to £120 a year. The Corporation have decided to join the Municipal Electrical Association, and be represented at the annual conference in Glasgow in June by Messrs. Mackenzie and Dobie and the resident engineer.

Crewe.—With regard to the great extensions which for several years past have been in progress at the London and North-Western Railway Company's station, and which are now rapidly approaching completion, we learn that it is intended to light the works and sidings, as well as the station platforms, by electricity. To this end what is said to be one of the finest electric lighting stations in the country has been fitted up.

Paddington.—The Borough Council, in granting an application of the Notting Hill Electric Supply Company to lay mains for electric supply in parts of Dawson-place and Chepstow-place, which formerly formed part of Kensington parish, added to their approval "subject to all the rights of the borough, 'including the powers of future purchase,' being reserved and protected to the satisfaction of the Council's solicitor."

Hampstead.—The Council have approved of the provisions of the Electric Lighting (London) Bill, making the areas of supply coterminous with the new borough boundaries. Distributing mains for the supply of electric current to private consumers are to be laid in Cecilia-road (Kidderpore-avenue to Ferncroft-avenue), Elsworthy-road (remainder to Merton-road), Sandwell-crescent, and a portion of Westbere-road.

Poole.—The Town Council have resolved to apply to the Board of Trade to revoke the Poole and Branksome Electric Lighting Order, 1897, in consequence of the default of the promoters in laying down mains within the time stipulated by the order, and a sub-committee is about to consider the advisability of applying to the Board of Trade for the granting of a provisional order enabling the Council to supply electricity within the borough.

Private Bills.—Several provisional orders made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, came on on Monday before the Examiners of the House of Commons for proof of compliance with the Standing Orders. This having been given, the orders were reported for second reading. They included Abertillery, Briton Ferry, Ebbw Vale, Llandaff and Dinas Powis Llangollen, Neath, and Tredegar, Ripon, and the Electric Lighting (London) Bill. The City and North-East Suburban Electric Railway Bill was read a second time in the House of Commons on the 22nd inst.

Stock Exchange.—The Stock Exchange Committee have appointed May 2 special settling day for Cape Electric Tramways, Limited, further issue of 40,000 shares of £1 each fully paid, Nos 400,001 to 440 000; and have ordered the undermentioned securities to be quoted in the official list: Willans and Robinson, Limited, further issue of 10,000 ordinary shares of £5 each fully paid, Nos. 80 001 to 90 000; Bournemouth and Poole Electricity Supply Company, Limited, further issue of 1,500 ordinary shares of £10 each fully paid. Nos. 6,001 to 7,500, and 1,500 cumulative preference shares of £1 each fully paid, Nos. 13 501 to 15,000; Castner-Kellner Alkali Company, Limited, further issue of £100 000 4½ per cent. first mortgage debenture stock. Applications have been made to the committee to appoint a special settling day in, and to grant a quotation to, Charing Cross and Strand Electricity Supply Corporation, Limited, provisional certificates for £250,000 4 per cent. debenture stock.

Dublin.—The Lighting Committee on Tuesday received from the Local Government Board a letter announcing that they had decided to remit the surcharges of £2,085 made against members of the committee last year by the auditor, on account of the expenditure in rewiring customers' premises; the Board considering that the auditor's action was lawful, but that as the Corporation believed they had legal power to incur the expenditure, it was fair and equitable that the surcharges should be remitted. The sub committee appointed to carry out the necessary arrangements in connection with the loan of £254,000, commented upon at p. 610 of this issue, submitted a report on their interviews and correspondence with the Local Government Board regarding an extension of the period of repayment; and also a letter from the Board of Works asking for further particulars of valuation, etc., and a letter from the Local Government Board regarding the works now in progress. The report was considered in every way satisfactory. Messrs. Stewart, of Belfast, will commence work at the Pigeon House buildings next week. Mr. John Simons was appointed clerk of works. A report from Messrs. Harty, Hammond, and Rudder fixing sites for 19 sub-stations was approved.

Arbitrary Arbitration.—Bumbledom does do strange things sometimes. On Tuesday a number of summonses were heard at Cardiff against a tobacconist, who during the hearing was described "as one of their biggest customers," and this is how he was treated: It was suggested that in December last, the defendant, not having paid his account, was cut off from the supply, and that shortly after the inspector passed defendant's premises and noticed that the light was again on. The collector and the inspector thereupon entered the shop, and the manageress gave them a cheque for the amount due. They saw the defendant, and told him that he must have broken the Corporation's seal, and he replied that he put the fuse in. In defence it was stated that the notices calling on defendant to pay the account had never reached his hands. On the day when the meter was disconnected the inspector was informed that if he waited a few minutes the defendant would be there, but the official would not wait. When the defendant arrived there was no gas laid on, and he, therefore, took the course of going into the cellar and putting in the fuse. The Stipendiary commented on the fact that the prosecution were not in a position to give evidence from which it could be inferred that the accused person did what he had done with a felonious intention, and it was, therefore, useless to proceed any further with a charge of fraudulent use. The summons was consequently dismissed. There one should think the matter ought to have rested, but, nevertheless, the summons charging defendant with having made an unlawful and improper use of the electricity was then proceeded with, and the Stipendiary said there were no grounds for the graver charge, but in disconnecting the meter the officials were acting within their legal rights, and he fined the defendant 20s. and costs (6s. 6d.). Further comment is useless.

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Northfleet.—The District Council have asked Messrs. Preece and Cardew for terms upon which they would undertake to advise in matters electric. They have also decided to approach the committee of the Gravesend Town Council to ascertain whether, in view of the fact that they were advised that a united district for matters electric was unknown to the law except when constituted by special Act of Parliament, they would entertain a scheme whereby Northfleet could take from Gravesend a supply of electricity at a price based on profit and loss for a limited term of years.

Fakenham.—The poll which was taken last week on the question as to whether the scheme for lighting the town by electricity should be adopted, resulted in a negative. The gas company issued a circular to the ratepayers a few days before the poll, offering the Parish Council a supply of gas for the present lamps during the same number of hours as heretofore, and to fit the same with Sugg's 5ft. burners, for the sum of £178; and to enter into a contract with the Council, if so desired, for three years. Many of the cottage occupiers abstained from voting. Out of 600 voters, 110 were in favour of the scheme and 165 against.

New Issue.—An issue has just been made of the British Insulated Wire Company's £250,000 4½ per cent. first mortgage debenture stock. The company's business has largely extended since its formation in 1897, and owing to the impossibility of further increasing the output from the present works the company has been obliged to refuse orders. Additional buildings and plant and more working capital is required. The net profits for the last three years are certified to have been £38,177, £57 063, and £88,219 respectively, an average of £61.153 per annum. The debenture stock will be redeemable at £105 on Jan. 1, 1925, and be secured on the company's leasehold and freehold property, and a floating charge on the undertaking and other assets.

Carnarvon.—At a recent special meeting of the Town Council it was reported that the Board of Trade had refused the electric lighting order for the town applied for by Mr. Peterson. A letter was also read from Messrs. Bennett and Ward-Thomas, engineers Manchester, asking the consideration of the Council to their scheme for introducing electric lighting works. The Town Clerk reminded the Council of the resolution already adopted by which the Corporation promised to undertake such a scheme themselves, and this resolution, he contended, had carried weight with the Board of Trade when they recently refused to grant a provisional order to a syndicate. After discussion, it was resolved to refer the whole question to the Electric Lighting Committee.

Swansea.—With the consent of the theatre company a distributing centre is to be fixed in the basement of the Empire Theatre, subject to payment by the Corporation of a nominal acknowledgment and to the removal thereof upon six months' notice. A main is to be laid from a transformer chamber (proposed to be fixed in a position hereafter decided near St. James's Church) across the Villier's Dry Dock and the river, and thence into Port Tennant-road. A sub-committee, consisting of the chairman, the vice chairman, Alderman D. Harris, and Councillor D. Davies, has been appointed to confer with the harbour authorities relative to the lighting of the harbour estate, with power to call in the assistance of expert advice as to the present actual cost to the trustees of current for lighting purposes.

Arbroath.—At the last meeting of the Gas Corporation considerable discussion took place with regard to the electric lighting question. It will be remembered that the Corporation, acting under a special order, agreed to undertake the electric lighting of the burgh in preference to handing it over to a company. Following upon this, the Corporation applied for borrowing powers to the extent of £40,000. Thereupon a public meeting was held, and a resolution was carried demanding a *plébiscite* on the question as to whether the Corporation should proceed with the work or allow a company to come in. It was resolved that, while the Corporation adhere to their former position in regard to introducing the electric light into the burgh, in consideration of special circumstances they should delay the whole matter for further consideration.

Burgess Hill.—The Examiners have passed the provisional order by which the Urban District Council are asking for powers to light the town by electricity, and for that purpose to break up the following streets not repairable by them: Fernvale-road, from Keymer-road to Glendale-road; Oakwood-road, from Junction-road to the east side of Summer Lynn; Inholmes Park-road, from Junction-road to the east side of Avonhurst-road; from Park-road northwards to the entrance gates to Wyberlye, and thence eastwards to the west side of Leicester Villa, and the Lewes branch of the London, Brighton, and South Coast Railway, at the level crossing over Junction-road; also to lay within two years from the passing of the Act good and sufficient distributing mains for the general supply of the town in Church-road, from the railway station to St. John's-road; in Keymer-road from the railway station to Ferndale-road; and in Junction-road from Keymer-road to Oakwood-road.

South-Western Polytechnic, Chelsea.—Sir William H. Preece attended the annual conversazione on Saturday evening, and distributed the prizes and certificates gained by the students of the evening classes and the day colleges for men and women, and then formally opened some new buildings which have been added recently. During the evening lectures were delivered by several of the teachers, a concert was given by the polytechnic orchestra, and there were exhibitions in the various laboratories, demonstrations being given by the students themselves. Mr. Frank J. Addyman's X-ray demonstrations drew crowded houses, as did Mr. W. H. Eccles's lecture on "Wireless Telegraphy," and Prof. Pullen's on "Great Achievements of Engineering." Perhaps the most interesting, and, as far as public lectures go, both unusual, pretty subject was that chosen by Prof. Schwartz on the "Formation of Crystals in Ether, etc.," for which he was rewarded with most appreciative audiences, amongst which we noted several members of the Royal Institution. The productions of electric cookery found a very ready sale.

Stepney.—The County of London and Brush Provincial Electric Lighting Company in 1897 obtained a provisional order to supply electricity within the areas of the late Limehouse District Board of Works and the vestries of Mile End Old Town and St. George's-in-the-East. Having, however, failed to carry out the works in the stipulated time, the late authorities obtained provisional orders enabling them to supply electricity within their districts. The Acts provided that if within six months the Brush Company served upon the local authorities or their successors notice in writing setting forth the amount which they claimed as representing (*a*) the cost of obtaining their provisional order, and (*b*) the cost incurred by the company with the object of affording a supply of electricity, such claim should be met by the authorities in equal parts. The company have now served upon the Stepney Borough Council a claim for the sum of £1,248 incurred under heading "*a*," and £20,746 incurred under heading "*b*." Under the provisions of the order, it is probable the Council will apply to the Board of Trade to appoint an arbitrator to determine the amount the company are entitled to receive.

Burton-on-Trent.—Colonel Coke has held an enquiry into the Council's application for sanction to a loan of £5,000 for electric light extension works. Mr. Whitehead, town clerk, said the electric light works were commenced in 1893 and the supply was first given to the consumers on Feb. 26 1894. Mains had been laid in the streets extending over 7,000 yards. In the first year there were 53 consumers and the loss provided out of the rates was £1,802. 9s. 3d. This had gradually decreased, until in 1900 there were 173 consumers, and the loss was but £5. 9s. 6d. It had been decided by the Corporation to fix a new machine in the space of one at present occupied by one of the small sets, by which the generating power will be of more than double its present capacity, without necessitating any addition or extension to the present building. None of the original small sets of machinery can capably deal with the load, except in the daytime and on Sunday. The Corporation originally charged the consumers an all-round price of 6d. per unit for lighting purposes; in 1898 the charge was altered to that of the Brighton system—viz., 6d. per unit for the first 1½ hours' maximum demand and 3d. per unit afterwards. By that alteration the average price per unit for lighting had been reduced to a fraction over 5d. per unit. Mr. F. L. Ramsden, the electrical engineer, also gave evidence.

Camberwell.—The last report of the Works and General Purposes Committee refers to an application from Messrs. Kincaid, Waller, and Manville, on behalf of the South London Electric Supply Corporation, for consent to lay mains across the district of Camberwell, through the undermentioned streets, for the purpose of supplying electricity to Lewisham: from Denmark-hill, through Champion-hill, Champion-hill-terrace, Dog Kennel-hill, Grovevale, Lordship-lane, North Cross-road, Upland-road, and Forest-hill to Honor Oak Station. The following report from the town clerk is quoted: "Gentlemen,—With reference to the application of the South London Electric Supply Corporation for consent to lay mains across this district for the purpose of supplying electricity to Lewisham, in my opinion it is not desirable to confer upon any electric lighting company powers which would be an addition to those already held by the terms of the provisional order or Act of Parliament under which it might be working. I do not think it would be well to complicate matters for the future by allowing a third company to have even running powers through Camberwell, and the interference with the footways or roadways to lay their pipes would be a great inconvenience, and I, therefore, suggest that the committee should recommend the Council to refuse such consent. I am, gentlemen, your obedient servant, C. WILLIAM TAGG, town clerk." The committee recommends that the Borough Council do not consent to the application.

Parliament.—The Examiner of Standing Orders in the House of Commons on the 22nd inst. held that those orders had been complied with in the case of the Board of Trade Bill which provides that in the transference of an area for electric lighting purposes within the new City (London) boundaries the council or company to whom it is transferred "shall take over from the council or company from whom it is transferred any mains, etc., within the transferred area, and shall pay to them such a price as may be agreed on, or as may be determined in default of agreement by a single arbitrator appointed by the Board of Trade as the actual value of the works or mains taken over." The objection from the electric lighting companies of the metropolitan area, alleging that due notice had not been given of the proposed alteration, was disallowed. In the House of Commons on the same day Mr. Rea asked the President of the Board of Trade whether, in view of the multiplication of the private Bills of companies established for the distribution of electrical energy, he intended to promote legislation to give effect to the recommendations of the Joint Committee of 1898 to confer additional powers upon the Board of Trade to enable the promoters of such Bills to acquire the necessary powers by means of provisional orders instead of by private Acts. Mr. Gerald Balfour replied that the recommendations of the Joint Committee had not been lost sight of, but he was unable to make any definite statement at present.

Brechin.—The buildings for the electricity works, erected from plans prepared by Mr. D. Wishart Galloway, architect, Brechin, for Edmundsons' Electricity Corporation, Limited (according to a

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report in the *Montrose Standard*), are now nearing completion. A start has been made with the laying of the cables in the streets, and in a very short time the electric light is expected to be switched on to the consumers. The boilers are now built in, and will be ready for steam whenever the flue is completed. These boilers are of the Babcock and Wilcox water-tube pattern. The steam drums are 22ft. long by 36in. in diameter, to which are connected the tubes by a process of expanding, no joints or composition of any kind being necessary. There are upwards of 2,000ft. of tubes. They are fitted with the makers' superheaters. The furnaces are a feature of the construction, and afford excellent means of consuming the black smoke. By a simple but ingenious arrangement a supply of fresh air can be admitted to the back end of the furnace, which causes the already heated gases to ignite, thus reducing the volume of smoke which would otherwise go direct up the chimney. There are two furnaces, each 8ft. long by 4ft. wide, fitted with water-pans for keeping the firebars cool. The whole boiler is suspended from steel girders, and has perfect freedom for expanding when under steam. The work has been executed by the company's representative, Mr. John W. Harvey, to whom great credit is due for the manner in which the work has been carried out, both as regards workmanship and expedience.

Imperial Theatre.—By means of a unique system of electric lighting, of which more anon, and thanks to exceptional good taste, backed up by the lavish expenditure of the *nervus rerum*, the old Imperial Theatre has been transformed into the most artistic hall of London. The principal source of light, caused by lamps hidden behind a ceiling partially composed of amber crystal, wonderfully reproduces the effect of subdued sunlight, illuminating a symphony of form and colour, the principal motive of which is marble and bronze. Secret lighting in the shape of electric battens behind the cornices enhance this effect. There are lamps placed in the auditorium, but each has its *raison d'être*, the conventional candelabra and brackets being conspicuous by their absence, and each lamp is either placed on the top of a column or supported by arms of classic design, while the hanging lights on the walls would not have disgraced a temple of the time of Polycrates. All these supports are made of beaten copper, and uniformity of design and excellence of taste ranges over the whole theatre—curtain, furniture, scenery, costumes; in fact, the smallest details. An innovation, the application of which the London County Council might make compulsory, is the way in which the word "Exit" is made to appear in lines of fire over each door. The whole of the electric lighting both for the stage and front of house was carried out by Messrs. Vaughan and Brown, Limited, who also supplied the gas braziers, fire hydrants, wrought-iron and glass ceiling for sunlight effect, arc lamps, fireproof curtain, outside fire-escape, from flies, and ventilation. The large tableaux curtain was also fixed by the same firm. The whole of this work was carried out under the personal supervision of Mr. G. C. Vaughan, A.M.I.E.E.

Dublin.—A paragraph appeared in a Dublin paper on Monday stating, among other things, that the Local Government Board had refused its sanction to a Treasury loan of £236,000 applied for by the Corporation on foot of the electric lighting scheme recently approved of by the Municipal Council. The *Dublin Evening Mail* understands, from enquiry at the city hall on the same afternoon, that there is absolutely no truth in the statement made therein. No such refusal has been either officially given or received, and the document from the Local Government Board, in which this refusal was alleged to have been conveyed, is, we are informed, purely imaginary. It appears, as a matter of fact, that the city hall authorities did receive a communication during the end of last week in reference to the proposed loan, not from the Local Government Board but from the Board of Works, and that it was the result of a formal application addressed to them as far back as February last, for their sanction to a loan of £256,000, after a Local Government Board enquiry had been held in reference to the matter of the projected electric scheme. To that application a reply came back asking for a statement as to the indebtedness of the city, and this was forwarded in due course. The fresh communication of last week was asking for a further statement, showing not only the indebtedness of the old city, but of the city with the added areas included, and specifying what the borrowing powers of the Municipality would be with these additions included. The letter concluded with the statement that nothing was to be expended on the proposed scheme until the Treasury had given their sanction to the loan. Upon this fabric the statement was built up that the Local Government Board had refused the loan until they had evidence before them showing that the projected works would be capable of providing for the lighting of the newly annexed districts.

Leeds.—Mr. H. H. Law held an enquiry on Friday into the City Council's application for sanction to borrow £510,500 for purposes of electric lighting. The Council's scheme includes the extension of the present works in Whitehall-road, the installation of engines and dynamos, the introduction of new plant, and the laying of mains in various parts of the city. Mr. Dickinson, manager of the works, said that between Sept. 1, 1898, and Sept. 29 1900, the Corporation had expended upon existing works £141,929. 13s. 11d., which had been met by bank overdraft. The sum which it was proposed to expend on new buildings and plant was £160,000. The Town Clerk said the electric lighting undertaking was acquired by the Corporation in December, 1898, by purchase from the House-to-House Electricity Company. The number of units sold in the year ended Dec. 31, 1898, was 130,000, and 2,530,414 in the year ended March 20, 1901, making an increase of over 25 per cent. on the preceding year. The number of lamps in 1893 was 10,647; this year it was 132,293, an increase of 26,000 on last year. The gross revenue had risen from £4 001 in 1893 to £43 624 in the year ended March 20 last. This meant an increase of £7,404 on the revenue of the previous year. The working expenses began with £2 706 in 1893, while this year they were £13 770, an increase of £3,850 upon the year 1900. The increase for the year ended March 25, 1901 as compared with 1900 was considerably more than 25 per cent., but the difference between what would have been the normal increase of working expenses and the actual increase was entirely accounted for by the increased cost of coal. The profit this year was £3,600 greater than last year. They started at Dec. 31, 1893, with a gross profit of £1,295, and this year it was £29,884, but naturally there was also an increase upon interest and sinking fund, that increase being altogether about £5,000. Mr. Charles France (of Messrs. Milnes and France, Bradford), the architect for the new works in Whitehall-road, explained the scheme.

Weston super-Mare.—An interesting report appeared recently in the *Weston Mercury and Herald* of a visit to the now practically completed electric light generating station in Locking-road, where Mr. S. G. Leech, the resident engineering manager of the Weston-super-Mare and District Electric Supply Company, Limited, explained matters. We understand that it is intended this week to give a 40-hour run of the engines for the purpose of charging the storage cells and in order to thoroughly test the system, and to start working within a week later. Already some 12 miles of wires have been laid within the compulsory area of supply. The company has made an exceedingly good start, for already 80 consumers have been secured, the amount of light which they are taking considerably overloading the first of the duplicate set of developing machinery, whilst when the light has once been duly switched on a large accession of consumers will, of course, be an inevitable result. No arrangement has yet been arrived at with the Urban District Council for street-lighting, but negotiations are pending, and in all probability 1902 will witness the completion of the public installation—in fact, the Council desired the company to undertake the lighting of Madeira Cove by July next, but it was found impossible to affix the equipment of arc lamps for this summer. Having thus far dealt with the supply generally, it may not be uninteresting to furnish a few particulars with regard to to the headquarters of the system—the generating station. The plans for the structure were prepared by Messrs. S. J. Wilde and Fry, of Boulevard-chambers, and Mr. Charles Taylor, of Weston-super-Mare, who received the building contract, may be deservedly congratulated upon the excellent manner in which he has put such plans into effect. A generating station essentially demands sound workmanship, and no doubt can exist as to the substantial and generally complete manner in which he has fulfilled the contract. The work is now practically finished, and last week the ponderous iron chimney cap of nearly four tons in weight was put into position. The building—which is of anything but unpleasing design—is of brickwork, with Bath stone dressings, and its commodious nature may be gauged from the fact that there is a superficial internal area of nearly 6 000ft. At the south-west corner is an octagonal chimney stack 100ft. in height, with an internal measurement across the face of 5ft. 6in. Considering the treacherous nature of the subsoil—peat being encountered a short distance below the surface—extensive precautions had to be taken in order to ensure the entire substantiality of the stack. Thirty-six 1ft. square piles were sunk at some depth, surmounted in turn by 6in. steel joists and a 4ft. thickness of concrete, finally surmounted by a brickwork foundation of considerable thickness. On the left of the principal entrance are the offices of the chief engineer and assistant engineer respectively, whilst on the other side of the hall are the general office and clerk's office, a door leading from the latter immediately into the stores, from whence necessary goods may be immediately passed into the mechanical department. The battery-room (28ft. by 18ft.) contains 270 cells of the "L" type, manufactured by the Hart Accumulator Company, possessing a high maximum power of discharge, 135 comprising the negative and 135 the positive batteries, the central 21 bars of each battery being used for regulating purposes, entailing the running of 44 bare copper leads from the respective cells to their regulating space on the switchboard. The engine-room—a lofty and well-lighted apartment of 44ft. by 25ft.—is traversed for its entire length by a five-ton overhead traveller fitted with two speeds for lifting. The machines at present installed are two 100-kw. four-pole continuous-current dynamos, coupled to engines of the Raworth Universal type. They run at 300 revolutions, and have cylinders of 16½in. and 25in., with 10½in. stroke. Each set will thus maintain 3 000 8-c.p. incandescent lights. We may add, however, that sufficient space has been reserved for a 200-kw. set to be put down in August next. The system of supply adopted is the three-wire. The whole of this plant has been manufactured by the Brush Electric Light Company, of London and Loughborough. Immediately above the switchboard—which is repletely fitted—appear "pilot" voltmeters. The boiler-house is situated at the west end of the block, but placed 10ft. below the engine-room in order to facilitate the running of the steam-pipes, as also the delivery of coal into the bunkers constructed in the wall. The boilers are of the Babcock and Wilcox's water-tube type, fitted with the firm's patent superheaters. A Desrumaux water-softening plant is utilised similar to that employed at the local pumping station, the dimensions of the tank being 46ft. by 10ft. by 3ft. 6in. Each of the boilers possesses a heating surface of 1,204 square feet and the superheaters of 142 square feet. Throughout the station plant, such practical measures have been taken for the economisation of manual labour that at the outset only a single eight-hour shift per day will be worked.

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The storage cells enable the workers to dispose of the "greatest load," and also admit of the station being shut down after the heavy load has been disposed of, the cells supplying for the remainder of the night and the following day until 4 p.m. The floors of the engine-room, passages, halls, and lavatories are of mosaic, and the remainder is composed of Stewart's granolithic, whilst the internal woodwork is of stained pine. The four-ton chimney cap was cast and supplied by Messrs. Hillman and Sons at their foundry in this town; the glazing was done by Messrs. Halliwell and Co., Bradford; the checker-plates and fittings were supplied by Messrs. Strachan and Henshaw, Bristol; the iron roof by Messrs. Gardner and Sons, Bristol; the pennant stone landings, steps, pavements, etc., by Messrs Free and Sons, Bristol; the bricks by the Ashton Vale Iron Company; and the major portion of the remaining material by Messrs. Thomas and Co., Wellington; whilst the electric light fittings have been supplied and fixed by Messrs. Bryant and Sons, of this town. The whole of the work has been carried out under the personal supervision of the company's resident engineering manager, Mr. Leech, who may well be congratulated upon the splendid results attained.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Maund and Robson, Limited.—Capital, £10,000. Object: to carry on the business of carriers of passengers and goods, electrical engineers, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic, and other apparatus, etc.

Electric Railway Omnibus, Limited. — Capital, £5.000. Object: to acquire the business carried on as the Electric Railway Omnibus Company, and to carry on the business of omnibus, cab, and vehicle proprietors, horse dealers, jobmasters, livery stable-keepers, makers of electrical, oil, and other motor vehicles, etc.

Vancouver Engineering Works, Limited.—Capital, £40,000. Object: to acquire from the Vancouver Agency, Limited, the engineering works and business now carried on by Armstrong, Morrison, and Co. on the harbour of Vancouver City, and to carry on the business of marine, mining, hydraulic, electrical and general engineers, shipbuilders and repairers, etc.

May-Oatway Fire Appliances, Limited.—Capital, £40,000. Object: to adopt an agreement with May-Oatway Syndicate, Limited, C. E. May, and G. H. Oatway, and to acquire and turn to account certain inventions, to manufacture and deal in fire alarms, telegraphic apparatus, signals, thermostats, wire, and apparatus of every description which may be required in the application of any inventions in which the Company is interested, and to carry on the business of mechanical and electrical engineers, promoters, financiers, etc.

PROVISIONAL PATENTS, 1901.

APRIL 15.

7676. Trolley connection guide for electric traction. Henry Hancock and David Walters, 50, Miers-street, St. Thomas, Swansea.

7687. Printing telegraphs. Edgar Kinsman, 31, Cannon-street, London.

7701. Improvements relating to means for controlling the trolley arms of electric tramcars driven from overhead wires. Peter Daniel Milloy and International Trolley Controller Company, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7702. Improvements in or relating to dynamo-electric machines. Wilfrid Swanwick Boult, 111, Hatton-garden, London.

APRIL 16.

7750. Improvements in and connected with electric safety cut-outs. William Livingston King, 121, West George-street, Glasgow.

7752. Improvements in controllers for electric motors. The British Thomson-Houston Company, Limited Bush-lane House, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

7790. Improved trolley car. Newton Hartley Aspden, 98, Alleyn-road, West Dulwich, London.

7796. An improvement in commutators for electric meters and the like. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Compagnie Anonyme Continentale pour la Fabrication des Compteurs à Gaz et Autres Appareils, France.)

7820. Improvements in devices for enabling trolley heads to be placed or replaced on the wire or cable with facility. William Frederick Hawksley, 6, Lord-street, Liverpool.

7824. Improvements in insulators for electric conduits. Karl Tomas Bennet and Johan Thure Johansson, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7848. Improvements in or relating to the manufacture of incandescent electric lamps. Paul Scharf, 111 Hatton-garden, London.

7855. Improvements in means or arrangements for regulating the excitation of alternating-current machines. Otto Titus Blathy, 18, Buckingham-street, Strand, London. (Complete specification.)

APRIL 17.

7867. Electrical explosive gases. Ernest Bailey, 12, Baile Hill-terrace, York.

7868. Improvements in safety devices or guards for use in connection with electric traction cars and the like. Alfred Charlesworth, 5, John Dalton-street, Manchester.

7873. Improvements in electric switches. Herbert Henry Berry, Philip Frederick William Simon, and Ernest Skinner, 128, Colmore-row, Birmingham.

7885. Improvements in electro-medical apparatus. Louis Petich, 56, Ludgate-hill, London.

APRIL 18.

7935. Improvements in or relating to the grids of secondary batteries George James Gibbs, 2, Market-street, Bradford.

7953. Improvements in surface-contact electric traction. Joseph Hines, 20, Riding-street, Southport.

7956. Novel or improved means for working or controlling semaphore or other signalling or indicating apparatus in connection with electric tramway systems by means of the trolley pole; also applicable for other purposes. Joseph Wilkinson, 8, Quality-court, Chancery lane, London.

7959. Increasing the economical efficiency of electric incandescent lamps. Erasmus Bushe, 32, Bullingham-mansions, Kensington, London. (Complete specification.)

7966. Improvements in or relating to electro-pneumatic controlling systems. Ernest Rowland Hill, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 20, 1900, being date of application in United States.)

8015. A direct acting combined magnetic regulator and brake for electric arc lamps. John Lenderyou and Tom Samuel Millward Wyatt, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 19.

8102. Improvements in switch systems for telephone circuits. Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

8110. Improvements in means for facilitating the installation and control of electric lighting and like apparatus. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

APRIL 20.

8132. An improved section or feeder pillar or box for electric cables. George Hill, 17, St. Ann's-square, Manchester.

8162. Improvements in and relating to electrical lamps. Victor Isidore Fesny, 60, Queen Victoria-street, London. Allgemeine Elektricitäts-Gesellschaft, Germany. (Complete specification.)

8186. Improvements in sockets or holders for incandescent electric lamps. Johannes Wilhelmus Huyberts Uytenbogaart, 55, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on May 11.

1900.

8303. Automatic telegraphic receiving instruments for Morse characters. Cerebotani and Moradelli.

8780. Dynamo-electric machines. Eugene-Brown.

9203. Dynamos. Parsons and Stoney.

9229. Method of and means or apparatus for testing alternating-current generators, transformers, meters, and analogous apparatus. Willans and Robinson, Limited, and Addenbrooke.

9612. Commutating switch and combinations of electric meters and batteries for controlling electric carriages and like purposes. Joel.

9781. Primary batteries. Mors.

9962. Alternate-current induction meters. Money.

10366. Electric arc lamps. Couchman.

10970. Electric telegraphs. Justice. (Rowland Telegraphic Company.)

11594. Incandescent electric lamps. Pauthonier. (Date applied for under International Convention, March 30, 1900.)

11695. Alternating-current wattmeters. Wise. (Union Elektricitäts-Gesellschaft.)

21478. Electric meters. Barker and Ewing.

21660. Reflector for electric or other lights. Hall.

21700. Telephony. Sterne. (Fowler.)

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1901.

2497. Electric igniters. Ricard and Gary.

2692. Incandescent electric lamps. Lobenthal.

4149. Electrically-operated railway and tramway switches. Spangler.

4388. Devices for producing by the electric volatilisation of metal wires flashes for use in photography. Courtier.

4695. Regulation of dynamos. Strickland.

4879. Electric couplings for railway cars. Abel. (Siemens und Halske Actiengesellschaft.)

5227. Arrangement of electrical cables or groups of conductors. Hultman.

5365. Microtelephones. Volkers.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Apl. 20	631	675	– 44	—	—
Birmingham Trams.	,, 20	4,255	4,978	– 723	64,768	—
Blackburn Corp'rat'n	,, 19	428	615	– 186	6,738	6,117*b*
Blackpool Corporatn.	,, 20	269	758	– 489	3,242	3,525
Blackpool-Fleetwood	,, 18	290	912	– 622	1,533	1 273
Bolton Corporation..	,, 21	1,526	1,290	+ 236	21,442	13,799
Bradford City Trams	Mar. 24	800	350	+ 450	9,167	4,189
Bristol Tramways Co.	Apl. 19	4,055	3,899	+ 156	—	—
Carlisle Tr'mw'ys Co	,, 20	152	—	—	1,990	—
Central London Ry.	,, 20	6,443	—	—	97,984	—
City & South London	,, 21	1,929	1,211	+ 718	32,020	19,689
Cork E. T. and L. Co.	,, 18	420	460	– 40	3,479	4 936
Dover Tramways ...	,, 20	195	247	– 52	2,668	2,487
Dublin & Lucan E.R	,, 20	103	180	– 77	1,279	1,175
Dublin U.T., elec. cars	,, 19	3,444	4,339	– 895	—	—
Dublin S.D. Electric	,, 19	757	1,505	– 748	—	—
Dundee Tram Co. ...	,, 17	581	414	+ 167	—	—
Glasgow Corporation	,, 20	9,294	9,724	+ 270	—	—
Halifax Corporation	Mar. 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	Apl. 20	762	853	– 91	2 535	1,469
Hull Corporat'n E.S.	,, 20	1,525	1 321	+ 204	4,864	3,162
Liverpool Corporat'n	,, 13	9,148	7,540	+1,608	119,488	102 027
Liverpool Overhead	,, 21	1,644	1,665	– 21	24,328	22,470
Portsmouth Corpn...	,, 20	545	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 21	3,460	—	—	—	—
Southampton Trams	,, 18	670	616	+ 54	—	—
Southport Corporat'n	,, 13	*a*665	—	—	—	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. *b* Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine (to March 25), £21 increase.

Barcelona, £461 increase.

Barcelona Ensanche y Gracia, £13 decrease.

Brisbane (week ended Feb. 27); £42 decrease, (week ended March 6) £361 increase.

Buenos Ayres and Belgrano Electric (week ended March 24), £565 increase.

Calcutta (April 13), £123 increase.

Cape Town (month of February), receipts, £13,594; expenditure, £5,712.

Mexico Electric (month of March), receipts, £17,150; expenditure, £9,900.

Perth Electric, £306 increase.

Port Elizabeth (month of February), receipts, £3,043; expenditure, £1,803.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Electric Railways.—			
Central London, Ordinary	10	–	9-9¼
—— Pref. Half-Shares	5	..	4¾-5¼
—— " " deferred	"	–	4¼-4¾
—— " "	"	..	4¼-4¾
—— 6 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	–	113-118
City and South London, Consolidated Ordinary	100	–	46-50
—— Ordinary	10	–	4-5
—— 4 per cent. Debenture Stock	100	–	113-118
—— 5 per cent. Pref. Stock '91	100	..	122-127
—— " " '96	100	..	122-127
Liverpool Overhead, 5 per cent. Pref.	—	..	12-12½
—— Ordinary, 1-50,000	—	..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,760	..	..	102-104
Waterloo and City, Ordinary	100	–	94-97
Telephones.—			
National Telephone, Ordinary	5	–	9¾-9¾
—— 6 per cent. Cum. First Pref.	10	–	11-12
—— 6 per cent. Cum. Second Pref.	10	–	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	4-4½
—— 4 per cent. Deb. Stock, Red.	100	–	96-98
—— 3½ per cent. Deb. Stock, Red.	100	–	87-90
Oriental Telephone and Electric Company	1	–	¾-1¼

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	2-2½
British Electric Works, Ordinary, 50,001-95,000	1	–	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	–	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	–	85-90
British Insulated Wire, Ord., 1-70,000	5	–	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	–	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4¼-5
Brush Electrical Engineering, Ordinary	2	–	1¾-1¾ xd
—— Non. Cum., 6 per cent. Pref.	2	–	2-2¼ xd
—— 4½ per cent. Debenture Stock	100	..	103-108
—— 4½ per cent. 2nd Debenture Stock	100	–	101-103
Callender's Cable, Debentures	100	–	109-113
—— Ordinary	5	–	15-16
—— 5 per cent. Pref.	5	–	5¼-6
Crompton and Co.	3	–	3¼-4
—— 5 per cent. Debentures	—	–	100-103
Edison and Swan United, Ordinary	3	–	1¾-2
—— 5 per cent. Debentures	5	–	5-6
—— 4 per cent. Deb. Stock, Red.	100	–	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	–	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2	–	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	–	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-180,000	1	–	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	–	15-16
—— 4½ per cent. Preference	5	–	5¼-6
—— 4½ per cent. Debentures	100	–	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	21-22
—— 4 per cent. Debentures	100	–	101-104
Telegraph Construction and Maintenance	12	–	36-40
—— 6 per cent. Bonds	100	–	101-104
Telegraph Manufacturing, Ordinary	5	–	10¾-11¼
—— 5 per cent. Cum. Pref.	5	–	5¼-6
Wilkins and Robinson, Ordinary, 1-30,000	5	–	11-12
—— 6 per cent. Cum. Pref., 30,001-60,000	5	–	6¼-7 xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	–	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,801-101,200	1	–	¾-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	–	70-75
Bournemouth and Poole, Ordinary	10	–	11¼-12¼
—— 4½ per cent. Cum. Pref.	10	–	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	–	7¾-8¼
—— 7 per cent. Preference	5	–	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5	–	6¾-7¼
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	–	5-5¼
Chelsea Electricity Supply	5	–	5¾-6¼
—— 4½ per cent. Debentures	100	–	109-112
City of London, Ordinary	10	..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10	–	12-13
—— 5 per cent. Debenture Stock	100	–	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	–	101-103
County of London and Brush Provincial, Ordinary	10	–	8-9 xd
—— 6 per cent. Cum. Pref.	10	–	11-12 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	–	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	5-5¼
—— 6 per cent. Cum. Pref.	5	–	5¼ 6
—— 4½ per cent. First Mort. Deb.	100	–	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	..	4¾-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	–	5-5¼ xd
Hove Electric Lighting, Limited, Ord., 1-11,000	5	–	7-8 xd
Kensington and Knightsbridge and Notting Hill	100	–	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	3	–	1¾-1¾
—— 6 per cent. Pref.	5	–	3¾-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	98-101
Metropolitan, Ordinary	10	–	10¾-11¼
—— " 85,001-98,769	5	–	8-9
—— 4½ per cent. First Mortgage Debenture Stock	100	–	110-113
—— 5½ per cent. Mortgage Debenture, Red	100	–	98-99
Notting Hill Electric Lighting	10	–	15¾-16¼
Oriental, 1879	1	–	1¼-1¾
—— £5 Shares	5	–	7-7¼
—— £4½ Shares, New	4½	–	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	–	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	–	65-75
Royal Electrical Company of Montreal	$100	–	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	–	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 6 per cent. Debenture Stock	100	–	90-90
South London, Ordinary	5	–	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	13¾-14¼
—— 7 per cent. Pref.	5	–	8¼-9¼
—— 3½ per cent. Deb.	100	–	98-101
Westminster, Ordinary	5	–	11¾-12¼
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	–	124-129
Blackpool and Fleetwood Tramroad	10	–	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2¾-3¼
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	..	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs all pd.	100	..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	–	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	..	10-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	..	98-100 xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	–	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10	–	12-13
—— 5 per cent. Perpetual Debenture Stock	100	–	119-122
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	–	104-107
—— Prov. Cert., all paid	100	–	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	–	1¾-1¾
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	..	98-102
Kidderminster and District Lighting and Traction, Pref.	5	–	3¼-4
London Street Tramways, Nos. 1-81,000	4	–	1-1¼
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	..	103-104
New General Traction, Ordinary	5	–	2¾-3¼
—— 6 per cent. Cum. Pref.	10	–	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10¾-10¾
—— 5 per cent. Cum. Pref.	10	–	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10	–	11-12 xd
—— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
—— 4½ per cent. Debenture Stock	100	..	107-109

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NOTES.

Book Received.—Messrs. Chas. Griffin and Co. have forwarded to us a work by Mr. Chas. H. Wordingham on "Central Electrical Stations," which is published by them at 24s.

Faraday House.—Yesterday evening Prof. C. A. Carus-Wilson commenced an interesting series of lectures to the senior students of the Electrical Standardising, Testing, and Training Institution upon "Dynamo and Motor Construction."

Wireless Telegraphy in the Navy. — What is truly a record feat in wireless telegraphic communication, certainly so far as the navy is concerned, was obtained a few days back, when a message was received on board H.M.S. "Hector" at Portsmouth from the naval authorities at Portland. The distance at which the information was taken off was 103 miles as the crow flies, and this new achievement is regarded as exceedingly gratifying. Previously to this, messages had also been received on board the "Hector" from H.M.S. "Majestic," some 90 miles away.

Glasgow.— Messrs. Alley and Maclellan, the well-known engineers, whose works are termed the Sentinel Works, have conceived the happy idea of issuing a fairly large index map of Glasgow for the use of visitors to the exhibition. The scale is 5in. to the mile, which is sufficiently large to show clearly all names of streets. The places of interest are named and their position, as are the principal hotels. This map should prove of excellent service, not only to visitors, but to the firm issuing it, whose specialities are illustrated around the borders of the map.

Motor-Control Trials. — Some highly interesting motor-control tests, the first of their kind that have taken place in London, were held at the Crystal Palace on Saturday. In all there were 68 entries, and the trials, which were organised by the English Motor Club, were specially arranged to demonstrate the amenability of the different style of cars to starting, stopping, and steering. Most satisfactory results were obtained notwithstanding the severity of the tests. Stations were marked out along the line of route, and the cars had to stop at each and start again on a given signal, and all this within 30 seconds. After the control competitions a 200 yards race took place, the highest speed attained by any car being at the rate of 51 miles an hour.

Hammersmith to Kew.—A local paper gives some interesting figures as to the speed obtained on the new electric tramcars now running between Hammersmith and Kew. The times of the particular car under observation were taken by a one-fifth seconds chronometer. A delay of some 2 minutes 15 seconds occurred at the Hammersmith terminus before a start was made, but the actual journey to the terminus at Kew was accomplished in 22½ minutes. Allowing for the intermediate stoppages *en route*, this gives a journey rate of 7⅓ miles an hour, which is certainly an advance on the old horse car. There were, too, several checks from other kinds of traffic during the run, and, further, the fact that the figures were noted at six o'clock in the evening, when the street traffic is fairly heavy, must also be taken into consideration.

Lecture Arrangements.—On Wednesday, the 8th inst., Mr. J. T. Morris, A.M.I.E.E., will commence a special course of six lectures at the East London Technical College, E., on "Electric Traction." These will deal alike with electric tramways and railways, and will include descriptions of the different systems of traction applicable in each case. The lectures, which are specially intended for mechanical engineers, will begin at 8 p.m. on each successive Wednesday until the course is completed. The fee for the six lectures is 5s. Mr. Morris has also arranged to give a course of seven lectures on "Capacity in Alternating-Current Work" on Tuesday evenings at eight o'clock, commencing on the 7th inst. In this case the charge will be 7s. 6d. the course. All lectures will be fully illustrated with experiments and lantern slides.

Society of Arts.—The arrangements of this society for the week ending May 11 include the third Cantor lecture on "Alloys" on Monday evening at eight o'clock. On this occasion Dr. T. Kirke Rose, who is assisting Sir Wm. C. Roberts-Austen, K.C.B., F.R.S., with the course, has arranged to deliver the lecture. On the following afternoon, at 4.30, Lieutenant Carlyon W. Bellairs, R.N., will discourse on "The Coal Problem—Its Relations to the Empire," before the Colonial section of the society. The Right Hon. Lord Brassey will preside at this meeting, which is likely to be largely attended in view of the importance attaching to the subject just now. At eight o'clock on Wednesday evening Sir Joshua Fitch, LL.D., will lecture on "School Work in Relation to Business"; and at the same hour on Friday the third Howard lecture on "Polyphase Electric Working" will be given by Mr. A. C. Eborall.

Shipowners and the Fastnet.—Under this heading we referred in our issue of last week to a letter addressed to the *Times* by the Marconi Company, in which it was stated that they were engaged in putting up a Marconi station on the mainland of the Irish coast, not far from the Fastnet, for the purpose of reporting ships that are fitted with the Marconi apparatus. We notice this letter has elicited some correspondence from the Liverpool Steamship Owners' Association, who say that, whilst the proposed station on the mainland will, no doubt, be of advantage to those shipowners whose vessels are fitted with the Marconi apparatus, it will not be satisfactory to the general body of shipowners. What is really wanted is an installation of wireless telegraphy on the Fastnet Rock itself, from whence communication can be made with the mainland. By this means vessels not fitted with the Marconi apparatus would be able to signal the Fastnet with flags, and the information so obtained could be communicated to the mainland by wireless telegraphy.

Submarine Electric Bells.—The New York correspondent of the *Morning Post* states that a number of experiments are now being carried out by the United States authorities, with some assistance from the British Government, on the utility of a system of submarine signalling by means of electric bells. An electric bell is placed below the surface of the water, and when rung it sends sound-waves through the water until they meet a delicately-adjusted receiver hung from a ship's side. The sound is caught by the receiver, and is conveyed by wires to the bridge of the vessel, where it strikes against a bell there and rings it. By placing two electric bells at certain points it is claimed that the amount of time elapsing between the receiver on a ship getting the sounds from each bell will enable a pilot to easily find his position with the help of charts. Experiments with the new system, it is said, have been successful up to within 10 miles of the bells. The naval attaché of the British Embassy in Washington is preparing an elaborate report on the subject for the Government.

Heavy-Duty Transmission Line.—The line which conducts current to the electrolytic plant of the Boston

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and Montana smelter at Great Falls, Mont., from the power-house (hydraulic) is, says the *American Electrician*, probably the only one of its kind in the world. Each conductor of the circuit consists of bars of copper 2in. by 12in., with the ends lapped and bolted together. The cross-sectional area of each conductor is, therefore, 24 square inches. The bars rest on glass blocks on top of a wooden trestle-work built for the line. It is found that 10,000 amperes heat the conductor comfortably warm in cool weather. As the dynamos that supply this line are run by waterwheels which have no governors on account of the load being constant, it is necessary to provide against a runaway in case the circuit should accidentally be broken. For this purpose there is an electromagnetic relay connected in the main circuit, and so arranged that if the current falls off a switch is instantly closed, putting on an artificial load in place of that accidentally cut out. This artificial load consists of common iron steam-pipe filled with circulating water from the river and used as dead resistance.

Discharges in Sign Work.—Mr. C. E. Skinner, the insulation expert of the Westinghouse Company, has invented an apparatus which is attracting considerable attention from the fact that while it furnishes the basis of a striking electric sign display, it also produces artificial thunder and lightning. Experiments are at present being carried out by Mr. P. M. Lincoln at Niagara Falls with this sign, which is lettered on a heavy plate of glass. When the current flows to the sign at a low potential each letter is seen surrounded by a violet fringe of light, and then, as the tension is increased, wriggling streamers of light, says the *Western Electrician*, shoot out in a manner that is beautiful in the extreme. These vary in length as the voltage is raised, and soon each letter is surrounded by a dazzling halation of strange light. When the voltage is still further increased the effect is to cause long streamers of light, which are said to assume the appearance of flashes of lightning. As each one of these is produced a sharp report is heard, which, with the lightning-like flashes, gives a true storm effect. The sign, which is seen at its best with the current at about 40,000 volts, will be one of the many attractive electrical features at the Pan-American Exhibition.

The School Board Litigation.—The decision of the London School Board not to further contest what is commonly known as the Cockerton judgment means that they accept the law for the present as laid down by a Divisional Court and confirmed by the Court of Appeal, that the education rate may not be expended on teaching persons over 16 years of age in evening schools, or in giving higher-grade education in the day schools. Before the formal resolution to this effect was passed at the meeting of the School Board last week, however, it was decided to throw upon the Government the responsibility of taking action in the matter. To this end, therefore, it was agreed to urge upon the Board of Education "to take steps during the current session by suitable legislation to secure school boards the right to maintain all their schools, both day and evening, by the aid of the school rate, and of the school fund generally, in accordance with the provisions of the education codes in force for the time being, and, further, ask the Board of Education to receive a deputation in support of this prayer." It is thought probable that one effect of the School Board's decision not to carry the case up to the House of Lords will be to determine the Government to carry their Education Bill this session, but if this course be not taken, Mr. Macnamara, it is said, will introduce a short Bill to legalise what is now practically admitted to be illegal. Replying to a question put by this gentleman in the House of Commons on Friday, Mr. Balfour said the Government proposed to introduce an Education Bill in the Commons, but he could give no assurance as to the time when it would be introduced.

Liverpool and Municipal Telephones. — To Glasgow and Tunbridge Wells belong the credit of being the first to decide upon the municipalisation of their local telephone systems, and it seems likely that Liverpool will come next in order of merit. The feeling has long been prevalent among the leading men of that city that they ought to have an independent telephone service under the control of the municipality, and thus put an end to the monopoly which has been so long enjoyed by the National Telephone Company without interruption. Matters will be brought to a crisis at the next meeting of the City Council, when that body will be asked by resolution to declare in favour of the establishment of a municipal system. In the case of Tunbridge Wells, the Corporation area is 180 square miles in extent. The charge made by the municipal authorities to a subscriber is £5. 17s. 6d. a year, covering an unlimited number of calls over the whole of this area. The National Telephone Company, on the other hand, it is said, impose a minimum rate of £8 a year, with an additional charge of 1d. for every call within the local area, but outside the borough. At the recent conference of the National Chamber of Trades at Southport the delegate from Tunbridge Wells read a paper on the state of things in his own town, in which he stated that one subscriber to the National Telephone Company at Brenchley, near Tunbridge Wells, had been paying £60 a year for his service. With the introduction of the municipal system, however, the Corporation quoted him an annual rate of £5. 17s. 6d. It is a matter for surprise that the municipalities have been so slow to recognise the great advantages to be derived from having the local telephone system in their own hands; but Glasgow and Tunbridge Wells having shown the way, we may look forward to greater enterprise in the near future.

Marconi's Wireless Telegraphy.—On the 26th ult. a deputation of the directors of Marconi's Wireless Telegraph Company and the Marconi International Marine Company waited upon the Marquis of Londonderry, Postmaster-General, at the General Post Office. The principal object of the deputation was to arrange, if possible, with the Post Office for the transmission of messages received from the sea over the land wires, and also for messages sent overland to be transmitted from the Marconi stations to vessels passing the coast. Major Flood Page, in stating the case for the deputation, said he felt sure that they could rely upon his lordship's sympathy in their endeavour to place their system on as many ships as possible. There could be no question that a ship equipped with the Marconi apparatus was rendered more secure thereby, this greater security extending, of course, the lives of the passengers. He then proceeded to relate some practical instances of the value of the system. In his reply, the Postmaster-General indicated his desire to facilitate the connection between sea and land telegraphy, but expressed some doubt as to whether messages by wireless telegraphy intended for the shore might not interfere with messages passing between the ships of the navy. With respect to telegraphing within the country, the Post Office must reserve to itself entire control. It was true arrangements had been made with the cable companies, and it was possible that some similar arrangement might be made for the transmission of messages to and from vessels at sea. He understood they were already in communication with the Admiralty, and he thought they must first come to a

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definite understanding with them. Lord Selborne, the First Lord of the Admiralty, was not at present in the country, but on his return he (Lord Londonderry) would be ready to consider the matter along with the head of the Naval Department. As to granting a license, that would have to be carefully considered.

Accumulator Boats.—In the course of an article reviewing the possibilities of the accumulator for boat propulsion from a commercial point of view, Mr. E. W. Ehnert, in the *Elektrotechnische Anzeiger*, makes some interesting comparisons between the respective merits of steam and electric propulsion. Apart from the superior cleanliness and decreased vibration obtained with the latter, the writer points out that the commercial possibilities of the accumulators for the purpose in question depends upon the employment of the boat. As regards the annual cost of maintaining a boat in constant service, the advantage rests undoubtedly with electric propulsion—for instance, when the vessel is required for police duties in a harbour, or is a pilot boat. Such boats must be kept in a state of constant readiness for service, which, when steam propulsion is used, means a constant expenditure of fuel, while an electric boat consumes no energy when stationary. Experience, further observes the writer, with accumulator boats point to the advisability of employing Planté-formed plates, despite their greater cost and weight, as compared with paste plates. So far as this country is concerned, it is mainly in the direction of pleasure launches that the advantages of electric propulsion have hitherto been practically recognised. Electrically-propelled river and lake pleasure boats are already quite common with us. We are inclined, however, to agree with Mr. Ehnert that what may be termed the floating field of utility for the accumulator is far from exhausted. The limited radius of action possessed by accumulator boats has been the chief drawback to their use except for strictly local service. But this difficulty seems in a fair way to finding its own solution, the multiplication of riverside charging stations being all that is needed, and it is only natural to assume this multiplication to be the logical outcome of the recognised superiority of electric propulsion for pleasure launches. Their existence should serve incidentally to stimulate the use of electric instead of steam power for propelling tugboats, and it is in this direction that we must look for developments.

Earth Potential Diagrams.—In the *Electrical World* for April 13 is given a series of curves joining equal potential points in the cities of Chicago, Toledo, and Columbus. These were presented before the Chicago Electrical Association by Mr. A. V. Abbott, the chief engineer of the Chicago Telephone Company. As head of this company, the author had exceptional opportunities for observing what the earth potentials at various points of the city were. The results obtained were most interesting, and become more so because the conditions to-day can be compared with those on a map which was made in 1897, when the current required for the street railways was not so much as at present. The shape of these curves has been altered very considerably, due, we presume, to the introduction of more generating stations or sub-stations. In making the observations, Mr. Abbott used telephone wires at various points in order to compare the potential of conductors placed in the earth, for which purpose, as a rule, water-pipe connections were used. These potentials were compared with the potential at one point by means of a low-reading voltmeter. We are not told how far these potentials varied at different times of the day, but presume the variations must have been considerable, as a curve is given of the real potential range over 21 hours at the point at which the voltmeter was placed. The range at this point was over 20 volts. On the equal potential curve diagrams the maximum ranges seemed to be from zero up to 10 or 12 volts. In the editorial comment on these curves attention is called to the fact that the water of Lake Michigan had not apparently any effect on the curves. Mr. Abbott adds that an inspection of maps such as he has prepared enables one to estimate what is the electrolytic danger to a conductor, by seeing how it crosses from one to the other of the equal potential lines. He concludes that although he is connected with a company that is likely to be harmed by electrolysis, he is not alarmed by the conditions obtained in Chicago. He thinks that with proper bonding all damage from this source can be avoided.

Electric Lighting in London.—It will be remembered that at the recent Board of Trade enquiry into the application of the electric lighting undertakings to increase their standard pressure of supply, strong opposition was offered on behalf of the Junior Constitutional Club. The vice-chairman of the club, Major-General A. E. Turner, has now written to the *Times* on the subject, stating that the committee has observed with pleasure that it is proposed to form an association for the protection of consumers of electricity, and that they will be pleased to render any such association all the reasonable assistance in their power. The letter proceeds: "As one of the consumers who took an active part in the late Board of Trade enquiry in resisting the proposed encroachments by electric light companies on the consumers' rights, one could not have failed to be struck with the advantage the companies possessed by co-operating for a common object, and the all but hopeless position of a consumer who by himself stood up in defence of his statutory rights to resist their encroachments." The writer then goes on to point out that "this right to be supplied at a lower pressure is a valuable one, because lower-voltage lamps are far more economical, and the consumer therefore gets his light at a reduced cost." This is rather jumping to conclusions having regard to the conflicting evidence given at the enquiry on this point, and now that the Board of Trade have given their decision in the matter we see that the limited number of obstructionists are not supported. The following extracts from the letter in question may be of interest to our readers. For instance, the writer says: "During the Board of Trade enquiry the electrical engineer of the Glasgow Corporation admitted that he had deprived consumers of their right to a supply at the lower pressure because it suited his purpose to do so, and the same arbitrary conduct was admitted by the electrical engineer to the St. Pancras Vestry. . . . Again, there is a clause in the Board of Trade rules, made under the Electric Lighting Acts, which prohibits the companies from allowing the pressure at the consumers' terminals to vary more than four volts above or below the normal pressure, and in the event of the supply company exceeding this limit the consumer's remedy is to summon the company in the police court." As showing in what manner this clause is adhered to Major-General Turner quotes, in conclusion, the case of the Westminster Electric Supply Corporation, reported in our last issue, in which a number of summonses against them for exceeding the limits of variation permitted by the Board of Trade were dismissed by the magistrate as due to "accidental causes."

The Sectional Third-Rail System.—Mr. Henry Hale has a good article in the New York *Electrical Review* on the Baltimore and Ohio Belt Railroad, which line extends through the city of Baltimore from the south-western to the north-eastern suburbs. Originally, the electric current was conveyed from the power-house by the overhead system, but on account of the considerable amount of

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leakage which occurred, in spite of the insulation, a change was made to the sectional third-rail system upon what is known as the Belt section. In the installation of the new system the motors which had been taking the overhead circuit, were again used as they required but few alterations—merely the attachment of cast-iron shoes to the exterior of each driving-wheel truck. The following method is adopted on this line in charging the rails. The motorman on the electric locomotive turns the controller to the first notch, opening at the same time the throttle to the air-engine. This, taking compressed air from the storage reservoir of the air-brake system, drives an electric generator, which generates sufficient current to operate the magnetic switch and connect the third rail with the current supply from the power-house. This switch has a capacity of 2,000 amperes, and is enclosed in a cast-iron weather-proof box. It is practically a solenoid with two windings; one a fine winding, with many turns around the magnet, taking a current of about 550 volts from the generator on the electric locomotive through the controller, the contact shoes, and the third rail. This current raises a plunger, which closes the switch and feeds the power-house current of 700 volts to the third rail. The moment the weaker generator current passes through the fine winding and closes the switch, current from the power-house passes through the heavy winding of the magnet and keeps the switch closed until the contact shoes of the electric locomotive have passed to the next section. The circuits around the magnet being broken, the switch opens by gravity. The contacts last to operate are of carbon, and the spark, if any, is between these contacts, thus preventing the metallic contacts from injury. At the instant the contact shoe at the forward end of the locomotive comes in contact with the forward section of the third-rail conductor, the switch controlling the feeder for that section closes, and the switch for the rear section opens. Each of the magnetic switches is provided with a single-pole double-throw knife switch in series with the fine winding of the magnet for use to test the magnetic switch, and ascertain whether it is in proper adjustment. One point of interest in connection with this sectional third-rail system is that the current rails are fully as heavy as those used in the construction of the track, weighing as they do from 80lb. to 90lb. to the yard. The locomotives in use on this line weigh 96 tons each, and are equipped with four General Electric motors, mounted directly upon the axles.

Electric Tramways Promotion.—The proposal to amend Standing Order No. 22 in the interests of tramway enterprise is made the subject of a letter to the *Times* from Mr. J. Clifton Robinson, the general manager of the London United Tramways Company. In it he expresses the belief that the order in question, as at present framed, has retarded more than anything else—save, perhaps, the confiscatory interpretation of the iniquitous purchase clause of the Tramways Act of 1870—the development of tramways in this country. Lord Morley has now taken the matter in hand, and Mr. Robinson thinks a fair prospect presents itself for the abolition of this "particularly objectionable anomaly." Standing Order No. 22 applies to all Tramway Bills, and the difficulties it creates, Mr. Robinson points out, are even greater in some parts of the country than in London. "No one without experience in tramway promotion," the letter proceeds, "can realise the difficulty of obtaining the necessary assents even from willing local authorities, the haggling over clauses, drafting agreements, and getting in the right form everything bearing upon the local conditions, and in time to be produced before the Examiner on Standing Orders. And if, after all, you fail to obtain the formal assents by the appointed date, your Bill is dead for another session, and all your time, surveys, parliamentary plans, and outlay are wasted, and require to be entered upon *de novo*." What Mr. Robinson calls the most heart-breaking part of the business is the fact that local authorities have joined the ranks of concession-hunters, and are now so much given to the practice of extorting what they call concessions—but what a parliamentary committee recently plainly set down as blackmail—from the promoters of various Bills. The unfortunate fact is, as Mr. Robinson points out, that "where such blackmailing practices do flourish, it becomes well-nigh impossible to introduce tramways in districts where such undertakings might otherwise be carried on both to the profit of the company and to the great advantage of the locality. And where tramways are constructed, they may be so handicapped by financial burdens of this character as to deprive the public of the economic benefits in low fares which electric tramways are so eminently adapted to afford. The sooner this most unsavoury and immoral business is put an end to the better." In the case of the London United Tramways Company in West London, Middlesex, and Surrey, Mr. Robinson says they had been forced to agree to spend scores of thousands of pounds in properties, road and bridge widenings, etc., unnecessary for the purpose of the tramways, to say nothing of wood paving, whole roadways and annual direct payments, in order to secure the permission of the authorities to provide the travelling facilities needed and desired by the people of the districts affected. By the proposed alteration of Standing Order No. 22 tramways would occupy the same footing as railways, gas, water, and other similar undertakings. Parliament would hear all sides of every question and decide each on its merits, and there would be an end to "this wanton trafficking in assents." In conclusion, the writer believes the time has arrived "not only for the suspension of Standing Order No. 22, but also for such a sweeping amendment of the general Tramways Act of 1870 as will meet the national demands in the development of electric traction, and until something in this direction is done Great Britain will continue to lag far behind Continental countries, the Colonies, and the United States, and the great problem of overcrowding in London and the larger cities will remain to plague the hearts of our rulers and our social reformers."

Telegraph Statistics.—The *Journal Telegraphique* for April gives two valuable supplementary tables of figures to the telegraph and telephone statistics published at the end of last year. Additional information is given as to those countries which were not included in the annual statement for 1899—viz., Italy, the Portuguese Colonies, New Zealand, and Queensland. Taking the case of Italy first, the length of the lines in operation totals to 27,588 miles, while the wire mileage is given at 87,413. In all there are 6,035 offices in use. The Morse system is generally adopted in Italy, the total number of instruments employed being 9,984, of which 191 are Hughes apparatus, 104 various types, and the remainder Morse instruments. This latter figure of 104 includes 22 Wheatstone automatic apparatus, 68 Wheatstone receivers, and 14 of the Baudot type. The number of messages received and dispatched during the year come to 10,918,615, of which 8,658,466 were inland telegrams, and 2,260,149 international. The service telegrams, to the number of 374,340, bring this total up to 11,292,955, which represents receipts amounting to £637,282. The expenses are put at £127,379, but this figure only includes payments in respect of salaries, materials, and maintenance distinctly attributable to the telegraph service. It omits all reference to expenses of administration, as the postal and tele

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graph departments in Italy are merged into one, and the postal figures are not given. The figures in the case of the Portuguese Colonies stand thus: length of lines, 1,869 miles; length of wires, 2,355 miles; offices open, 77; inland messages, 60,395; international messages, 2,720; service messages, 16,397; receipts, £3,961; and expenses, £17,453. In connection with this last item, it must be remembered that the exceptionally heavy cost of constructing the lines in the Zambesi district is taken into account, and this is mainly responsible for the receipts being out of all proportion to the expenses. In these colonies, which also include the province of Angola and the Portuguese Indies, Morse instruments are universally used. In New Zealand there are 7,725 miles of line, 20,946 miles of wire, 915 offices open, 342 Morse and 887 other instruments in use (including 829 telephone apparatus), 3,408,004 inland and 61,627 international messages dispatched and received, £124,626 receipts, and £190,878 expenses. The type of instrument in use in Queensland is not stated, but the following are the figures given: 10,952 miles of line, 20,380 miles of wire, 456 offices in operation, 1,203,864 inland, 8,080 international, and 131,045 service telegrams received and dispatched, and £89,927 receipts. In the case of Queensland no expenses are given, it being pointed out that owing to the arrangement of treating the postal and telegraph departments as one it is impossible to give the expenses attributable exclusively to the telegraph service. The second table in question gives the lengths of the lines and wires in operation in practically every country in the world. From this table we gather that Great Britain and Ireland have 47,930 miles of line and 352,415 miles of wire; France (including Algeria and Corsica), 90,597 and 347,539 miles respectively; Germany, 33,638 and 306,790; Russia, 98,610 and 215,991; Austria, 24,434 and 75,048; Italy, 27,588 and 87,413; and the British East Indies, 27,588 and 87,413 miles respectively. In the matter of length of local submarine lines and wires, France comes first with 6,204 and 6,806 miles respectively; Great Britain and Ireland next with 2,701 and 9,221 miles respectively; and Germany third with 2,558 miles of line and 5,598 miles of wire. Germany takes first place as regards underground wires with 4,230 miles of line and 28,731 miles of wire. Next in order is France with 3,667 and 17,321 miles respectively. Great Britain and Ireland comes third on the list, having 1,230 miles of line and 50,476 miles of wire underground. Although, according to the figures before us, France takes the premier position as regards submarine cables, this does not give quite a correct idea, because the French colonial lines are included, whereas such is not the case with England.

Patent Law Reform.—Mr. Alexander Siemens read a paper on this subject before the Society of Arts last week, in which he claims that an ideal state of affairs would be reached if the patent laws of all civilised countries were made identical on the lines sketched out by him. If this were done, a patent taken out in one country could be registered, at the option of the inventor, in all the others without any further examination of any kind, and in the event of litigation the commercial use in one country would be recognised by all the courts. A reformed patent law should have for its principal object the introduction of new inventions for the benefit of the public, and while the interest of the inventor should not be entirely neglected, it should be subordinate, the author contends, to the "advantage and good of the people." To carry out this object, information about new inventions should be made readily accessible to the public, and every facility should be given to persons desiring to utilise an invention to obtain licenses from the patentee, and to overcome vexatious obstruction of any kind. As a matter of fact, a good deal has already been done to make information about novelties easily accessible to the public. Another important point was that it should not be possible to keep up a patent for more than four years unless it could be shown to the satisfaction of the examiner that the invention had been worked for more than one year on a commercial scale before the fifth year's taxation became payable. If several methods of carrying out the same manufacture were described in one patent, the satisfactory working of one modification should be sufficient to keep up the whole patent; and, further, to facilitate the introduction of new manufactures, the system of compulsory licenses should be extended, so that anybody who was prepared to carry out an invention or adopt a novel device, but had been refused a license by the patentee, should be able to obtain one from the Patent Office. The author then proceeded to quote the opinion of the Board of Trade Committee, who recently issued their report on the subject, to the effect that the machinery as to the actual grant of the license is needlessly complicated, and recommending that the jurisdiction be referred to the High Court. Under a good system it was not to be anticipated that many compulsory licenses would have to be granted, as inventors would find that it was more to their interest to grant licenses on reasonable terms than to refuse them. A licensee should also, whilst he was working his license, be entitled to bring an action for infringement. But in no case should an action for infringement be allowed to proceed when the defendant could prove that the plaintiff knew of the infringement for six months before action. Such rules as he had suggested might prevent blackmailing by men of straw or speculators who bought up patents, and enable licensees to protect their interests in cases where they could not induce the patentee to prosecute third parties for infringement. On the other hand, it should not be possible to invalidate a patent which had been worked for more than two years on a commercial scale by the patentee or his licensees, except by proving that the invention was in use on a commercial scale for a reasonable time before the first application for a patent was made. In the discussion which followed the reading of this paper, Mr. E. Carpmael, Mr. J. T. Thornycroft, and Mr. Fletcher Moulton, K.C., were all agreed that the author's suggestions in regard to compulsory licenses were not required. The difficulties in the way of ingenious inventors were sometimes insuperable, and in many cases patents were not made workable until years after they were granted. The Lord Chief Justice of England, who presided over the meeting, did not think that any Government guarantee was desirable, and anything like examination into novelty would be difficult. Many *bonâ fide* inventors were far before their time, and care should be taken that the rights of such men should not be taken away after so short a period as 15 years; but the inventor should certainly have all the benefit of the knowledge of the Patent Office as to identical or similar inventions, and the public were also entitled to such information. He could not but join in the chorus of disapprobation of Mr. Siemens's suggestion that a patent should be invalidated by five years' non-user, and he could produce more than one instance of the reader's distinguished uncle's (Sir William Siemens) inventions not having been productive or workable for several years. The report of the committee of which he and his friends Mr. Fletcher Moulton and Mr. Carpmael were members embodied what he fully believed were reasonable recommendations. A vote of thanks to the author closed the proceedings.

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BARNES AND MORTLAKE ELECTRICITY WORKS.

Introductory.

For once in a way an ancient name has prevailed, for in olden times the name of this place was Bernes or Berne, which Lyson says means "a barn." Perhaps the aboriginal inhabitants had a granary here—hence the barn. The town is celebrated in the popular mind as pertaining to *the* boat race; in a citizen's point of view as being one of the points where Thames water is purified and stored for household use. Barnes does not pride itself upon its ancient estate, but upon its modern utility. Its local authority has been enterprising enough to establish an electric light installation, which proves it to be in the forefront of modern progress. Still, there are various interesting events connected with the older history of this locality which, when it is posing to be quite up to date, we may briefly refer to. Thus, a long way back, even in the time of Athelstan the Saxon, we find that the manor was given by the King to the Dean and Chapter of St. Paul's, and we are told in the Doomsday Book that "the canons of St. Paul's, London, hold Berne." But later on, the Archbishop of Canterbury seems to have had a lien upon the manor, in that he was entitled to a sparrow hawk or 2s. in money annually, and also £2 every twentieth year for ever from the lords of the manor in order to excuse them from serving the office of Reeve at Wimbledon. A few events in this locality belong even to English history. It was at Barn Elms that Sir Francis Walsingham, Secretary of State to Queen Elizabeth, entertained his Royal mistress. Near Barn Elms was the house where Jacob Tonson lived, the secretary of the celebrated Kit-Cat Club, whose members are called "the patriots that saved Britain," and whose portraits were placed in their meeting-room, having been painted by Sir Godfrey Kneller. It would be useless now, when visiting the fine church, to examine the churchyard for any traces of Mrs. Baynard's tomb, but the epitaph remains among the antiquarian lore of last century. The first two lines of the epitaph read—

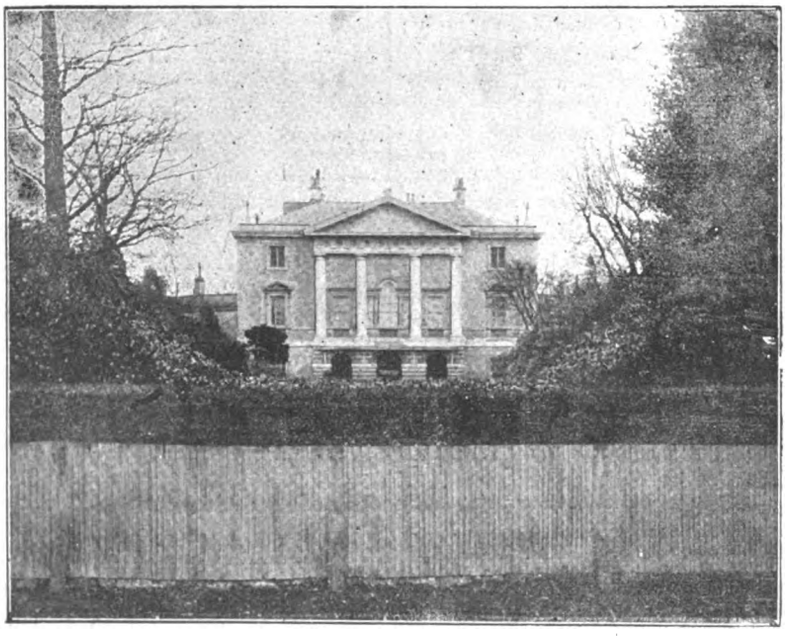
"Here lies that happy maiden, who often said,
That no man is happy until he is dead."

Among the buildings or residences of note around Barnes, White Lodge takes a prominent position. The Lodge is generally associated with Richmond, and comparatively few people know that it is really within the bounds of Mortlake. According to Anderson, in his "History of Mortlake," the Lodge was built by George I., but remained in an unfinished state until George II.'s daughter, the

W. FAIRLEY, ESQ.,
CONSULTING ENGINEER.

S. W. LAMBERT, ESQ., J.P.,
CHAIRMAN OF COUNCIL.

W. H. COLLIER, ESQ., F.S.I.
CHAIRMAN OF LIGHTING COMMITTEE.



White Lodge.

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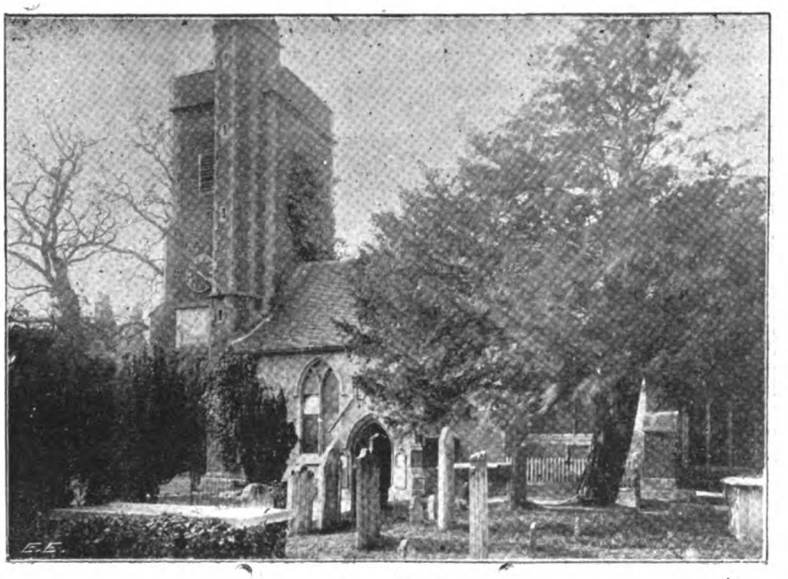
Princess Amelia, became Ranger in 1751. It is a matter of common knowledge that the Lodge was long the residence of the late Duke and Duchess of Teck and family, but not so generally known that his Majesty King Edward VII. spent some of his early days within its precincts, while Prince Edward of York was born there. The present Ranger is his Royal Highness the Duke of Cambridge. A view of the Lodge is given herewith.

Sheen Lodge, one of the residences of his Grace the Duke of Fife, is situated on the south side of the parish.



Barnes Church.

The premises which now serve as the headquarters of the Sheen Club were formerly occupied by the Duke de Paris.

So far as we can discover there is no particular history attaching to Barnes Church, which is the subject of another of the accompanying illustrations. It is a very ancient structure, as may be seen. Dr. John Dee lived at Mortlake, and was in 1575 visited by Queen Elizabeth at his house, which was situated near the present Queen's Head-court. Mortlake at one time was very celebrated for its tapestry works.

Ranelagh Club House, Barnes.

Barnes has many picturesque spots. The High-street, leading from the river to the pond on the common, is very quaint. At the east end of the parish stands Barn Elms, now occupied by the Ranelagh Club, a popular home of golf and polo.

The urban district of Barnes consists of the parishes of Barnes and Mortlake, which have a combined population of nearly 20,000, and a ratable value of £148,029. Gas is supplied to the district by a neighbouring company at the not immoderate rate of 2s. 11d. per 1,000 cubic feet. For the electricity supply it is proposed to charge 6d. per unit for lighting purposes and 3d. per unit for power and heating. The works are starting with about 50 consumers connected, representing an aggregate load of between 2,500 and 3,000 8-c.p. lamps, including the lighting of the Council offices, works lighting, etc. There is no public street-lighting at present. Having regard to the popularity of the neighbourhood as a residential centre, it will be seen that the prospects of the undertaking are bright. The natural advantages of the site selected for the works are also in favour of the undertaking, the situation being practically ideal in all those respects which bear on the question of economical generation and supply.

Evolution of the Lighting Scheme.

The question of the electric light first came before the Urban District Council in June, 1896, when a neighbouring company gave notice of their intention to apply to the Board of Trade for powers authorising the supply of electrical energy within the jurisdiction of the Council. The subject was referred to a committee, and on their recommendation the Council in November, 1896, resolved to withhold their consent. On July 26, 1897, the then chairman, Mr. Laidlaw, gave notice that he would move at a meeting, to be held on Sept. 28 of that year, that the Council apply for a provisional order. In the month of August, the company who applied the previous year again approached the Council with the view of obtaining their consent under the Electric Lighting Act. The Chairman's motion, on coming before the Council in

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September, was unanimously adopted. The company was, therefore, again refused.

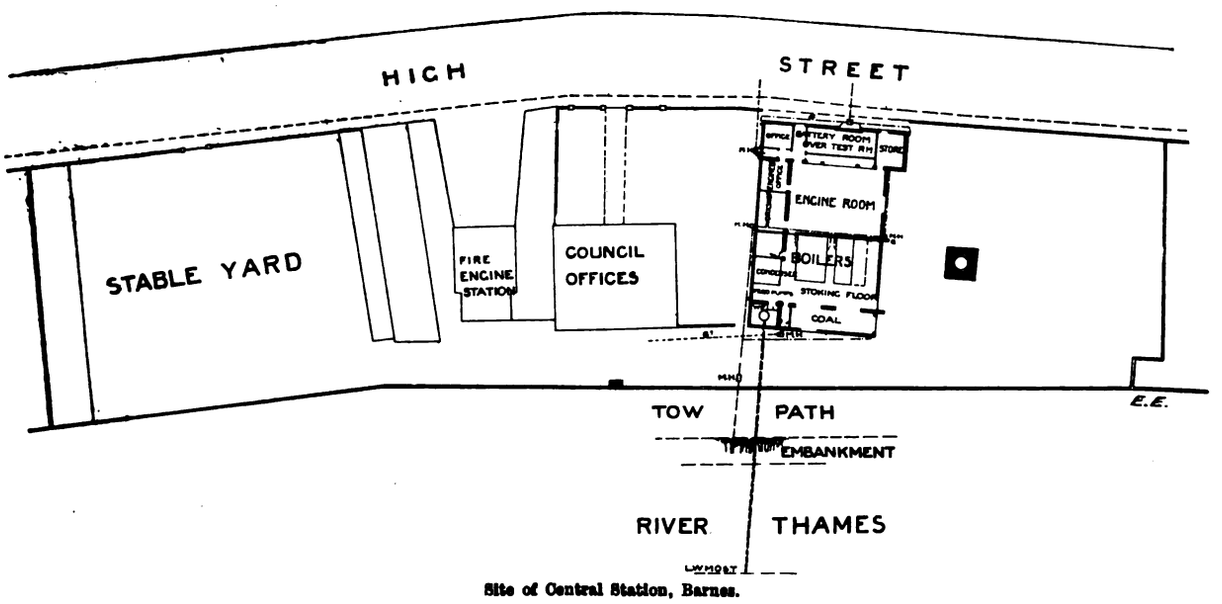
About this time the Council appointed a special committee, and conferred upon them power to make all necessary arrangements for obtaining the order. The committee after having settled the necessary details of the order, issued in February, 1898, a circular letter to 1,145 occupiers of premises of a ratable value of £20 and upwards for the purpose of ascertaining whether in the event of the Council obtaining the order there was likely to be a demand for the light. A postcard was enclosed for a reply—of these cards 483 were returned, 257 being favourable and 226 in the negative. The total number of 8-c.p. lamps required was 9,062; of this number 5,751 were on the line the Council proposed to lay mains at once. On May 2, 1898, the committee was informed that the Barnes electric lighting order had been made by the Board of Trade, and on July 1 of the same year it was confirmed by the Electric Lighting Orders Confirmation No. 6 Act, 1898. In the August of that year two companies gave notice of their intention to apply for powers to supply energy within the district, and were informed that as the Council had their own order any such applications would be opposed. In the beginning of the year 1899 several applications were received from companies desiring to lease and work the Council's order. These applications were referred to a special committee, who were instructed to report whether the Council should part with the order or work it themselves, and a direction given that the committee should employ technical scientific advice.

On Feb. 14, 1899, the committee called in Mr. Fairley, of Victoria-street, Westminster, to assist them in their deliberations. Mr. Fairley prepared a report dealing fully with the question. The report was carefully considered by the committee, and upon their recommendation the Council in July, 1899, decided to at once proceed to carry out the order themselves.

Site and Accepted Contracts.

The question of finding a suitable site was next dealt with, and as the Council had available land adjoining their existing offices and facing the river, with convenience for water and barging, it was decided to erect the station there. The Local Government Board was accordingly approached and their sanction obtained. Tenders for the several works were next invited and received from firms of the highest standing, the following being a list of those accepted: Buildings, Munday and Sons. Boilers, steam plant, and condensers, Babcock and Wilcox, Limited. Steam dynamos, Siemens Bros. Storage batteries, Electrical Power Storage Company. Cables, Callender's Cable Company. Overhead travelling crane, Chatteris Engineering Works Company. Meters, Schattner Electricity Meter Company. Wiring, Johnston and Fitzer.

Sheen House, Barnes.



Site of Central Station, Barnes.

Buildings.

The generating station is situate on the north side of High-street, Mortlake, adjoining the towing-path, on what was part of the Council's depôt, and practically in the centre of the district. It comprises engine-house, boiler-

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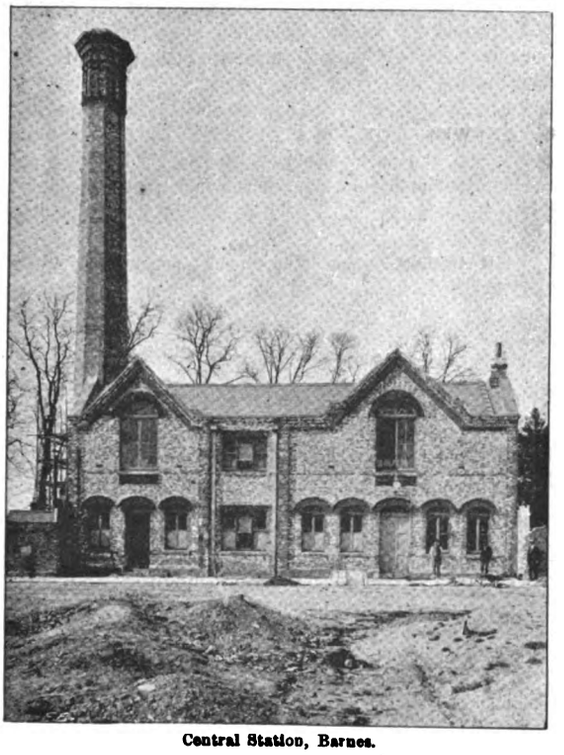
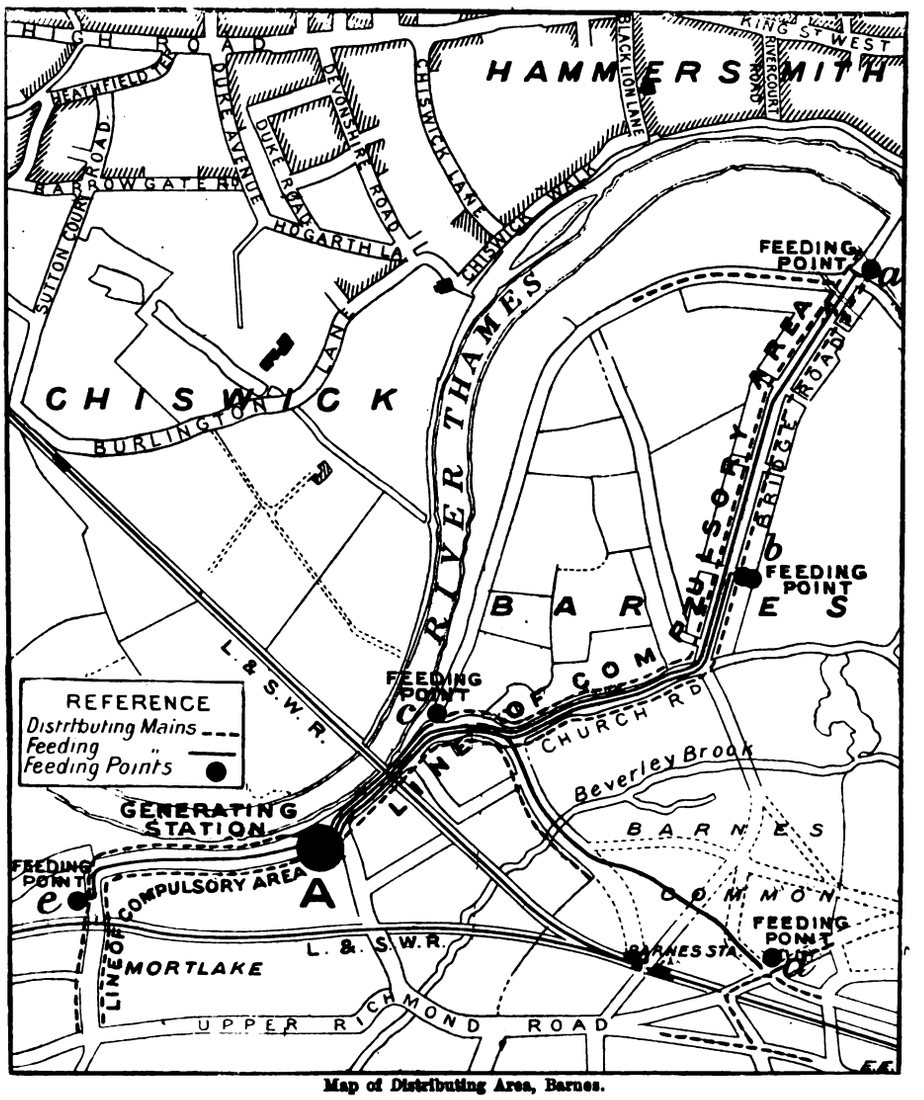
house, coal store, offices, test-room, battery-room, etc. The buildings generally are one storey high, except in the



Central Station, Barnes.

front, where there are two, and are built in stock bricks, with blue brick plinth, red gauged arches, and red brick and terra-cotta dressings, and the front portion is finished with a parapet and stone coping. On entering the building, the general office is on the right, and on the left is the test-room, switchboard enclosure, and engineer's store. The entrance hall leads directly into the engine-house, which is 43ft. long, 31ft. 9in. wide, and 21ft. high. The walls are faced in brown, green, and white glazed bricks to a height of 6ft., the upper portion being faced in pressed gault bricks, with red brick dressings. The roof is an open one having a glazed ventilating skylight the whole length. The engineer's office is at the side of engine-house, having a window giving a view of all parts of the engine-house. At the rear of this office is the work-shop, and beyond this the workmen's messroom and condenser pit. The boiler-house is alongside the engine-house and of the same length and breadth, but the height is 22ft. The walls are faced in stock bricks with red arches and blue brick angles; the roof is similar to that of the engine-house; the boiler fronts are faced with Rockingham glazed bricks.

Both the engine and boiler houses are fitted with temporary ends, covered on the outside with galvanised corrugated iron, and matchlined and varnished on the inside, so as to allow of any future extension that may be necessary. At the rear of the boiler-house is the coal store, 10ft. wide, with high openings opposite the boilers to allow of the tubes being withdrawn when necessary. At the end of the coal store, and adjoining the condenser pit, is the well-house, where a well has been sunk for water for condensing purposes; this well is about 5ft. below the lowest recorded tide, and an 18in. pipe is carried out to low water, so there should always be sufficient water available for condensing; above the well-house are fixed the main water-tanks, containing about 4,700 gallons supplied from the company's mains. The battery-room is over the general office, test-room, and stores the whole length of the building, and is 65ft. long and 15ft. wide with open timber roof, and is approached by a spiral staircase from



Map of Distributing Area, Barnes.

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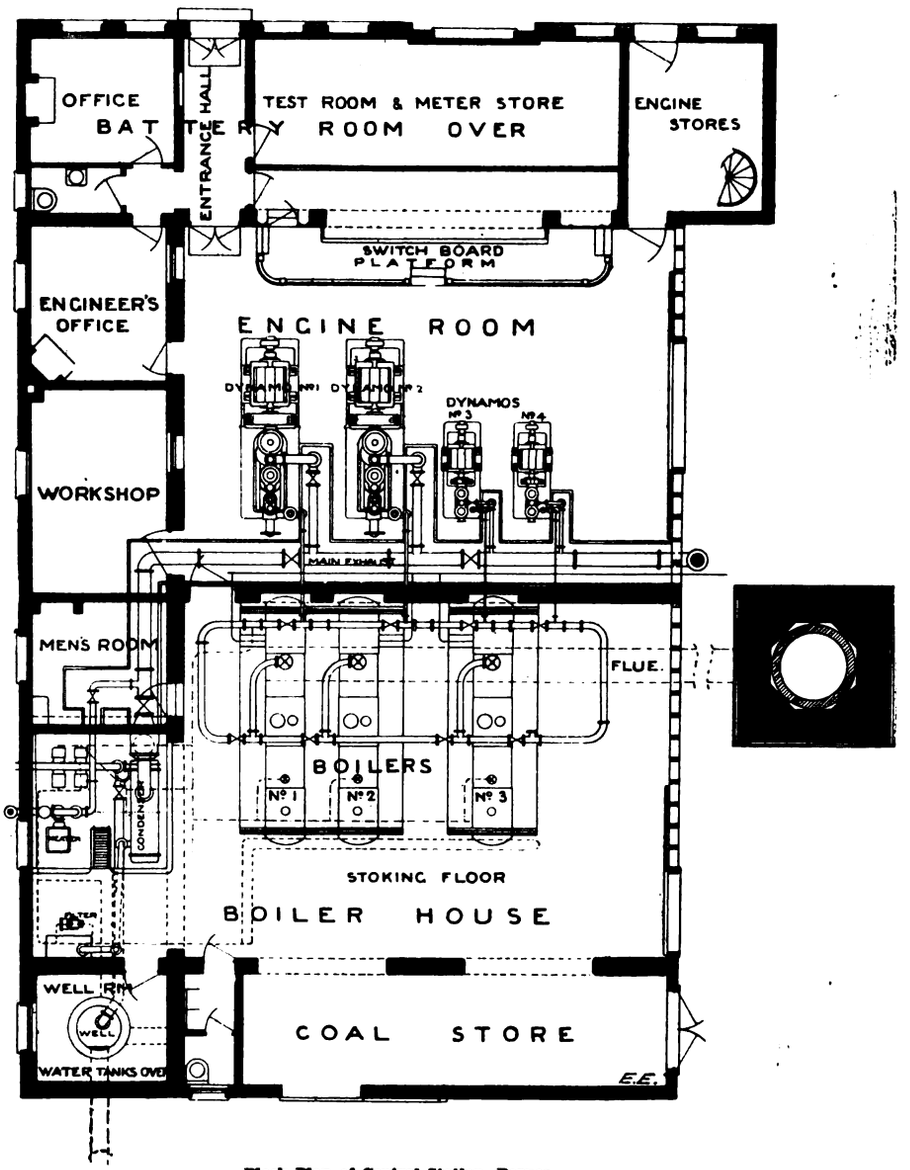
the engineer's store, and has a door in the end wall for hoisting materials.

The chimney shaft is 16ft. from the present end of boiler-house, the flue being carried underground and a false opening left on the opposite side, so that, if necessary, a flue can in the future be taken in there. The height of the chimney above ground is 120ft., and 143ft. above the bottom of foundations. The cement concrete foundations are taken down into the London clay, which was expected to be met with about 18ft. below ground, but was not found until 23ft. in depth. The footings were built in cement mortar, and from the bottom of flue to 70ft. above ground in lime mortar, and the upper portion in cement. The shaft is carried up square to a height of 21ft. above ground, and then octagonal, faced in stocks with red brick quoins and dressings, and finished with a terra-cotta cap and blocking course. The shaft in the lower part is lined with firebrick (entirely separate from the ordinary brickwork) 7ft. in diameter, with an air-space all round to allow for expansion, having flues through the walls of shaft on each face of shaft.

(To be continued.)



Block Plan of Central Station, Barnes.

Formal Opening Ceremony.

Wednesday last witnessed the formal inauguration of the supply from the Barnes and Mortlake electricity works, when after a few remarks fitting the occasion addressed to the guests by the chairman of the Urban District Council, Mr. S. W. Lambert, J.P., that gentleman shared the honour of starting the first two engines with the chairman of the Lighting Committee, Mr. W. H. Collier, F.S.I. The inspection of the works which subsequently took place found everything in very shipshape order. The compactness of the buildings and general arrangement of the plant were remarked upon. A champagne luncheon served to nearly 100 guests in the Council-chamber followed, Mr. S. W. Lambert taking the chair.

In proposing "Success to the Undertaking," Mr. THOS. SKEWES COX, M.P., alluded to the substantial manner in which the works just opened had been carried out. Despite the name of their consulting engineer, the work had not been "Fairley" but, on the contrary, "very" well done.

The CHAIRMAN, who responded, remarked that the success which had attended the undertaking up to date surpassed even their anticipations. They had not expected to have so many as 3,000 lamps connected up to the mains at that early stage of the supply.

The CHAIRMAN, in proposing "The Engineer," spoke in very appreciative terms of Mr. Fairley's services, especially in his capacity as engineer to the Richmond Main Sewerage Board, who could not wish for a more competent servant. The works which they had just opened were not only a credit to Mr. Fairley, but also a monument to his skill. The instructions given to Mr. Fairley were that they wanted everything of the very best that money could buy, on the principle that any attempt at economy in connection with such an undertaking would be misplaced. This policy had been strictly adhered to, and the result was that their station would safely bear comparison with any station of similar size extant. The district owed much to Mr. Fairley for what he had done.

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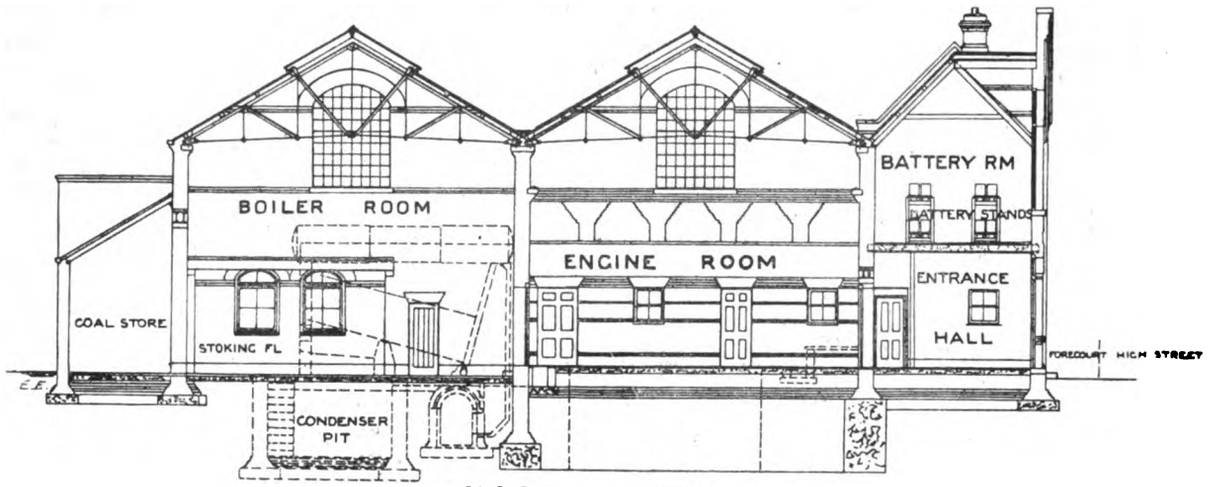
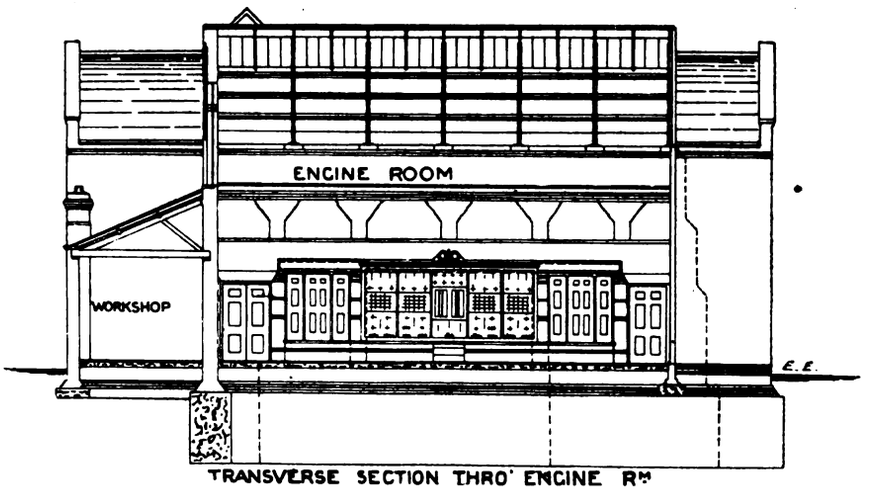
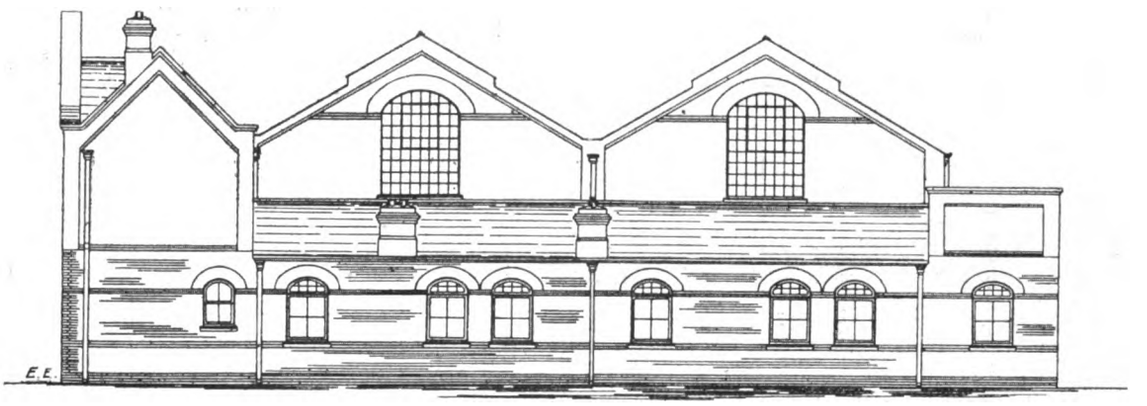
In responding to this toast, Mr. FAIRLEY took advantage of the occasion to publicly thank the chairman and others concerned for the hearty support received from them throughout. It was nine months only since the commencement of the scheme, and its completion in that short space would not have been possible without the assistance of firms of very high standing. The contractors had fallen in with every suggestion likely to benefit the scheme.



LONGITUDINAL SECTION



TRANSVERSE SECTION THRO' ENGINE Rm



EAST ELEVATION

SOUTH ELEVATION

Details of Central Station, Barnes.

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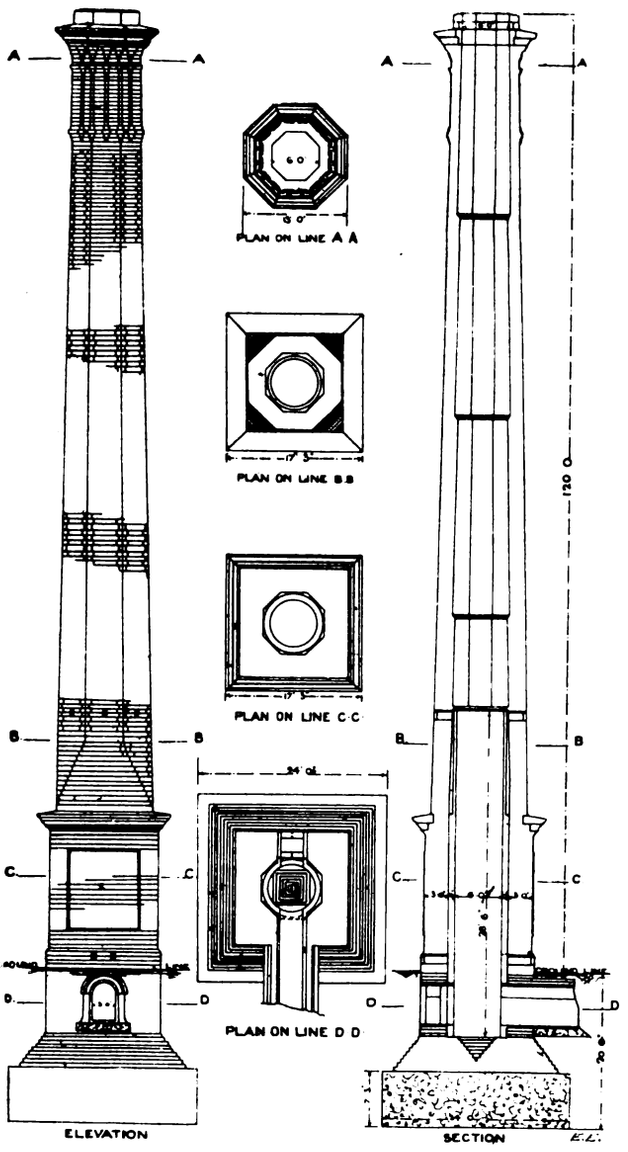
The Council had also been very fortunate in obtaining the services as resident electrical engineer of Mr. Davidson, who had proved himself a most energetic and competent officer, and was, moreover, sanguine of having a very successful first year. The successful completion of the scheme had been due in a large measure to the services rendered by the officials, and especially to the untiring efforts of Mr. Tomes, their surveyor, and Mr. Goodale, the latter gentleman having been responsible for the finances of the undertaking. In this connection he might mention the station held the record, being the first to start with a profit, for according to Mr. Goodale's showing they had a balance of £24. 4s. 3d. on the right side. But he (Mr. Fairley) had not enquired as to the manner of arriving at this astonishing result.



Chimney Details, Barnes.

"The Contractors" was the next toast on the list. This was proposed by Mr. COLLIER and responded to by Mr. TOM CALLENDER—who expressed a hope that the present rate of profit-making would be maintained—and other contractors' representatives present.

WIGAN OPENING CEREMONY.

In our issue of Feb. 1 we described and illustrated the Wigan central station, the formal opening of which was deferred from that time, because of the national loss sustained in the death of Queen Victoria, to April 24, when the Mayor, Mr. Councillor Fyans, in the presence of a large company, formally opened the works.

Councillor T. WORTHINGTON, in opening the proceedings, referred to the lamented death of the late sovereign, and stated he was going to ask the Mayor to give the finishing touch to their new station by declaring it open. Less than two years ago Mr. Councillor Gee laid the foundation stone of the building, since when some £80,000 had been spent on the works, and the whole town had been furnished with cables and subways for the distribution of electrical energy. A tramline had been constructed and opened, and within another month he hoped a second line would be in existence. Further, he hoped by the middle of July to have the sanction of Parliament to construct a further line, and he did not think the committee would stop at that or fail to appreciate the value of electricity until they had covered every highway possible within an easy radius of Wigan. He pointed out various applications of electricity, and trusted the inhabitants would take full advantage of these applications. He expressed great confidence in their engineer, his designs, and the success of his work. He had great pleasure in asking his Worship the Mayor to declare the works open, and on behalf of the committee presented him with a silver key, which he trusted the Mayor would take home as a memento of the ceremony of that day.

The MAYOR tendered them his very grateful thanks for the handsome present they had given him as a memento of that occasion. He thought that, while their thanks were due to others, they should not stint their praise to Mr. Councillor Worthington in consideration of the zeal, time, and devotion Mr. Worthington had given to the attainment of the great work of an electric installation. Then in Mr. H. Collings Bishop, the electrical engineer, they possessed one of the most valuable officials that any corporation could possess. He alluded to the objection some people took to the spending of a little money for the purpose of gaining information, yet, as a rule, this expenditure was all clear gain to the Corporation. From a financial point of view they must ask the public to bear with the committee a little longer, because at first the undertaking would hardly be at its full capacity, and a short time must elapse before financial success could be reached. In conclusion, the Mayor thanked them for their present, which he would treasure very highly.

Councillors GEE and SUTHERLAND also addressed the assembly, which subsequently adjourned to the machinery department, where the Mayor, amid applause, started the engine, turned the current on to the switchboard, and declared the works open.

Altogether the ceremony was extremely successful, and we have no doubt that the enterprise of the Corporation will be ultimately as successful.

THE COMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

(Concluded from page 589.)

THE APPARATUS FACTORY IN THE ACKERSTRASSE.

The factory in the Ackerstrasse (Figs. 10 and 11) represents the intermediate stage in the growth of the huge business now possessed by the Allgemeine Elektricitäts-Gesellschaft. It was acquired in 1887, when the original factory in Schlegilstrasse was found insufficiently large, and was devoted, until in its turn outgrown, to the manufacture of dynamos, motors, instruments, cables, india-rubber, and other installation material. Since the year 1896, when the manufacture of large generators and motors was transferred, as described above, to the Brunnenstrasse, and in 1897 the cable and indiarubber business to a new factory at Oberschöneweede, the premises at Ackerstrasse have been devoted entirely to instruments, arc lamps, and other accessories in connection with electrical installations.

The buildings constituting the factory form the four sides of a large square fronting four streets. The ground covered is 15,000 square yards, and as the premises are in four storeys, the working area amounts to over 60,000 square yards. Although, of course, in 1888 electric lighting was a proved success (and it goes without saying that the Ackerstrasse factory was lit electrically), yet at that date little practical experience or knowledge was to be

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obtained of the results of factory driving by motors, energy transmission by electricity being then more or less an academic question. The arrangement of the factory with four wings and in four storeys was not, however, well adapted to the transmission of energy by means of steam-engines, to accomplish which would have involved the installation of several separate plants. It was, therefore, decided by the directorate to adopt electric driving, which lent itself so conveniently to the nature of the premises, and which only meant the building of one generating station. The foresight thus shown was well rewarded by the successful results which followed, and the economy and flexibility of the system being soon recognised, the factory of the Allgemeine Elektricitäts-Gesellschaft became the model upon which numbers of other workshops were equipped. Each department is driven by its own motor, which is mounted on a bracket close to the roof, and is belted to the countershafting. In addition to these motors which drive the general shafting, there are many separately-driven tools, and here, as in the Brunnenstrasse, portable tools electrically operated are largely used, notably in the switch-board department for drilling the marble or slate bases of the boards.

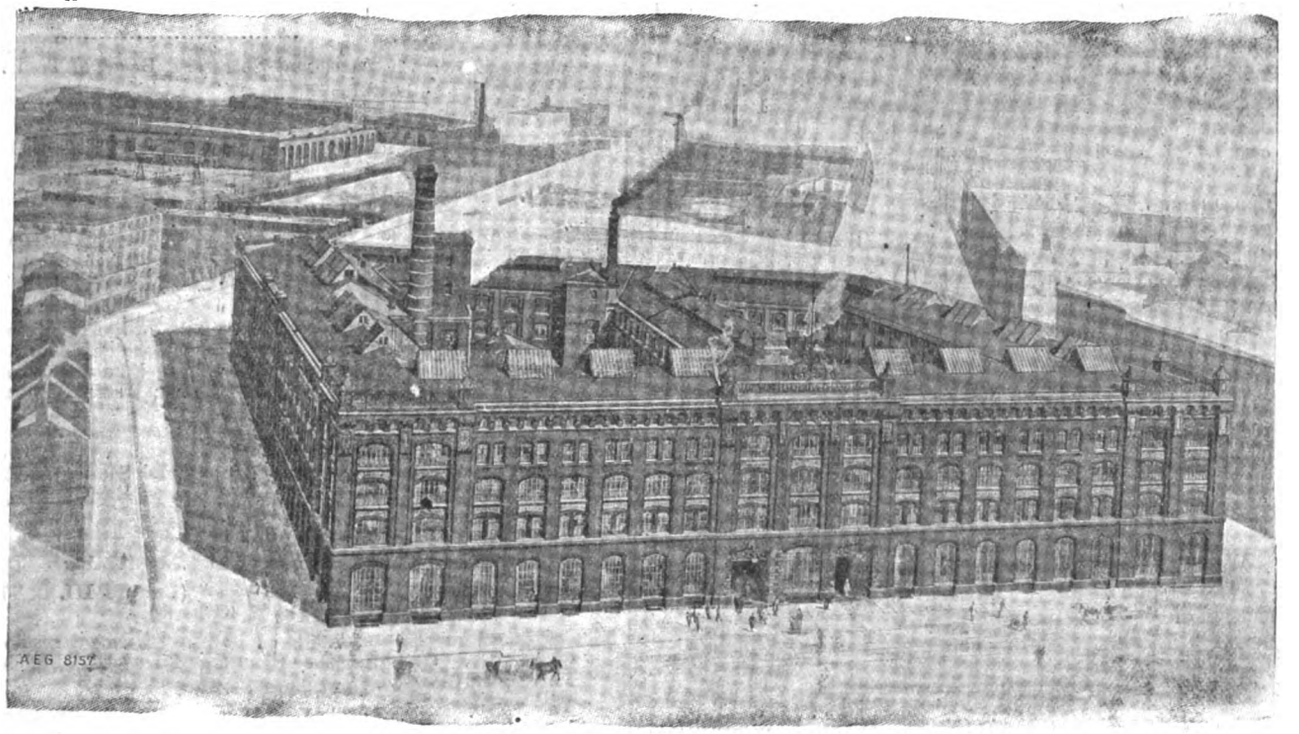

FIG. 10.

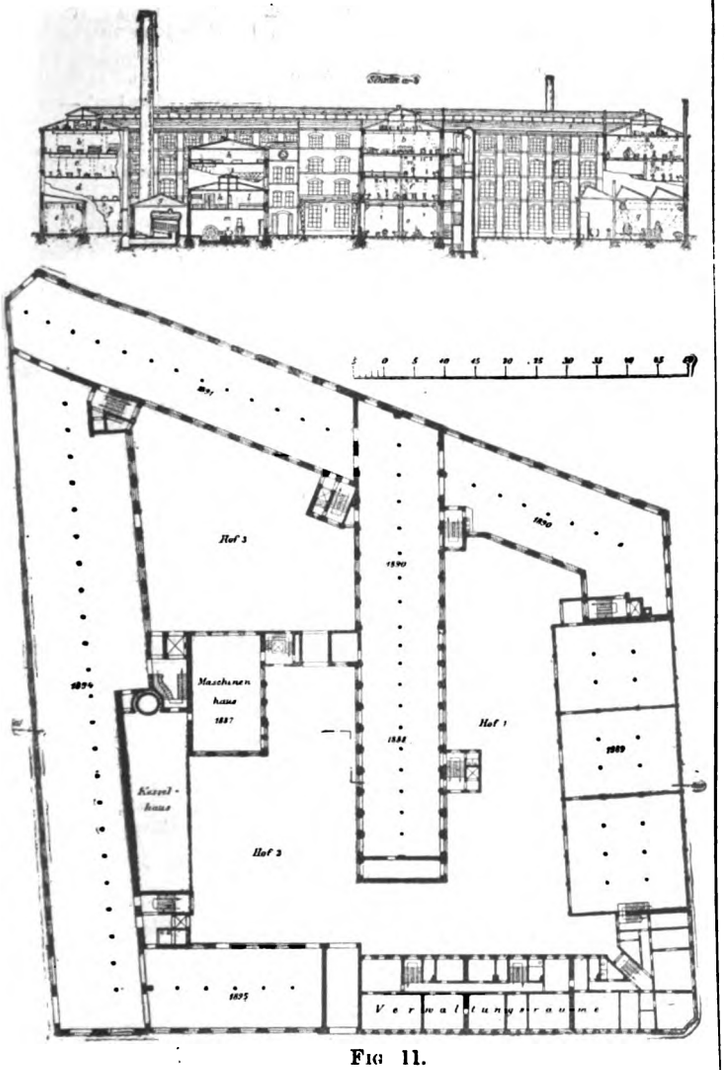

FIG 11.

FIG. 12.

The most noteworthy departments are those devoted to the manufacture of arc lamps (Fig. 12), measuring instruments, switchboards, and resistances, although there are many others covering all classes of electrical accessories for lighting, power transmission, central station, and traction appliances. In the first-mentioned department every stage in the manufacture of shunt and differential and enclosed arc lamps for both continuous and alternating currents can

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be seen. Every lamp is carefully regulated and subjected to a lengthy test before being sent out. A special motor-generator is provided for the testing of the continuous-current lamps, the ordinary supply being three-phase. In the switchboard department, naturally the high-tension apparatus excites the most interest. The standard switches designed by the Allgemeine Elektricitäts-Gesellschaft operate satisfactorily for tensions up to 12,000 volts without the necessity of an oil break. The blades are carried on special insulators, and are actuated by a neat lever arrangement, causing them to fly apart simultaneously over a long arc of a circle. The high-tension fuse consists of a glass tube filled with a special powder for a certain distance at each end, and containing in the middle three short glass tubes supported between asbestos discs. The fuse is formed of three wires in parallel, one of which passes through each of the small inner tubes. All switches, fuses, and other installation materials are designed to conform with the requirements of the Verbandes Deutscher Elektrotechniker. The power required to drive the Ackerstrasse factory is obtained from the central station in the Brunnenstrasse factory, the transmission cables being brought through the tunnel connecting the two works. There is also, however, a separate station in the former of about 1,000 h.p., which is kept in reserve and for overloads.

We hope that the above information will be sufficient to convey to our readers a general idea of the nature and extent of these works, and that it will serve to make a personal acquaintance with them more useful and interesting.

ELECTRIC LIGHTING ACTS, 1882 AND 1888

The Board of Trade, after consideration of the representations made at the recent enquiry held at the Westminster Town Hall with respect to the regulations made by them under the Electric Lighting Acts for ensuring a proper and sufficient supply of electrical energy, have decided to make further regulations in the accompanying form amending those previously made:

BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

Regulations Made by the Board of Trade for Ensuring a Proper and Sufficient Supply of Electrical Energy.

Principal Regulations.—1. In these regulations the expression "principal regulations" means the regulations for ensuring a proper and sufficient supply of electrical energy made by the Board of Trade under the ———— Order, ——, and referred to in the letter from the Board of Trade to ———— of the ——— day of ———.

Amendment of Regulation 5 *of Principal Regulations.*—2. Regulation 5 of the principal regulations shall be read as if the following provision were added at the end thereof: "Provided that so long as effect is given to the next following regulation, the undertakers shall not be bound, under this regulation or any regulation corresponding thereto, previously made, to comply with any condition which has been or may be imposed thereunder, the effect of which is to prohibit any change in the pressure of the supply to any premises except with the consent of the consumer."

Amendment of Regulation 6 *of Principal Regulations.*—3. Regulation 6 of the principal regulations shall be read as if the following provision were added at the end thereof: "But where the consumer withholds his consent after the undertakers have offered to comply with the general terms and conditions imposed by the Board of Trade (county council, local authority), and, if not required to do so under those terms and conditions, also to pay the reasonable cost of or incidental to the change (including compensation for any loss or damage incurred in consequence of the change), the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, give their consent to the change on such terms and conditions as they impose, and the consent of the Board so given shall, for the purpose of this regulation, have the same effect as the consent of the consumer."

The Board of Trade may, if they think it necessary in any case, refer to a single arbitrator appointed by them to determine what terms and conditions it would be proper to impose under this provision in case the consent of the Board is given.

Any such arbitration shall be subject to the like provisions as an arbitration in pursuance of a special Act under Part I. of the Board of Trade Arbitrations, etc., Act, 1874, and shall also be subject to the provisions of the Arbitration Act, 1889, as if the arbitration were pursuant to a submission, except that the powers under the last-mentioned Act with respect to the costs of the reference and award shall be exercised by the Board of Trade instead of by the arbitrator.

Made by the Board of Trade this —— day of ———.

.....

Assistant Secretary, Board of Trade.

FORTHCOMING EVENTS.

FRIDAY, MAY 3.

Society of Arts.—At 8 p.m., Mr. A. C. Eborall on "Polyphase Electric Working" (Lecture II.)

Royal Institution.—At 9 p.m., Mr. Chas. Mercier, M.B., on "Memory."

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. The Northcott Prize paper on "How may the best efforts of Employers and Employed be exerted for their mutual advantage and for the national benefit?" by Mr. William Powrie, will be read and discussed.

SATURDAY, MAY 4.

Institution of Electrical Engineers (Students' Section).—Visit to the Davies-street works of the Westminster Electric Supply Corporation.

MONDAY, MAY 6.

Royal Institution.—At 5 p.m., general monthly meeting.

Society of Arts.—At 8 p.m., "Alloys" (Lecture III.). This lecture will be delivered by Dr. T. Kirke Rose.

Society of Engineers.—At 7.30 p.m., "The Treatment of Low-Grade Iron Ores for the Smelting Furnace," by Mr. Thomas B. Grierson.

TUESDAY, MAY 7.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting.—(Students' Section), at 7.30 p.m., meeting at the Finsbury Technical College. Paper: "Recent Work on Hertz Wave Phenomena and their Application to Wireless Telegraphy," by Mr. F. L. Hiss, jun.

Society of Arts (Colonial Section).—At 4.30 p.m., Lieut. W. Bellairs, R.N., on "The Coal Problem: Its Relations to the Empire."

WEDNESDAY, MAY 8.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., annual general meeting.

Society of Arts.—At 8 p.m., ordinary meeting. Sir Joshua Fitch, LL.D., on "School Work in Relation to Business."

Iron and Steel Institute.—At 10.30 a.m., annual meeting opens at the Institution of Civil Engineers. Report and treasurer's statement for 1900: presentation of the Bessemer gold medal for 1901 to Mr. J. E. Stead, F.I.C.; president's inaugural address. Papers as follows: "On the Properties of Steel Castings," by Prof. J. O. Arnold; "On the Physical Properties of Steel," by Mr. J. A. Brinell; "On the Heat of Formation of Carbides and Silicides of Iron," by Mr. E. D. Campbell; "On the Use of Hydraulic Power in the Manufacture of Iron and Steel," by Mr. R. M. Daelen; "On British and American Rolling-Mill Practice," by Mr. William Garrett; "On Dust in Blast-Furnace Gas," by Mr. A. Greiner; "On a Water-Cooled Blast-Furnace Bosh," by Mr. Axel Sahlin; "On the Economical Significance of High Silicon in Pig Iron for the Acid Steel Processes," by Mr. Axel Sahlin; "On Crystals of Carbo-Silicide of Manganese and Iron from a Blast-Furnace Burden," by Mr. J. E. Stead; "On the Effect of Copper in Steel Rails and Plates," by Messrs. J. E. Stead and John Evans; "On the New Bessemer Shop and Heating Pits at the Works of the Barrow Hematite Steel Company," by Mr. J. M. While; "On the Measurement of Young's Modulus for Iron Rods by Tension and by Bending," by Mr. H. E. Wimperis; "Note on a Medal struck in Steel, presented to the Institute by Mr. E. J. Ljungberg," by the Secretary.

THURSDAY, MAY 9.

Iron and Steel Institute.—At 10.30 a.m., annual meeting (second and last day).

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting, at the Society of Arts. Paper on "Storage Batteries in Electric Power Stations, controlled by Reversible Boosters," by Mr. J. S. Highfield.

FRIDAY, MAY 10.

Royal Institution.—At 9 p.m., Prof. J. C. Bose on "The Response of Inorganic Matter to Mechanical and Electrical Stimulus."

Physical Society of London.—At 5 p.m., ordinary meeting. Papers: "Applications of Elastic Solids to Metrology," by Dr. C. Chree F.R.S.; and "The Thermal Properties of Isopentane compared with those of Normal Pentane," by Prof. S. Young, F.R.S., and Mr. J. Rose-Innes. Council meeting at 4 30 p.m.

Society of Arts.—At 8 p.m., Howard Lecture on "Polyphase Electric Working," by Mr. A. C. Eborall. (Lecture III.).

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BRADFORD ELECTRICITY ACCOUNTS.

From the accounts of the Bradford Corporation electricity works just issued it appears that the total expenditure on capital account to Dec. 31, 1900, amounted to £241,409. 15s. 5d. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. :

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£5,976	7	9			
Oil, waste, water, and stores	880	17	2			
Wages at generating stations	2,306	10	0			
Repairs and maintenance: buildings, £458. 19s.; machinery, £2,110. 4s. 7d.	2,569	3	7			
				11,732	18	6
Distribution of Electricity.						
Wages and other remuneration	225	19	3			
Repairs, etc., of mains	553	10	2			
Repairs, etc., of meters, etc.	343	18	2			
Wages—meter inspection	191	17	9			
				1,315	5	4
Public Lamps.						
Repairs and renewals				773	5	9
Rents, Rates, and Taxes.						
Rents payable	250	16	8			
Rates and taxes	1,001	17	11			
				1,252	14	7
Management Expenses.						
Salaries—Engineers' department	533	19	0			
Accountant, staff, etc.	836	17	5			
Proportion of salaries and expenses	175	0	0			
Stationery and printing	195	3	2			
General establishment charges	650	7	0			
				2,391	6	7
Special Charges.						
Insurances, etc.	122	4	6			
Incandescent lamps	680	0	2			
Motor and arc lamp hiring department	1,523	1	6			
				2,325	6	2
Total expenditure				19,790	16	11
Amount carried to net revenue account				18,756	6	1
				£38,547	3	0

Cr.	£	s.	d.
Sale of current per meter for lighting and motive power, £30,980. 10s. 2d.; tramways, £3,972. 18s.; public lighting, £523. 10s.	35,476	18	2
Rental of meters, £1,078. 2s. 1d.; sale of incandescent lamps, £29. 12s. 7d.; sundry sales, £99. 1s. 8d.	1,206	16	4
Rents receivable	3	15	0
Motor and arc lamp department—hire, sales, etc.	1 859	13	6
	£38,547	3	0

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	229,536	11	1
Sundry creditors	1,717	3	8
Net revenue account—balance at credit thereof	10,190	14	5
Sinking fund account	10,101	13	1
Depositors	243	0	0
Owing for interest on loans, etc.	2,008	15	6
Ditto to bank	61,185	0	3
	£314 987	18	0

Cr. Assets	£	s.	d.
Capital account—amount expended for works	259,413	11	0
Stores on hand	1,274	8	6
Hired motors and arc lamps	25 487	2	2
Sundry debtors for current supplied	19 294	17	3
Other debtors	3 145	11	8
Cash in bank and in hand	6 372	7	5
	£314 987	18	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		4 141,284
Quantity sold	Public lamps 76 445; Private consumers by meter 3,348,213	3,424,658
Quantity used on works		414,058
Total quantity accounted for		3,838 716
Quantity not accounted for		302,568
Number of public lamps (arcs)		51

Total maximum supply demanded (kilowatts): lighting 2,275; traction, 467—total, 2 742.

LEITH ELECTRICITY WORKS.

From the electric lighting accounts of the above town for the year ended Dec. 31, 1900, it appears that the total expenditure on capital account to that date amounted to £44,042. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal and other fuel	£1,795	8	11
Oil, waste, water, and engine-room stores, etc.	93	3	1
Wages at generating station	742	0	1
Repairs, etc.—Buildings	45	8	10
Engines and boilers	103	1	9
Dynamos, motors, etc.	44	19	4
Other machinery, instruments, and tools	57	6	1
Accumulators and accessories	1	4	0
Distribution of Electricity.			
Wages and repairs, etc., of mains	28	14	6
Repairs, etc., of transformers, etc.	4	7	0
Public lamps—wages, carbons, and repairs	530	7	4
Rents rates, and taxes	443	4	4
Salaries—Engineer's department	343	13	10
Accountant and clerical staff	126	11	2
Accounting and collecting	99	0	1
Stationery and printing	73	13	8
General establishment charges	145	8	7
Special charges—insurances, etc.	66	6	6
	4 743	19	1
Balance carried to net revenue account	1 641	4	7
	£6.385	3	8

Cr.	£	s.	d.
Sale of current—Private lighting at 5d. per B.T.U.	3,041	5	4
Motor power at 1½d. per B.T.U.	1 167	12	10
	4 208	18	2
Public lighting—arc lamps at £20 per annum	2 160	7	9
Miscellaneous receipts—retesting installations, etc.	15	17	9
	£6,385	3	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Public Works Loan Board—balance due on mortgage	33,188	0	0
Edinburgh Savings Bank—balance due on mortgage	9,000	0	0
Royal Bank of Scotland on account current	2,785	9	1
Sundry creditors	428	18	0
	45,402	7	1
Surplus—contributions from revenue for instalments of mortgage debt repaid	1,812	0	0
	£47,214	7	1

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	44 042	4	10
Stores on hand	328	19	9
Sundry debtors for current supplied	2,464	11	8
Burgh general assessment	378	10	10
	£47,214	7	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		576 329
Quantity sold	Public lamps 213,646; Private consumers by meters 298,119	511,765
Quantity used in station		13,500
Total quantity accounted for		525,265
Quantity not accounted for		51,064
Number of public lamps		110
Total maximum supply demanded, kilowatts		356

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LOCALISATION OF FACTORIES.

SIR,—As is well known, there is a remarkable tendency for trades to keep themselves to particular localities, and the reasons for this under modern conditions are not always apparent. To the electrical manufacturers or firms contemplating the putting down of new works it would be a matter of great interest to ascertain what part of this country is really best adapted for the purpose. It has occurred to me that perhaps some of your readers would be able to furnish information on this point, and I venture to put before them the question, "What part of the country should be chosen for entirely new electrical works, assuming that the firm putting same down had an entirely free hand, and was not influenced by any outside considerations other

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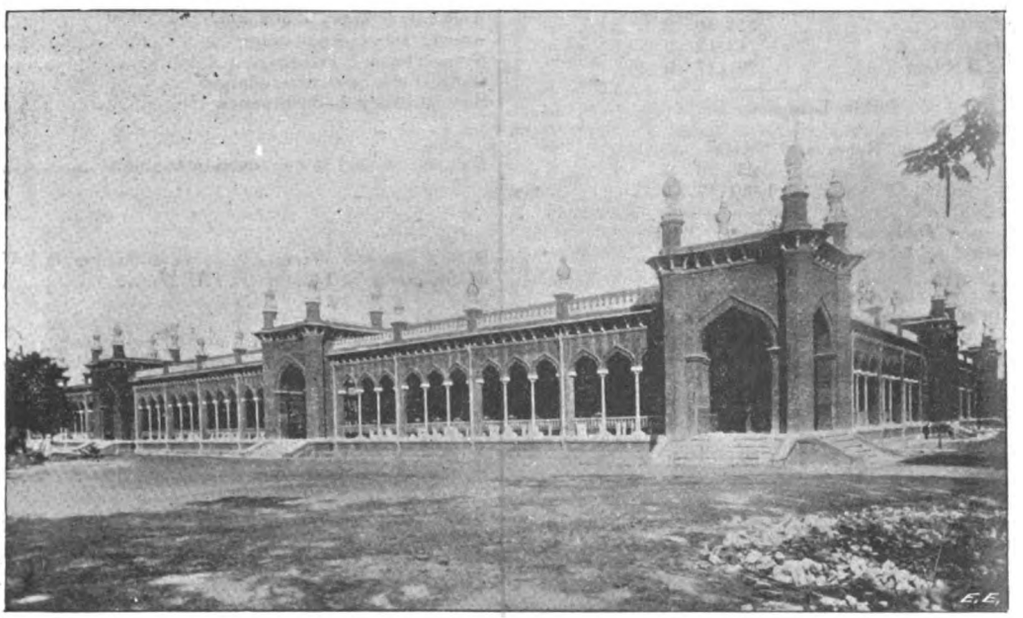
than the actual general adaptability of the locality?" I feel sure a discussion of this question would be of considerable interest to your readers generally, and I trust you will see your way to insert it in your columns.—Yours, etc., RICHARD V. LYNN.

37, Foxley-road, North Brixton, S.W.

ELECTRIC LIGHTING IN INDIA.

SIR,—In your issue of the 5th inst., p. 483, the building you describe as an Indian fruit market furnished with the electric light is not a fruit market, but a small part of the High Courts of Madras, and designed by H. Irwin, C.I.E. This building is not lighted with the electric light. The market, which I designed, and which was opened by Sir Arthur Havelock on Nov. 30 last, is lighted by arc lamps.



Indian Fruit Market.

I enclose a photograph of the market in case you would like to reproduce it.—Yours, etc., R. E. ELLIS.

London, W.C., April 27, 1901.

THE HIRAM S. MAXIM ELECTRICAL CORPORATION IN LIQUIDATION.

SIR,—With reference to the recent advertisements concerning the liquidation of this company, there appears to be some misunderstanding as to the reason therefor, and I am instructed to inform you that the business of this company has been sold on favourable terms to the Sir Hiram Maxim Electrical and Engineering Company, Limited. The liquidation proceedings were purely voluntary, and were instituted for the purpose of carrying out this sale. The whole of the old company's creditors are being paid in full, and the shareholders will receive for their present holding shares in the Sir Hiram Maxim Electrical and Engineering Company, Limited.—Yours, etc.,

W. J. WHEATLEY, Secretary and General Manager,
Sir Hiram Maxim Electrical and Engineering Company, Limited.

KING'S LYNN ELECTRICITY WORKS.

SIR,—In your report of the starting of the new extensions with steam power, you state that the original plant consisted of gas-engines driven by Dowson gas. Permit me to inform you that our company are the *only* makers of the Dowson gas plant, and that we never supplied directly or indirectly any of the plant at King's Lynn.

Whoever supplied the gas plant for that place has no right whatever to lead anyone to suppose that a Dowson gas plant was put in, or that Dowson gas is used. An imitation of it has probably been attempted, and as it appears to have been a failure, it will prejudice us to have the name of Dowson connected with it any way. We trust therefore to your sense of justice to let our disclaimer appear.—Yours, etc., W. B. MERCER, Secretary.

The Dowson Economic Gas and Power Company, Limited.

THE LIGHT RAILWAYS ACT.

SIR,—At the present juncture it may interest you to know what action the Tramways and Light Railways Association has taken with regard to obtaining modifications in the Light Railways Act, which is now before Parliament for renewal.

On Feb. 28 last a deputation was received by the President of the Board of Trade from this association, represented by our Law and Parliamentary Committee and one or two other of our members. This deputation laid before Mr. Gerald Balfour the following suggestions to be embodied in the new Light Railways Act, at the same time detailing their opinions on the various points. (See below.)

It is hardly necessary to say that the views put forward by the different speakers of the deputation had been most carefully considered beforehand, and it was felt that the amendments suggested were only fair and reasonable. It was understood that the views of the deputation should receive every attention, but it is much to be regretted that the President of the Board of Trade has not seen his way to include more of the suggestions of this association in the new Bill.

The idea seems prevalent in some quarters that as yet sufficient experience has not been obtained to enable a permanent measure to be satisfactorily drafted, and it is therefore proposed to do little more than prolong the Act for another five years in its present form. We cannot believe, however, that the majority of those competent to judge on the question can agree with this, and before the new Bill is passed, we trust that all those who are in any way interested in tramway and light railway matters will do their utmost to bring the necessity before Parliament of inserting further modifications in the new Light Railways Act than appear in the Bill as at present drafted.—Yours, etc., NORMAN A. THOMPSON.

SUGGESTED POINTS FOR AMENDMENT IN THE LIGHT RAILWAYS ACT.

1. Applications under the Light Railways Act should not be refused a hearing on the ground that the proposed light railway lies wholly in a single urban district.
2. Make the Board of Commissioners a permanent paid body and increase their numbers.
3. The Act should not be regarded as incorporating any of the provisions of the Tramways Act, 1870, or as making any of the provisions of that Act applicable to any order promoted thereunder.
4. The Commissioners to have power to amend the provisions of the existing local Acts and orders relating to any tramway undertaking to be worked in connection with the light railway, including power to postpone the date of purchase.

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5. Commissioners to have power to allow land to be taken compulsorily for the purposes of constructing a road over which the light railway is to run.

6. Section 9, Sub-Section 3. Add at end of sub-section, "But shall, if so required by the promoters, submit the same to Parliament as a provisional order."

7. The Commissioners to have power in suitable cases to grant compulsory running powers subject to Section 23 of the Act.

8. Section 13, Sub-Section 1. Omit the words "and contiguous."

9. Insert provisions enabling the Commissioners to authorise statutory companies to raise additional capital and subscribe to light railway companies and to be represented therein, and *vice versâ*.

10. Section 7, Sub-Section 3. Omit the words "whether made formally or informally," and insert "made in the prescribed manner."

11. Questions of speed not to be dealt with in the order, but left to the Board of Trade inspector hereafter.

12. Commissioners to have power to vary Section 92 of the Lands Clauses Act, "Part of a House," and to insert "Underpinning Clause." (See Model Bill.)

13. No local enquiry to be essential to an amending order, and enquiries into unopposed orders may be held in London.

CATALOGUES RECEIVED.

Messrs. Robert W. Blackwell and Co. have just issued their catalogue No. 35, which is devoted to tramway tools, supplies, and sundries. In this list we find well-illustrated descriptions of a vast number of details standardised by Messrs. Blackwell and Co. for tramway work. These range from car couplings, gear wheels, etc., down to the hundred and one tools which are required by the permanent-way department when equipping new lines or when making repairs on old ones. We notice that the car heaters are made in a variety of forms, which can be varied according to the energy which the tramway undertaking is prepared to use for heating purposes. These heaters have also regulating gear supplied with them, so that the amount of resistance wire in circuit can be altered according to the conditions of the weather. The rail saws which are now supplied in a portable form are another interesting feature in the list, as while these saws, as a rule, will be required in the workshops, cases may arise in which they are required on the line when making urgent repairs. These saws are provided with automatic feed, and are as a rule worked by hand. From the design, however, it would be exceedingly easy to drive them by electric motors. The "Conant" rail-joint tester is also included amongst the list of accessories. This instrument is based on the principle of ascertaining what length of rail has the equivalent resistance to the joint which has to be tested. For this purpose three staffs are used with metal ends, which make connection with the track at three points. Two of these points are placed equidistant from the joint which has to be tested, and the third point is moved along until the resistance of the rail between it and its adjacent contact is equal to the resistance of the joint. The connections used are those of a Wheatstone bridge, a telephone serving as the indicator, and an interrupted current is sent through the rails to be measured. With this instrument it is exceedingly easy to quickly locate a badly-bonded joint.

Messrs. Peto and Radford, Limited, have forwarded to us their catalogue of pocket and portable accumulators as specially designed for a great variety of purposes. Amongst these we see a four-cell battery, which is made up in a curved form so as to go easily into the breast pocket. This class of cell is largely used for giving the light required by omnibus inspectors and ticket collectors on lines where the illumination of the carriages is not good. The larger sizes of accumulators are made up in rectangular boxes, and where high voltages are required a number of these are grouped together in a wooden case. From the illustrations we gather that the firm have made a speciality of supplying electric accumulators suitable for the sidelights of ordinary carriages. In these cases the accumulators are carried under the coachman's seat. There are also illustrations in the list of these accumulators attached to bicycles, but we do not think the average cyclist will care for them owing to the increased weight, which is considerably more than that of the small accumulators which have been successfully used for bicycle lamps.

From the British Westinghouse Electric and Manufacturing Company, Limited, we have received a copy of their circular No. 1,045, entitled "Lightning Protection," which, we are told, supersedes circular No. 1,006. It gives a quantity of information calculated to be of value to those who may be interested in up-to-date methods of protecting electrical apparatus against injury through lightning. A number of arresters of the firm's design and manufacture are fully described and illustrated, besides which some useful instructions are given for installing the same.

Messrs. John Gibbs and Son have sent us a copy of their new booklet, "Ventilation," giving particulars of the various standard makes of fans turned out by them, and also of their patent motor safety starting and regulating switches. With regard to the latter, their design renders it impossible to turn on the current without the resistance being in circuit. Another important feature claimed for them is the combination of the safety fly-back with absolute speed regulation, thus permitting the speed of the motor to be increased or diminished at pleasure, while retaining the safeguard of the flyback. Both the motor-starting switches and motor-driven fans illustrated in the booklet are characterised by their compactness.

Correction.—In our last issue we referred to an electrical progress sheet as having been received from the Electrical Company, of Charing Cross-road. We are reminded that the sheet was, in fact, sent us by the General Electric Company, of Queen Victoria-street, who drew our attention to the curling-iron heaters with automatic switch, a quantity of which were supplied to H.M.S. "Ophir" for the Royal tour; also to the patent hydrometer, which should prove most useful for the small accumulators used in connection with electrical ignition for motorcars.

THE NEW COUNCIL OF THE INSTITUTION.

The following is the belated list of the nominations by the present Council for the Council for 1901-2. This list was read out at last night's meeting:

President.—W. Langdon.

Vice-Presidents.—R. K. Gray (remaining in office); Major P. Cardew, R.E., S. Z. de Ferranti, and John Gavey (new nominations).

Members of Council.—H. H. Cunynghame, C.B.; Henry Edmunds; Robert Hammond; Hugo Hirst; J. E. Kingsbury; A. J. Lawson; R. Percy Sellon; C. P. Sparks (remaining in office); H. E. Harrison; Lieut.-Colonel H. C. L. Holden, R.A., F.R.S.; the Hon. C. A. Parsons, F.R.S.; W. H. Patchell; J. H. Rider; Mark Robinson; J. Swinburne (new nominations).

Associate Members of Council.—W. R. Cooper, M.A., B.Sc., and R. W. Wallace, K.C. (remaining in office); W. Duddell (new nomination).

Hon. Auditors.—F. C. Danvers; E. Garcke.

Hon. Treasurer.—Prof. W. E. Ayrton, F.R.S. (past-president).

Hon. Solicitors.—Messrs. Wilson, Bristows, and Carpmael.

Any outside nominations of candidates for office must, under the articles of association, be made by two members and supported by eight other members, and the proposal sent to the secretary within seven days of last night's meeting.

At the same meeting the PRESIDENT announced that M. Mascart had been elected an honorary member of the Institution, and had sent a letter thanking the Institution for the honour they had conferred upon him.

The PRESIDENT also said that a committee had been appointed to determine whether it could recommend the Council to take any action, and if so, what, to assist the industry in connection with the matters dealt with in Mr. W. L. Madgen's recent paper. The committee was anxious to enquire impartially into the matter, and to hear the views that might be put forward on all sides of the question. A procedure in many respects similar to that of a Parliamentary committee would therefore be followed. Proof offered by the witnesses would be circulated among the members of the committee before the meetings, and that proof would then be discussed with the gentlemen presenting it. In order that the mass of evidence which it was hoped would be obtained should not be lost, shorthand notes would be taken of the proceedings at the meetings.

It was then announced that the annual general meeting previously fixed for May 23 would be held at the Society of Arts on May 30, and that the annual conversazione would be held on Friday, June 14.

St. Marylebone.—At last night's meeting the Council agreed to purchase the portion in St. Marylebone of the Metropolitan Electric Supply Company's undertaking on terms to be agreed, or failing agreement, to be determined by arbitration under the Lands Clauses Acts, and to empower the Lighting Committee to enter into an agreement for this purpose with the Metropolitan Company.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventers are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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THAT HOUSE LIST.

The man in the street is great upon the subject of a "strong president"; but then his views are generally pure "echoes," for "he has been told," and "someone has said," so that the reproduction of what has been said is automatic. The man in the street is too often merely a loud talker, without a foundation of facts for his arguments, relying upon emphasis and verbosity for conviction rather than anything possessing reality and tangibility. He knows his schoolmates and the chums that form his clique. He fights for them, rightly or wrongly, because his horizon is near at hand and rigidly defined. Of those who went before and smoothed his path for him he knows nothing; they are—being unknown—merely fossils, worn out, weak, and far from up to date. We all go through the mill, except such as are born with old heads on young shoulders, and have to live before learning that the world, the profession, and the industry have debts to pay for work done in the long ago. Now that the house list is really promulgated and open for discussion, it may be well to enquire a little more closely into the claims of the president nominated by the Council. Of course, there may be concerted opposition to the house list. We trust not, because the younger men might be given to understand that time is on their side, and if someone has to give place now, it does not mean permanently standing aside, but merely deference to the claims of older men, whose years do not permit of lengthy waiting for the recognition which is their due. Although an open secret, it is unnecessary for us to discuss further the reasons that led to the non-publication of the house list at the last ordinary meeting, except to say that the President might well have authorised the list to have been announced, instead of temporising, so that the annual meeting will have to be held at another date than the one arranged on the card.

It will be of interest to our readers who belong to the Institution of Electrical Engineers to know something of the career of the gentleman whom the Council has nominated to hold the office of president in 1901-2. In Mr. Langdon we have a representative of those who served under the pioneers of telegraphy, who has kept well in line with modern electrical engineering. Born in 1833, son of Commander John Weeks Langdon, R.N., assistant hydrographer at the Admiralty, and inheriting his father's scientific bent, at the age of nineteen he entered in 1852 the service of the Electric and International Telegraph Company, in which he soon came to the front as a junior engineer. When the telegraphs of the United Kingdom in 1870 were transferred to the Post Office, Mr. Langdon rapidly passed from the charge of the telegraphs of the South-Western Railway to the service of the Post Office, in which he occupied the important post of assistant divisional engineer until 1878, when he was appointed, on the recommendation of his then chief, Mr. (now Sir William) Preece, to the charge of the electrical department of the Midland Railway Company, which office he still holds. To Mr. Langdon must be credited the complete reorganisation of the block system. It

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must also be remembered that since 1880 some of the most important trunk telegraph and telephone lines in the kingdom have been erected and maintained for the service of the Post Office on the Midland Railway. The rapid expansion of the electrical engineering needs of a railway company may be realised when it is understood that under Mr. Langdon the mileage of wire has increased from eight thousand to twenty-seven thousand, and the instruments in use from seven thousand to twenty thousand. At present the ever-increasing requirements of a great railway company for the applications of electrical engineering requires the use of over one thousand telegraph stations, one thousand and seventy posts where block signalling is established, and eleven stations where electrical energy for lighting and other purposes is generated. The latter have a collective output of some five million units. It will not be wondered at that some one thousand nine hundred to two thousand employés in these various undertakings look to Mr. Langdon for guidance. Besides being an able inventor in the improvement of the appliances which are in his charge, he has not failed to provide that the systems of which he has control shall apply all the most modern improvements—for instance, such as quadruplex telegraphing—which the railway authorities allow him to adopt. To Mr. Langdon, who joined the Institution (then the Society of Telegraph Engineers) in 1872, was due its gratitude, when in 1877, at a moment of emergency, he volunteered to act (in addition to his official duties) as secretary, and continued so to act for eleven months. The grateful and appreciative wording of the Council's minute, when he ceased to act, shows the importance of the service then rendered. Like many others of its distinguished members, Mr. Langdon, owing to his residence away from London, was not, until 1895, able to become a candidate for the Council, but he was elected that year, and has served continuously since, first as member, and for the last three years as a vice-president. He is the author of papers read before the Institution in the years 1874, 1876, 1877, 1895, 1896, 1898, and 1900.

Major Cardew, who is nominated by the Council as a vice-president, hails from Cornwall, and both on his father's and mother's side comes from an intellectual stock. He received his commission in the Royal Engineers (with the Pollock medal and the sword for good conduct) in 1871, and was the first of his term. Since 1876 his career has been devoted to electrical engineering, especially whilst still on the active list, in connection with the early development of submarine mining, and the application of search-lights, and the firing of explosives for purposes of warfare. Besides, for several years, he was an instructor in practical electrical engineering at the Royal Engineers' schools at Chatham. During eleven years Major Cardew held the office of electrical adviser to the Board of Trade, and, in consequence, has been intimately in touch with all matters appertaining to electric traction and lighting. His suggestions in 1883 in connection with traction were especially noticeable at the time. Major Cardew's name is perhaps best known outside these kingdoms by the successful inventions with which his name is connected. He has belonged to the Institution since the seventies, and has three times served as a member of Council.

Mr. S. Z. de Ferranti, who is also a nominee of the Council, was born at Liverpool in 1864, and was educated at Hampstead School, St. Augustin's College, Ramsgate, and at University College, London. His entry into the field of electrical research dates back to 1877. Although he helped at the arc lighting of the King's Cross railway station so early as 1878, his first practical connection with electrical engineering was with Messrs. Siemens Bros. When still but nineteen years of age his name was given to the Thomson-Ferranti alternator, and ever since it has been intimately associated with generation at high pressure, transformation, and the measurement of alternating currents. As a scientific manufacturer, and as an electrical engineer of the first order, his name is indelibly connected with Deptford, Charterhouse-square, and later on with the works at Hollinwood, near Manchester. Since 1883 his name has been so prominently before the electrical world that it is unnecessary to remind our readers of his unrivalled claim to be honoured by high office in the service of the Institution of Electrical Engineers. In 1891, when he was engineer to the London Electric Supply Corporation, he was elected a full member, and he has since 1895 served on the Council.

Mr. John Gavey, who has also been nominated by the Council as a candidate for one of the vacancies of the vice-presidentship, is a Guernsey man, and has by his energy and experience attained the head position in that part of the profession which is actively engaged in telegraph and telephone work. When eighteen years of age he entered the service of the Electric and International Telegraph Company, and when the telegraph systems in the United Kingdom were acquired by the State, Mr. Gavey transferred his services to the postal telegraphs, in which branch of the public service he has remained up to the present time. In 1892, after filling the position of superintending engineer in several parts of the kingdom, he was moved to London, where he has filled the offices of chief technical officer, and of assistant engineer-in-chief, and electrician to his Majesty's Post Office. In telegraphy he has been intimately connected with all the triumphs achieved in the improvements in high-speed working, and from 1894 onwards he was Sir William Preece's executive officer in the Post Office experiments on wireless telegraphy. Mr. Gavey is, perhaps, better known outside the United Kingdom in connection with the telephone ever since its practical introduction, and besides having had charge of the consolidation of the telephone trunk-line system of these kingdoms, is engaged at present in establishing in the metropolitan area a telephone exchange which promises to become probably the largest in the world. He has belonged to the Institution since 1872, is a member of the Institution of Civil Engineers, and was a juror at the Paris Universal Exhibition of last year. He has

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read several useful papers before the Institution, and is a representative man from a great body of engineers who are employed in the telegraph and telephone industries.

When Mr. H. S. Harrison was transferred from the class of associates to full membership of the Institution in 1883, he had been in charge of one of the most important branches of the Hammond Company's business at Sheffield, and on the establishment of the Electrical Standardising, Training, and Testing Institution in Faraday House he was placed at the head, where he has since been carrying on its work in a thoroughly genuine way, and so as to afford sound theoretical and practical training to the students. He is now principal of the institution.

Major Holden, Royal Artillery, was educated at the Royal Military Academy, Woolwich. He became an associate of the Institution in 1883 and a member in 1888, as "having been intimately associated with electrical science in its numerous applications to military purposes, and in its uses in the War Department manufacturing establishments, and having distinguished himself in his power of applying the science to practical purposes." He is at present superintendent of the Royal Gun Factories, and was elected a Fellow of the Royal Society in 1895.

The Hon. Charles Parsons comes of a family well known for its production of scientific men. As a B.A. of Cambridge he became eleventh wrangler in 1877. His success as the inventor of the steam-turbines has now attained for him world-wide renown. At first all these steam-turbines were used for driving electric generators, and placed great advantages on the score of speed at the disposal of electrical engineers.

Mr. W. H. Patchell joined the Institution as an associate in 1888, and was transferred to membership in 1891. His first training as an engineer was with Messrs. Robey, of Lincoln. He was works manager of the Electrical Power Storage Company and also of the Electrical Construction Company between 1886 and 1893, when he was appointed engineer-in-chief to the Charing Cross and Strand Electricity Supply Corporation. He is now carrying out extensive work for the lighting of the city of London.

Mr. J. H. Rider became an associate of the Institution in 1885, and was transferred to full membership in 1891. His apprenticeship was under Messrs. Paterson and Cooper, and his chief early experience was as manager of the electric light department of Messrs. Blakey, Emmott, and Co. In 1893 he was appointed borough electrical engineer to the Corporation of Bolton, following which he filled a similar appointment under the Corporation of Plymouth. He has now entered the tramway service of the London County Council as chief engineer of that department.

Mr. Mark Robinson joined the Institution as member in 1888, when he was already the managing director of the well-known firm of Willans and Robinson. His connection with the development of high-speed vertical engines for central-station work is well known. He received the "Institution premium" in 1895 and the "Willans premium" in 1897 for contributions to the *Journal*, and for his valuable services to the electrical industry.

Mr. James Swinburne took a prominent part in all the electrical developments in the earlier days of electric lighting. He was employed under Mr. J. W. Swan in organising one of the first electric lamp factories, and he also contributed largely to the literature on the design of direct-current dynamos. Of late years Mr. Swinburne has been connected as expert witness with all the important electrical cases which have come before the Law Courts, and he is largely responsible for the organisation and publication of *Science Abstracts* by the Institution of Electrical Engineers jointly with the Physical Society.

Mr. W. du B. Duddell, who is nominated for the vacancy in the associate members of Council, is a Whitworth Exhibitioner of 1896 and Scholar of 1897. Conjointly with Mr. Marchant, he received the Institution's Paris Electrical Exhibition's premium in 1899, and he also received a gold medal at the Paris Universal Exhibition of 1900 for his oscillograph.

LEAD-POISONING.

Mr. Wynne E. Baxter, the East London coroner, concluded last week an enquiry into the death of A. Welsh, a paster at the works of the Electrical Power Storage Company at Millwall. The deceased died on Thursday, April 18, and the inquest was formally opened on Tuesday, the 23rd. At an adjournment of the inquest the Coroner informed the jury that he had only heard of the death on the night before the day arranged for the funeral, and it having been suggested to him that the man had died from lead-poisoning, he had had the funeral stopped. A *post-mortem* examination had been made without his knowledge, and a portion of the body taken away. A certificate was given stating that death was due to intestinal obstruction. That might be correct, but death might also arise from lead-poisoning. It was further alleged that others had died and certificates been granted. In all cases where lead poison was suspected or suggested it was the duty of the medical man to report the same to the coroner, so that the case might be properly investigated.

Mr. Hore and Mr. Ireland, his Majesty's inspectors of factories, with Dr. Legge, medical inspector of factories, were present from the Home Office. Mr. Watson, solicitor, appeared for the Electric Storage Company.

A considerable amount of evidence was given as to the precautions adopted at the works to prevent those men engaged on pasting accumulator plates from being poisoned due to the lead oxides which they have to handle. We regret that the full report of this case is too long to give in our columns, but we have received from the Electrical Power Storage Company some remarks which we think in justice to them ought to be made public, in view of the fact that the verdict at the coroner's inquest was that the deceased died from "lead-poisoning," and that such death was due to "misadventure." The remarks we have received from the company are as follows: "The practice of supplying the workmen with baths, aprons, and pasting gloves was originated by this company before there were any rules made by the Home Office on the subject. The existing rules, to a large extent, were framed on the practice which had been voluntarily initiated by the company. The company has always been most careful as to the quality and suitability of the gloves, and experience has shown that with reasonable care the gloves supplied should last at least a month. Needless to say, the gloves supplied are not old and worn as was represented, but are the very best obtainable, and are made specially for the work. The public account of the inquest states that we have only two baths for 150 workmen. It is difficult to say what this latter figure is based upon. The total number of our workmen is far in excess of that number, but the company is only required to provide baths for the men—18 or 20 men in all—who are engaged in handling the lead oxides, and for these the two baths provided are more than sufficient. The baths are carefully examined at short and regular intervals, and

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it is quite untrue that some of them have been out of order for months. As a matter of grace we have been in the habit of allowing the use of the baths to other workmen, at such times as they were not being used by the men already referred to. With regard to the statement that the men were allowed to go through the mixing shop when the mixing was going on, it is only fair to state that such a practice was not only unnecessary, but was strictly forbidden, and any men who did go through went in distinct contravention of the manager's instructions. The company has for years voluntarily employed and paid a medical man to make fortnightly examinations of the workmen purely in the interests of the men themselves, and whenever the doctor recommended a change work was found for them in other departments as far as possible. The *post-mortem* examination on the deceased was not made in the interests of the company, as suggested, and as a matter of fact the company did not know this was contemplated until after it had been made. The verdict of the coroner's jury was in direct opposition to the certificate of the cause of death (pyloric obstruction, with malignant growth of uncertain duration), and to the evidence given on oath by the two medical men who attended the deceased and who performed the *post-mortem* examination. No representative of the company other than the solicitor was allowed to be present at the inquest, and as the latter was necessarily unacquainted with many of the questions arising as to the company's practice, the company was at a distinct disadvantage."

We certainly think that when such enquiries are being held, expert evidence should be brought on both sides. From the point of view of the men, it is important that they should have, as they had at the inquest above referred to, the full support of the coroner, so that they can give their evidence without fear of prejudicing their employment. On the other hand, it is not fair that statements should be heard as to the organisation of the works unless those responsible for such works have also an opportunity of giving evidence and of being cross-examined on the points which have arisen.

COMPANIES' MEETINGS AND REPORTS.

INDO-EUROPEAN TELEGRAPH.

The annual meeting of the shareholders was held at the offices of the Company on Tuesday.

Mr. J H. Tritton, who presided, said there had been a strong agitation both in this country and in India for a reduction of the rate to the latter country. He had now to tell them that the directors had, in the two countries, actively advocated a reduction, recognising the anomaly of the lower rates to Australia than to India, the Australian rate being 3s. 6d , while the Indian remained at 4s. The reduction of the Australian rates had had fairly satisfactory results. If the international telegraph conference, which was to have been held in May, had not been postponed until next year. this question might have been settled without delay and trouble. The Company was still in negotiation with the German Government for the extension of the German concession. The Board were sorry that this had not already been granted, but an important question of that sort often necessitated prolonged negotiations. The directors were about to give evidence, in common with other telegraph companies, before the Cables Communication Committee, and they were glad that the public would shortly be suppplied, through the report of the committee, with full and accurate information concerning the telegraph companies. They were now experimenting with a new instrument which had, on a trial over a distance of 3 400 miles averaged from 80 to 100 words per minute, and it was hoped that the speed of the line would be still further increased by the use of this instrument. He moved the adoption of the report, which was seconded. The motion was carried.

CALCUTTA TRAMWAYS.

At the ordinary general meeting of the proprietors at the Cannon-street Hotel on Thursday week,

Mr. E C. Morgan, who presided, said the receipts showed the satisfactory increase of upwards of £12,000 as compared with those of last year, and were indeed the largest receipts taken in one year since the Company was established. That was the more satisfactory because, for the first half of the year the working of the Company was considerably interfered with by the reconstruction work, and when he last met the shareholders he did not anticipate that they would show such good results for the year. The mileage showed an increase of about 425,000 miles, and they were now running at even a higher rate with correspondingly satisfactory results, which augured well for the prospects of the system when, by means of mechanical power, they could further largely increase the mileage. When they met last year he told them that the Board had concluded a contract for the electrical equipment, but that they would themselves have to erect the power-house and the necessary sheds for the storage of the cars. For that purpose it was needful to secure convenient sites, and they had purchased three valuable plots of freehold land for the purpose. On one of these the power-house was almost completed and fit for the reception of the plant, which was, some of it, actually in position, and by the time the remainder of the generating plant arrived in Calcutta there was not likely to be any detention in its immediate erection. Work was also proceeding with the new car-sheds, so that by the time the cars arrived he believed they would be in a position to erect and house them at once. The Board had every reason to be satisfied with the progress made last year and up to the date of their last advices from India. The heavy payments which the Company was now making had nearly exhausted their available funds, and the Board would in consequence offer for subscription almost immediately debenture stock for £100,000, being the balance of the stock created when the arrangements for the conversion were completed. As soon as the amount had been subscribed they would apply to the Stock Exchange to have it quoted with the existing £250.000, with which it would rank *pari passu* He moved the adoption of the report and accounts.

The motion having been seconded, it was carried unanimously.

OSWESTRY ELECTRIC LIGHTING AND POWER.

The annual general meeting of the proprietors of this Company took place recently at Oswestry.

The Chairman (Mr. A. W. Corrie), in moving the adoption of the report, said that but for the increase in the price of coal they would have earned on the coal bill alone nearly enough to pay another 2 per cent. The directors did not increase the price of current to make up for this loss, but, all the same, the shareholders were to be congratulated on getting 4 per cent. The management expenses were not high considering the work done. The sale of current. they would be glad to notice, had now reached four figures—£1,069.

Mr. Minshall seconded the motion, which was carried, and a dividend of 4 per cent , free of income tax, was declared.

Mr. Wynne Corrie having been unanimously re-elected a director, a shareholder called attention to the smoke nuisance. It was pointed out that the directors had spent a large sum on the fixing of a mechanical stoker. It had been in operation five days, and the result was that they could not detect the slightest discoloration of the atmosphere.

The proceedings closed with a vote of thanks to the chairman.

ORIENTAL TELEPHONE AND ELECTRIC.

The ordinary general meeting of the shareholders was held on Friday last at Cannon-street Hotel, Sir Auckland-Colvin presiding.

In moving the adoption of the report, the **Chairman** congratulated the shareholders on the continued progress of the Company, and mentioned that on the present occasion the Board were enabled to recommend a dividend of 6 per cent. as compared with 5 per cent. a year ago. In Egypt the work of placing all telephone wires underground was about to be commenced, and every effort would be made to complete it in time for the opening of the next business season in October. In Hong Kong the future was also very promising. An opportunity occurred last year for the China and Japan Telephone Company to acquire their own freehold premises both in Hong Kong and in Kowloon, at an outlay of about £2,500. This investment was certain to increase in value as time went on, while it afforded for that company's business permanent accommodation far more suited to its increased importance than were the old hired premises. Mr. H. Johnstone Grewing, one of the directors, was at present making a tour of the more important subsidiary businesses in the Eastern seas, India, the Straits, and Burma.

Mr. Henry Grewing seconded the motion, which was adopted.

CALLENDER'S CABLE AND CONSTRUCTION.

The accounts for the year ended Dec. 31 last show a credit balance on the year's operations of £70 546. Together with the balance brought forward from 1899 of £8,211 this makes £78 768. From this sum £7,246 is written off for depreciation, and £3,000 to machinery renewal fund. leaving £68,522 Out of this sum has to be paid interest on debentures and dividend on preference shares, leaving net available £56,972. The directors propose to place to the reserve, thus bringing up this fund to £100,000, £23 616, leaving an available balance of £33,355, and they recommend the payment of the usual dividend on the ordinary shares of 10 per cent. and bonus of 5 per cent., making 15 per cent. in all for the year, part of which has already been paid as interim dividend. This leaves £10,855 to be carried forward.

CALCUTTA ELECTRIC SUPPLY.

Directors: Colonel A. J. Filgate, R.E. (chairman); E. Boulnois, Esq , M.P.; J. G. H. Glass, Esq., C.I.E.; P. V. Luke, Esq., C.I.E ; Sir Guilford L. Molesworth, K.C.I E. Secretary: Francis R Reeves, Esq., M I E.E.

Report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on May 8, 1901, at 2 p.m.:

The capital expenditure, which at the end of the year under review amounted to £118,266, includes a sum of £4,330 for the purchase of a site for the new generating station in the Alipore

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district. The license for the Alipore district was officially gazetted on Sept. 12 last. The designs for the station are prepared, part of the necessary plant ordered, and a large supply of material for mains shipped to Calcutta. The number of units of electrical energy sold during the year were 412,950, and the gross revenue from all sources amounted to £11,147. 15s. 8d. The working costs were £5,752. 17s. 4d., so that the result of the year's operations was a net profit of £5 394. 18s. 4d. Exchange is calculated at 1s. 4d. per rupee. To this sum must be added £651. 15s. 9d., the balance from last year, and £306. 4s. 4d., amount of interest on deposits at bankers, making together £6,352. 18s. 5d., less the interim dividend £1,436. 9s. 10d., leaving a balance of £4,916. 18s. 7d. available for distribution. The directors propose to place £2,500 to the credit of depreciation account, to pay a final dividend at the rate of 4 per cent. per annum on the paid up share capital, making with the interim dividend 3½ per cent. for the year, and to carry the balance £327. 7s. 9d. forward. During the past year the Board have issued 10,000 additional shares at a price of £5. 10s. per share, the premium on the issue, £5,000, being placed to reserve fund. During the year 1900 there were 294 houses connected to the mains, the total number of houses on the system at Dec. 31 being 409, the equivalent connections in 8-c.p. lamps amounting to 28,748, an increase during the year of 19,285 lamps. During the year the running of the station has been good. In September last abnormal rains were experienced in Calcutta, over 40in. having been registered in a single week. As a result several weak places developed in the underground mains, but by the exertions and skill of the Company's engineering staff, the difficulties were surmounted with but little interruption in the supply. The popularity of the electric ceiling fans continues to increase, and it is anticipated that a very large number will be in operation in Calcutta before the close of the present year. There is every indication that the current year will be prosperous, as numerous applications from customers are received by each weekly mail. The directors have appointed Mr. James George Henry Glass, C.I.E., late chief engineer and secretary public works department in Calcutta, to be a member of the Board, to fill the vacancy caused by the death of Mr. Harrison Hayter. In accordance with the articles of association, Sir Guilford L. Molesworth retires by rotation from the Board of directors, and, being eligible, offers himself for re-election. The auditors in London, Messrs. J. H. Duncan and Co., chartered accountants, and in Calcutta, Messrs. Lovelock and Lewis, chartered accountants, also offer themselves for re-election.

REVENUE ACCOUNT.

Dr. Generation and Distribution.	£	s.	d.
Coal or other fuel	1,175	14	11
Oil, waste, water, and stores	218	6	5
Proportion of salaries of engineers, etc.	810	16	2
Wages and gratuities	919	19	11
Expenses of working fans	71	17	8
	3,196	15	1
Repairs and maintenance—amount expended	326	7	3
Rents, rates, and taxes	126	15	7
Management expenses	2,102	19	5
Total expenditure	5,752	17	4
Balance carried to net revenue	5,394	18	4
	£11,147	15	8

Cr.	£	s.	d.
Sale of current (412,950 units), less rebates, etc.	9,674	18	10
Rental of meters	407	8	6
Rental of electrical fans	1,021	3	5
Transfer fees	10	12	6
Difference in exchange	33	12	5
	£11,147	15	8

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	116,943	0	0
Sundry creditors	2,511	13	6
Unclaimed dividends	34	11	9
Reserve fund	5,000	0	0
Balance at credit of net revenue account	4,916	8	7
	£129,405	13	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	118,266	4	8
Stores on hand	37	6	10
Sundry debtors for current, etc.	2 008	14	6
Cash at bankers and in hand	9,093	7	10
	£129,405	13	10

WESTERN TELEGRAPH.

The directors' report shows that the revenue for the half-year ended Dec. 31 amounts to £264,717 and the working expenses to £84,139. After providing £10,291 for debenture interest and sinking fund, and £6,361 for income tax, there remains a balance of £163,925. Adding £8,571 brought forward from June 30 last, this makes a total of £172 496. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £100,000 to the general reserve fund and £2,000 to a reserve fund for maintenance ships, there remains a balance of £7,069, which is carried forward to the next account. The revenue includes £11,888 dividends upon the Company's investments in other telegraph companies. The laying of the additional cable between Rio de Janeiro and Monte Video was successfully accomplished on Dec. 8 last. The Company has acquired an interest in Electra House, Limited, a company formed by the Associated Telegraph Companies to erect and manage a building to provide offices in London for submarine cable companies and others. The premises are in course of erection, and it is expected will be ready for occupation in March next year. The tariffs for correspondence with South America have recently been reduced by the Company.

WEST COAST OF AMERICA TELEGRAPH.

The directors' report for 1900 states that the gross income was £30,888, as against £28,347 in the previous year, and the working expenses £23,046, as against £21,065. After providing for the interest on the 4 per cent. debentures and the interest on the 4 per cent. income bonds, the net balance of profit was £1,041, and adding £256 brought forward, there remains an amount of £1,298, out of which the directors have appropriated £709 for the balance of the expenses of reconstruction, leaving £588 to be carried forward. The improvement in trade on the West Coast was maintained, and the rate of exchange at Valparaiso on London shows a further rise. The cables, land lines, and repairing steamer have been kept in a state of efficiency. The report will be presented at the meeting on the 7th inst.

SUBMARINE CABLES TRUST.

The directors' report shows that the revenue for the year ending April 15, including the balance of £74 brought forward, amounts to £24,976. The expenses amount to £1,383, and the payment of the coupons to £20,061, leaving a balance of £3,532, out of which £3,487 has been transferred to the redemption fund. This leaves a balance of £44 to be carried forward. During the year the Eastern Extension, Australasia, and China Telegraph Company, Limited, issued new share capital, which was offered to their shareholders, *pro rata* to their holdings, at £13 per share. The trustees disposed of the allotment to which this trust was entitled, the transaction resulting in a net profit of £2,623. In accordance with the terms of the trust deed 21 certificates have been redeemed since the last report, either by tender or purchase in the open market, and 30 have been drawn by lot—together 51 certificates—costing the sum of £6,111.

LEGAL INTELLIGENCE.

LONDON COUNTY COUNCIL v. METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

In the Chancery Division of the High Court last week, Mr. Justice Farwell heard this action, which was brought to obtain the construction by the Court of a clause in the Act relating to the making of the new avenue from Holborn to the Strand.

Mr. Haldane, K.C., Mr. Jenkins, K.C., and Mr. T. T. Methold were counsel for the plaintiffs; and Mr. Cripps, K.C., Mr. Butcher, K.C., and Mr. C. H. Sargent for the defendants.

It appeared that the County Council, in taking over certain occupied ground for the purposes of the new thoroughfare, had obtained the site of the defendants' electric generating station in Sardinia street, which defendants were entitled to have reinstated with all the capacity of the old station at the Council's expense. This capacity was stated to be 4,000 kw. The only question to be decided was whether, in providing a new station, the Council should equip it with spare plant over and above the generating plant sufficient to supply that amount. The Council took the negative view, saying they were only obliged to give the company what they had before, and no spare plant. The company, on the other hand, contended that the Council would not be giving them that capacity unless they were equipped with spare plant to provide for emergencies.

A number of expert witnesses having been called on either side,

Mr. Justice Farwell gave judgment. In his opinion, the theory of the section in dispute, which was a statutory bargain between the Council and the company, was that the company was to be compensated by being put as nearly as possible in the same position as before their premises were taken for the purposes of the proposed improvements. They were to have a new site adjacent to the old one, and they contemplated not merely replacing the old generating station, but having a larger station for transforming and transmitting electrical energy. An arbitrator had already been appointed, under the provisions of the Act, to settle the amount of compensation to be paid by the Council, and a decision was asked for in the present case for the guidance of the arbitrator in settling that amount. He found as a fact: (1) that all first-rate generators were made so as to have a small margin of possible supply in case of need—for example a machine marked "1,000 kw." would be capable of producing on an emergency and temporarily perhaps 1,250 kw.; (2) that there was no fixed ratio between output of machine and supply—there was a difference between "4 000 kw." as applied to the machines and as applied to the generating station. A station effectual to supply 4,000 kw. would have to be furnished with machines capable of producing more than 4,000 kw. He had also this further fact—that all the witnesses agreed that if you gave a

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manufacturer an order for machines of 4 000 kw. you would get machines of 4.000 kw., but that if you asked an electrical engineer to plan a station to supply 4.000 kw. he would require further information for the preparation of a proper scheme. The defendants' evidence had rather consisted of what an engineer would advise, and that was a material consideration when the difference between the figures as stated in the defendants' claim for compensation and the figures given in the statute was as much as 50 per cent. As to the interpretation of Sub-Section 7, which was the material sub-section the whole question seemed to him to turn upon whether it was the new generating station that was to be of a capacity "to generate and supply electrical energy to an output of not less than 4.000 kw.," or whether it was the new plant that was to be of that capacity. The plaintiffs contended for the latter interpretation, and, so far as it was possible to apply any theory of certainty as to the words actually used, he found it all in favour of the contention of the plaintiffs. Grammatical construction was also on their side, and their view was also borne out by the words "of not less than 4,000 kw.," which in his opinion meant that the machines would be tested up to something more than the figures marked on them They must be machines with an output of 4,000 kw., and not machines that would at a pinch produce that amount of electrical energy. The plaintiffs were therefore entitled to their declaration. Judgment was then entered for the plaintiffs with costs

FINCHLEY URBAN DISTRICT COUNCIL v. FINCHLEY ELECTRIC LIGHTING COMPANY.

This case came on for settlement in the Chancery Division of the High Court of Justice on Friday, before Mr Justice Kekewich. The District Council was represented by Mr. Warrington, K.C., and Mr. Lyttelton Chubb, instructed by Mr. A. M. M Forbes; Mr. H. C. Buckmaster, instructed by Messrs. Denham and Meyer, appeared for the defendants. The Urban District Council sought to restrain the company from breaking up any road within their district for the purpose of laying electric mains or otherwise. The Council's action was based upon an allegation that the defendants had, on a previous occasion, obtained permission to open the Regent's Park-road for the purpose of laying a water-main, and had taken advantage of the permission given to them so to do to lay, in addition to the water-main, a pipe containing electric wires. They then applied to the District Council for permission to open the East End road for the purpose of laying an electric main, and the Urban District Council, who have themselves obtained an electric lighting order, refused the permission, and obtained an interim injunction restraining the defendants, as asked by the Council, until the hearing of the motion. When the motion came on for hearing on the 16th inst. it was adjourned until Friday in order to allow the parties to come to terms, the injunction being continued in the meantime. Mr. Warrington now stated that the parties had come to an agreement upon the following terms: The defendants not admitting that they had any intention of breaking up the East End-road without the consent of the Urban District Council, and undertaking not to break up any roads within the urban district of Finchley without giving to the Urban District Council 14 days' notice of their intention so to do, action would be stayed without costs. The judge made the necessary order.

LIVERPOOL MORTGAGE INSURANCE COMPANY v. BRITISH ELECTRIC WORKS COMPANY, LIMITED.

In the Chancery Division of the High Court of Justice on Tuesday an application on behalf of the plaintiffs was made to Mr. Justice Cozens-Hardy for the appointment of a receiver and manager of the British Electric Works Company, Limited. Counsel stated that the action was commenced on the previous day in the Liverpool District Registry by the trustees of a debenture trust deed on the ground that the security had become enforceable. One of the provisions of the trust deed was that the company should keep up its stock-in trade to the value of £30,000, and if they did not the security became enforceable. The trustees had certified that the value of the stock-in-trade was now below £30,000. By Clause 35 of the deed the trustees were to be at liberty at any time, if the security became enforceable, to apply to the Court to have the trusts carried into execution, and to ask for the appointment of a receiver and manager.

Counsel for the defendant company consented to the application.

Mr. Justice Cozens-Hardy said he would appoint a receiver and manager, but he was not to act as manager for more than two months without the further leave of the Court.

CLAIM FOR ELECTRIC LIGHT.

Alleged Defective Supply.

In the Westminster County Court on Monday his Honour Judge Lumley Smith, K.C., disposed of a case in which the London Electric Supply Corporation sued to recover the sum of £17. 9s. 7d. for electric light supplied to the defendant, Mr. Saunders, architect, of Adelphi terrace. The defendant did not dispute the claim, but set up a counterclaim for 15 guineas damages for loss and annoyance owing to the alleged defect in the power supplied.

His Honour gave judgment for the plaintiffs with costs, and judgment for the defendant on the counterclaim for 40s. without costs.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

373. What is the practical method of determining the diameter and width of a phosphor-bronze worm-wheel and the diameter of the worm, the latter being driven by an electric motor of specified horse-power at 1,000 revolutions per minute? The ratio of reduction is 20 to 1, and the gearing is to be completely enclosed, the worm running in an oil bath. What percentage loss of power will occur in the gear at full load in various sized designs of 1/10 b.h.p. to 5 b.h.p. capacity? What is the best lubricant? An 80deg. F. temperature rise in eight hours' full load run is permitted on the gear box.—DISPAR.

374. I wish to have a motor driven by a dynamo at a short distance apart, but the motor to correspond in speed *exactly* to that of dynamo, however varied the speed of the dynamo may be. What peculiarities in design or other detail are necessary to ensure perfect synchronism, and would it be reliable?—INDUBIO.

ANSWERS.

Question No. 367.—Wanted instructions for making a resistance at a moderate cost to break down from 220 to 55 volts for use with an arc lamp and capable of carrying a current of 70 amperes if required. It must be light, portable, and not liable to get out of order in travelling.

Best Answer to No. 367 *(awarded* 10*s.).*—The questioner is contemplating a very uneconomical procedure, and will find that whatever type of resistance he adopts, and however it is made, it will be very bulky and awkward to carry about. It is evident that to take a supply of electricity at 220 volts, and reduce it to 55 volts by means of any form of resistance, must be costly. The volts to be lost amount to 165, and since watts = volts × amperes, and the current required is 70 amperes, the electrical energy which is simply thrown away = 165 × 70 = 11,550 watts, or 15·48 e.h.p. The costliness of this procedure is seen from the fact that every hour when the full 70 amperes is required 220 × 70 or 15·4 Board of Trade units have to be paid for, while only 55 × 70 or 5·85 Board of Trade units are required, and 165 × 70 or 11·55 Board of Trade units are dissipated uselessly. Looking at the question from a financial standpoint, supposing the current costs 6d. per Board of Trade unit, the bill each hour will amount to 7s. 8½d., of which 5s. 9d. will be wasted and only 1s. 11½d. legitimately used. In other words, the efficiency is only 38 per cent. This method of lowering the effective E.M.F. is even worse than that which has at times been adopted—through ignorance, let us hope—of varying the speed of a motor by a variable resistance in the armature circuit. "L. W. G." would be far better advised if he were to abandon all idea of his portable resistance, and have a light transformer made to meet his requirements. The initial cost might be a little higher, but even after allowing liberally for low efficiency he would save 5s. per hour, which would soon clear off his sinking fund.

Supposing, however, that he is wedded to his scheme of a resistance, he may adopt one of two types, either a liquid resistance or a metal resistance. The former will be handy in one way, as the electrolyte need only consist of salt and water, which is cheap, and can be thrown away after each occasion of use, and the tank can then be used as a box in which to pack the rest of his paraphernalia

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when travelling. If a metal resistance is used, it will have the advantage of making a very good heating or working apparatus, and in winter time could usefully be adapted for warming the room.

We have seen that the energy lost is equal to 11,550 watts, and it has recently been shown in these columns that for an enclosed motor the rise of temperature expressed in degrees Fahrenheit will be equal to $W \times 200 \div A$; where W = watts lost, and A = area in square inches of the outside of the case. The rise of temperature for an enclosed resistance will be analogous to that for an enclosed motor, except that the case through which the heat will have to permeate will be thinner, and possibly the frame will not be airtight; hence we may in this instance write the formula as $x = W \times 150 \div A$, where x is the rise of temperature in degrees Fahrenheit, and we get the equation for the area of the case, if we take a limiting value of 100deg. F. for the rise in temperature, as—

$$100 = W \times 150 \div A;$$
$$100\ A = 11,550 \times 150 \text{ square inches};$$
$$A = 17,325 \text{ square inches.}$$

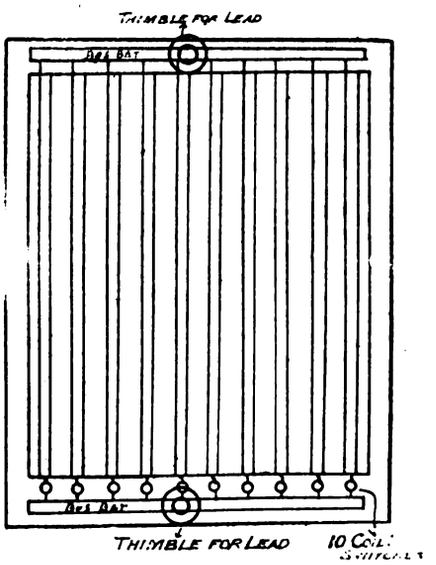
If, then, the frame is made cubical, with sides of equal area, each side must contain nearly 3,000 square inches, or will measure 4ft. 6in. approximately in each direction. This will constitute rather a bulky package to carry about, unless, as before suggested, it be divided into a number of frames worked in parallel, when they might with advantage be distributed over the room as radiators.

A simpler method will be to use an unenclosed resistance composed of coils of high-resistance wire, and open on all sides to the air. It must be remembered that the fall of volts is, in accordance with Ohm's law, that $E = CR$; and the question is so framed that it would appear as though 70 amperes is the maximum, and as though at times a smaller current will be used. Now, with 70 amperes the resistance required will be 2·36 ohms, but with 35 amperes the resistance must be 4·72 ohms, and so on. The simplest form of resistance would be that shown in the figure, and consists of a wood or iron frame, with a 'bus bar top and bottom, and all the coils in parallel, each being controlled by a separate switch, so that the resistance may be varied, and with any current up to the limit the resultant E.M.F. may be constant.

Turning to Messrs. W. T. Glover and Co.'s table, we find that if 6·7 amperes flow through a No. 15 reostene wire the rise in temperature will be 90deg. F., so that 10 such wires in parallel will transmit 70 amperes with an approximate rise of 100deg. F. Each coil will have to dissipate one tenth of the total energy to be wasted, or 115·5 watts; and we find from the same table that each yard of this gauge of wire when seven amperes is passed through it will consume 13 watts. Hence each coil must be $115 \cdot 5 \div 13 = 90$ yards, or 270ft. long. If this wire be wound on a mandril $1\frac{7}{8}$in. in diameter, each turn will be 6in. in length, and there will have to be 540 turns. A No. 15 wire is 0·072in. in diameter, and allowing an equal space between the wires in order to prevent short-circuiting, the length of the coil when wound and stretched out will be 78in., or 6ft. 6in., and the width of the frame, allowing for clearance between the coils, will be 2ft. 6in. In order to prevent sagging and short-circuiting from coil to coil, the wire should be wound on supports; to obtain the best cooling effects, bare wire wound on porcelain would be the best. But as it is doubtful if porcelain rods of this length could be obtained, and even if they could, if they would stand the knocking about in transit, I would suggest that the wire be double cotton covered and wound on iron rods covered with asbestos.

What, then, will be required is an iron frame 6ft. 6in. by 2ft. 6in., with a 'bus bar, insulated from the frame, top and bottom. Ten iron pipes $1\frac{3}{4}$in. in diameter will reach from the top to the bottom. These will be covered with $\frac{1}{16}$in. asbestos, and on each will be wound 540 turns of No. 15 D.C.C. reostene wire, each coil being controlled by its own switch, as shown in the sketch. If finer adjustment is needed, one or two coils of fewer turns or of finer wire may be added, or one coil may be wound with bare wire and fitted with a sliding contact.

The final arrangement is that of the liquid resistance. The horse-power to be dissipated, we have seen, is 15·48, or 510,840 foot-pounds per minute. Now, it requires 772 foot-pounds to raise 1lb of water 1deg. F., or the power to be dissipated will raise 660lb. of water 1deg. F. each minute, or, practically, 10 cubic feet of water; hence, as little allowance can be made for the cooling effect of radiation, if the power is required for any length of time the tank should be, say, 5ft. by 2ft. by 2ft. All that is required is a watertight tank—if of wood with two iron metal electrodes of large area; if of iron the tank itself may be used as one electrode, and a central plate insulated from it as the other. The water resistance admits of easy manipulation, and enables a constant E.M.F. to be maintained. If it is possible to arrange for a continual flow of cold water through the tank, a much smaller one will do.



But after all these devices have been discussed, the writer would still pin his faith to a rotary transformer for direct or a static transformer for alternating currents as being more economical, or, failing this, he would get a 100-volt lamp.—M.

Answer to No. 367 (*awarded* 10*s.*).—A resistance board for 220-volt circuit to pass 70 amperes is made as follows: It is first necessary to calculate the resistance to be connected with the various steps of the board. For practical purposes we may neglect the resistance of the arc. In view of the variation of current caused by the carbons burning away, it is better to make the last step of the board to pass 80 amperes. Assuming that a difference of five amperes between every step is suitable, and that a variation of from 25 to 70 amperes would meet all requirements, the calculations are worked out as follows:

		E.M.F./Current = Resistance.
therefore the last or	12th step,	220/80 = 2·75 ohms.
	11th ,,	220/75 = 2·93 ,,
	10th ,,	220/70 = 3·142 ,,
	9th ,,	220/65 = 3·384 ,,
	8th ,,	220/60 = 3·6 ,,
	7th ,,	220/55 = 4 ,,
	6th ,,	220/50 = 4·4 ,,
	5th ,,	220/45 = 4·8 ,,
	4th ,,	220/40 = 5·5 ,,
	3rd ,,	220/35 = 6·285 ,,
	2nd ,,	220/30 = 7·3 ,,
	1st ,,	220/25 = 8·8 ,,

One of the best wires for resistance work is that sold under the name of "Beacon." It has 51 times the resistance of copper, while the resistance of German silver is only 16 times that of copper. It can be easily wound in a spiral, and does not break like hard German silver. In selecting the size of wire, it might be said that one has only to use one coil for each step of large enough sectional area, but this turns out to be expensive. A better plan is to use three coils for every step and run the current through these in parallel. This effects a considerable saving

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in the cost of wire. Using No. 10 S.W.G. wire, which has a resistance of ·104 ohm per yard, the number of yards for each step is found by dividing the various resistances already calculated by this resistance. Working this out the lengths are as follows:

Last or 12th step 26 44 yards (this is divided into six coils and arranged in two sets of three coils in parallel).
11th step 1·76 yards, divided into 3 coils arranged in parallel
10th „ 2·01 „ „ „
9th „ 2·32 „ „ „
8th „ 2·72 „ „ „
7th „ 3·21 „ „ „
6th „ 3·84 „ „ „
5th „ 4·7 „ „ „
4th „ 5·88 „ „ „
3rd „ 7·55 „ „ „
2nd „ 9·76 „ „ „
1st „ 14·42 „ „ „

The resistance board should be made up of two slate slabs, 17in. by 10$\frac{3}{4}$in. by $\frac{3}{4}$in. thick, kept in position, as shown in Fig. 1, by means of iron rods let through the

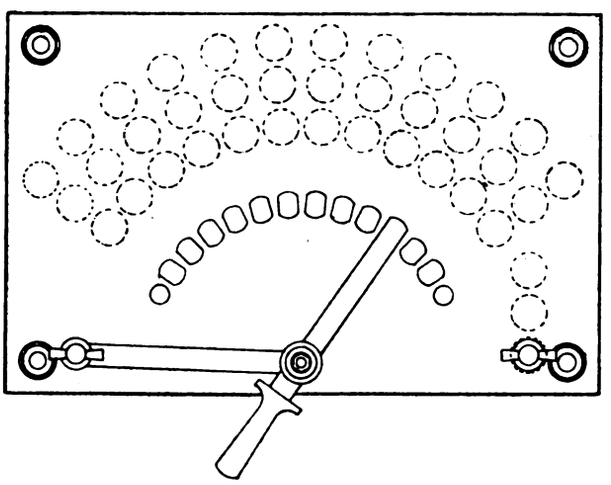

Fig. 1.

corners and fastened by means of jamb nuts above and below slate. The steps should be $\frac{3}{8}$in. diameter, with small shoulder. They should project above slate about $\frac{1}{2}$in., and be screwed to fit the blocks to which the coils

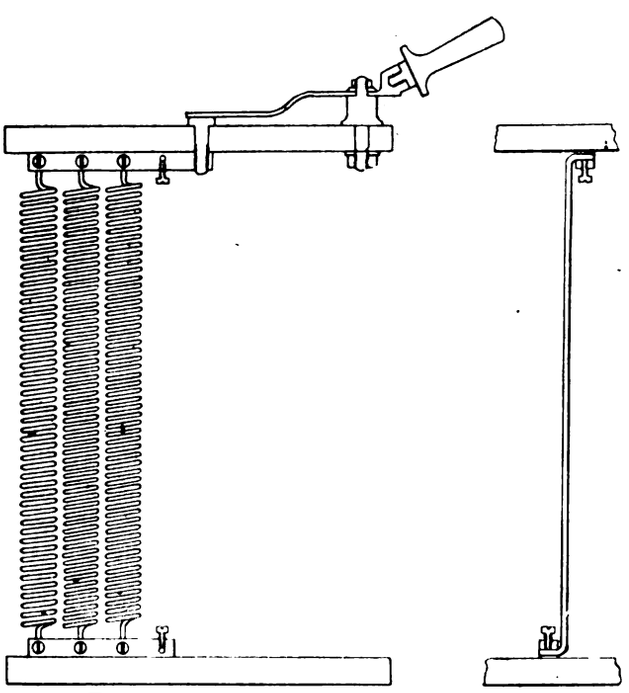

Fig. 2.

Fig. 3.

are fixed. These blocks should be 5$\frac{1}{4}$in. long by $\frac{1}{2}$in. broad by $\frac{1}{2}$in. thick, and should have four pinching screws, three for the coils and one for the wire, passing from the bottom of one to the top of the other. The blocks are tapped to suit the steps, and have a steady pin to keep them from turning. The sliding bar is of brass, $\frac{5}{8}$in. broad by 14 S.W.G., and the vulcanite handle is made to screw out to prevent it getting broken when being taken about. The whole board can be enclosed in a perforated iron box with hinged lid. The brass terminals are bolted through the top slate. These should take $^{19}/_{16}$ S.W.G. cables. The six coils in connection with the last step are connected together at bottom, and the terminal on right-hand side of Fig. 1 is screwed through the brass block in the same manner as the other steps screw into their respective blocks. Two brass stop pins are bolted through the top slate to prevent the sliding bar breaking the circuit at first and twelfth steps. These pins are $\frac{1}{4}$in. higher than the steps. Fig. 2 shows a section through slate slabs, brass blocks for coils, step, sliding bar, and bar bolt. Fig. 3 shows section of block through wire from bottom block to top one. The drop of potential is, of course, proportional to the resistance and current.—T. D. Frew.

Answer to No. 367 (*awarded* 5s.).—There are many different types of resistance frames, some good for one thing, some for another; but one of the simplest to make (all the tools required being a drilling machine), having very little labour on it, is one the writer has designed

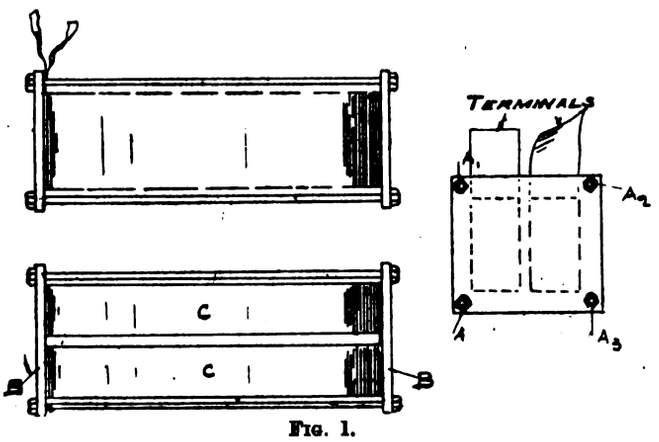

Fig. 1.

for a welder (as shown in Fig. 1), and which is small, mechanically strong, and light. A, A_1, A_2, A_3 are clamping bolts, B, B_1 are clamping plates about $\frac{1}{4}$in. thick, C is iron strip alternate with asbestos (or mica) about $\frac{1}{32}$in. thick

Fig. 2.

(thinnest made) as shown in Fig. 2. For our calculation say the iron is ·01in. thick, then the width is proportional to the current angle of coil, say 4in. size of frame. Drop of volts = 220 − 55 = 165; current = 70 amperes. Therefore resistance needed = $\frac{165}{70}$ = 2·35 ohms. From many experiments the writer has found that the above type of frame will allow a density of 3,000 amperes per square inch in the conductor for a temperature rise of about 470deg. F., which is not too high for the insulation used, and is a great advantage, because the higher the temperature possible the smaller the weight of the frame.

Width of conductor = $\frac{70}{3{,}000 \times \cdot 01}$ = 2·3in.; specific resistance of iron at, say, 70deg. F. = ·0000009 ohm; specific resistance at 470deg = ·0000009 (1 + ·00625 × 400) = ·0000315 ohm; length of conductor = $\frac{2\cdot35 \times 2\cdot3 \times \cdot01}{\cdot0000315}$ = 1,716in.; and as there are two lengths of resistances, each = $\frac{1{,}716}{2}$ = 858in.; number of layers of iron = $\frac{858}{4}$ = 215 say, then

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the thickness of the iron = 215 × ·01 = 2·15in.; length of asbestos then = 216 × $\frac{1}{3\cdot5}$ = 8in.; therefore total length between clamping plates = 8 + 2·5 = 10·15, depth = 4in.; total width = 2·3 + 2·3 = 4·6 + ½in. between the two resistances.—T. W. S. H.

Answer to No. 367 (*awarded* 5*s.*).—Iron wire or rod makes a good, cheap, durable resistance coil, especially if galvanised. I have used it for years, and find that if placed horizontally and not very close to other bodies it will carry 2,000 amperes per square inch of sectional area without being unduly heated. Under these circumstances I have never known a coil lose its elasticity. I have some spirals placed vertically doing about the same work, but I consider them rather too hot to be safe near the top. If local circumstances will permit, I should consider the best and cheapest resistance for the purposes in the question would be made of iron rod (galvanised would be best) ·212in. in diameter—*i.e.*, No. 5 S.W.G. This would carry 70 amperes as required. The volts to be lost are 220 – 55 = 165. And $\frac{165 \text{ volts}}{70 \text{ amperes}} = 2\frac{3}{7}$ ohms = 2·357 ohms. As iron will gain about ·388 per cent. in resistance for each 1deg. F. rise of temperature, and as we know that the coils will get hot when at work, and the amount of rise in temperature will depend upon the temperature of the surrounding air, whether the coil is placed in a draught or not and whether it is dusted occasionally or not, we must allow a little margin, so probably two ohms will be enough for our purpose if measured while the iron is cold. Two ohms of No. 5 iron rod would measure 1,490ft. in length. This could be made into spirals 1ft. in diameter, and these could be pulled out lengthways so as to leave half an inch between the turns of the spiral to allow air to pass freely. The total length of these spirals would then be 30ft. This, however, might be a little reduced, because ¾in. air space would be enough, although ½in. would be preferable. Possibly this 30ft. spiral might be put all in one length on a stone or brick wall. It could be supported by its two ends, and as it would weigh about 100lb. it would probably require support in one or two places besides. Of course, all supports would have to be carefully insulated. If it could not be fixed thus, then a wooden frame would have to be provided and the spiral divided into suitable lengths. These would be joined in series, and the whole would be fastened to insulators put on the wooden frame. Probably for portability and travelling sub-division and the frame would be best. The rise of temperature in the above would be about 50deg. F., and, if so, the total resistance while hot would be about 2·4 ohms. All joints in the coil should be well bound with copper wire, and then soldered as usual. Carbon rods are sometimes used for these resistances, but they are too brittle to be portable. Various metallic alloys are used for resistance coils, but as C^2R represents the heating effect, as the heat must be dissipated from the surface, and most of these alloys are fairly expensive, I do not think iron can be beaten for such a coil as the question requires.—F. G. A.

Question No. 368.—A compound-wound traction generator, 200 amperes 500 volts, with six poles and carbon brushes, is run in parallel with a battery on the line. At regular intervals of six bars, black patches, covering from two to three bars, appear on the commutator. The battery has not been known to back on to the machine. Another machine of exactly the same size and make, which runs alternately with the machine in question, does not exhibit the above complaint. Give full explanation of cause.

Answer to No. 368 (*awarded* 7*s.* 6*d.*).—Without full particulars of the winding of the armature it is not possible to be quite sure as to the correct explanation, though the following is perhaps the most likely one.

It may be assumed that the armature is a slotted one. Now, it is well understood that a slotted armature is not electrically symmetrical if it has more commutator plates than slots—*i.e.*, if each slot contains more than one section. For should a slot contain, say, two sections, both cannot be commutated in the same strength of reversing field. If the brushes are set to reverse the first section in the correct position, commutation of the second section will take place in a field which is too dense, since, whilst the commutator plates are spaced perfectly evenly all round the circle, the sections to which they are connected are spaced unevenly and occupy different angular positions relatively to their commutator plates.

In the machine under consideration it would seem that there are as many as six sections in each slot, or six times as many commutator plates as slots. This is an unusually large proportion, ordinary practice seldom exceeding three, or at the most four, sections per slot. Fig. 1 shows diagrammatically how the angles of the various sections to their commutator plates, and consequently the angles of brush lead, vary for the six sections in a slot. Suppose the brush is set to give sparkless commutation of the section marked No. 2, then section No. 3 will have rather too strong a reversing field, No. 4 will be worse, and so on until No. 7 is reached. The last two or three sections (Nos. 5, 6, and 7) in each slot will, therefore, spark more or less and get blackened, thus producing the effect noticed. If the brushes are set once for all and run constantly in this one position, the commutator will soon become marked regularly all round in alternate bright and black patches; but if the brushes are shifted occasionally in such a way that sometimes the position is correct for section No. 2 and sometimes for section No. 7, the alternate bands will disappear, and the commutator will only become

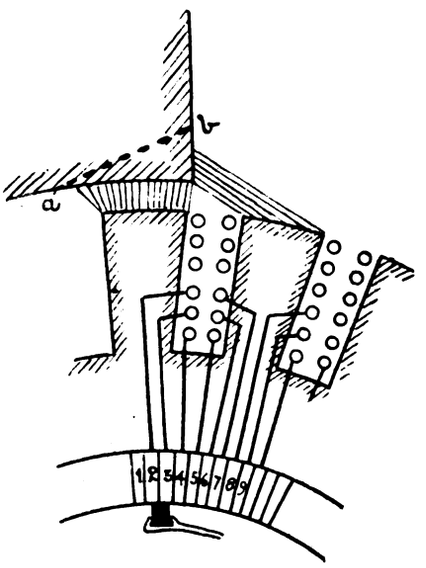

Fig. 1.

more or less black all over. It seems likely that this occasional shifting has taken place when the second machine has been in use, and consequently no definite marking has occurred. This absence of marking may, however, also be accounted for by assuming that in this case the brushes have happened to be set for sparkless commutation of the third section (No. 4, Fig. 1) in each slot, thus reducing the maximum deviation from the correct position by half and making the commutator marking much less definite.

By way of a remedy, it would be well to increase the uniformity of the fringe of magnetic lines in which commutation takes place. This may be done in various ways, but perhaps the simplest is to bevel off the forward tip of each pole, as shown by the dotted line, *a b* (Fig. 1). The only complete remedy, however, is a new armature with more slots and fewer sections per slot.—Q.

Answer to No. 368 (*awarded* 7*s.* 6*d.*).—The question tells us very little, and the point to be discussed is why do the black patches appear at regular intervals; it must be owing to some inherent defect in the machine. The second part of the question does not help us, and is, moreover, not correct. If the machine which is used alternately with the one under discussion does not exhibit these black patches there must be some difference between them, and they cannot be of "exactly the same size and make"; if they were both identical, each would show the same characteristics. We can then leave out the second machine, and ask why does a commutator go black in

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patches. The answer is owing to (1) want of homogeneity in the sections; (2) loosely-built commutator and bars, which lift and fall; (3) excessive momentary loads; (4) asymmetrical armature winding. We are not told how the armature is wound, whether ring or drum, whether smooth or slotted core, whether bar or wire wound; we have no information as to how the inductors are connected to the commutator, or whether any patent or unusual winding has been adopted, such as a chord winding or Sayers's patent winding, and without much fuller details it would be impossible for anyone to attempt to give "a full explanation of the cause."

Turning to the four causes which may give rise to such patches, the first two may be neglected, as the black patches would hardly appear regularly every six bars if the cause was variation in the hardness of the section or a loosely-built commutator. The same remarks will also apply to the third cause, while, in addition, we should expect the momentary loads to appear also with the alternative plant. The fault will therefore probably be found in the fourth cause—viz., an asymmetrical winding. At the time when a coil is under the influence of the brush it is short-circuited on itself. Before the coil reaches the brush it is carrying a current in, say, a right-handed whorl; after it has passed the brush it is carrying an equal current in a left-handed whorl. During the time it is under the brush the current has to die away, and a current in the reverse direction has to flow in it. A very low E.M.F. or weak field will generate this current, as the resistance of any one coil is extremely low. If, now, the resistance of each coil is not equal owing to a longer length of wire in the end windings, or to imperfect or dirty connections, the currents generated in the coils while short-circuited will not be equal, and sparking will be set up owing to the fact that a current either from the brush to the commutator, or *vice versâ*, must be broken as each section recedes from the brush; and this will give rise, with carbon brushes, to blackening of the commutator, and probably this asymmetrical winding will be found to be the cause. If the armature has a smooth core, it will probably be found that while the winding is apparently symmetrical, in reality it is not so, as the driving horns disturb the magnetic flux sufficiently at the points of blackening to cause a variation in the current generated in the particular coil when short-circuited.—M.

Answer to No. 368 (*awarded* 5*s.*).—From the information given with this question it is understood that the two generators have been running under precisely the same conditions, and as the black patches appear only on one of the commutators, one would naturally look for the cause in that machine. The writer has often observed the same effects on the commutator of a multipolar machine running on lighting 'bus bars in parallel with a battery, but under circumstances when it would have been impossible for the battery to have backed on the machine. The most likely explanation is that the regularly spaced patches are caused by the "chattering" of the carbon brushes on the surface of the commutator. This causes the carbons to partially skip over two or three segments at regular intervals and make rather indifferent contact with them. The result is that the surface of those bars becomes slightly burnt, and the discoloration would probably be increased by the deposition of fine carbon from the (negative) brushes during the period of light contact, and if paraffin be used for cleaning the commutator, it would be further aggravated by the burning of the oil at the same time. Patches caused in the above manner may, if the machines have a very long run, develop into a series of "flats" around the commutator, as the writer has known from experience. Adjusting the pressure on the carbons may be found to diminish the "chattering" referred to, otherwise it would be as well to try some carbons with a greater percentage of graphite, which would reduce the friction and secure smoother running.—D. J.

Answer to No. 368 (*awarded* 5*s.*).—Black patches on commutators with carbon brushes are almost invariably caused by an uneven commutator, and I think in this case, in spite of the regular intervals at which the black patches occur, that this will be found to be the cause. Carbon brushes will not follow the slightest irregularity of the commutator. In some modern machines the commutator is so made that sections of about six or eight bars can be removed without disturbing the rest; this is done by cutting one of the cone rings into a number of parts, and screwing them up with a bolt through to opposite cone as shown (Fig. 1). After the machine has been in use some

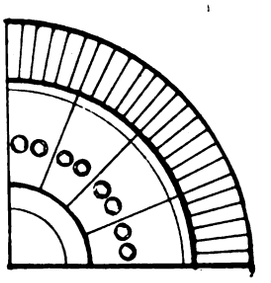

FIG. 1.

six months, it is not unusual for the commutator to warp slightly out of shape, principally where the one section of the cone joins the next. The result is that a slight jump takes place where the brushes pass over these points, causing sparks under the brush, which blacken the commutator and a general rattling noise can be heard. It is not generally worth while taking out the armature and having it turned up, and grinding arrangements are not always at hand, nor are they always easy to fit up, and

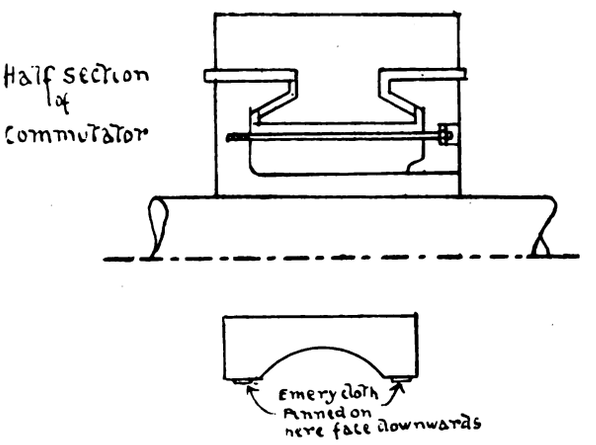

FIG. 2.

are expensive. I have used with very fair success a piece of hardwood fitted to the arc of the commutator (Fig. 2) and about 3in. broad, embracing about a dozen segments, with a piece of emery cloth pinned on with drawing pins, and applying this to the commutator every day when the machine is run up just before switching in.—C. E. S.

APPOINTMENTS VACANT.

Electrical Engineer, South Shields. Details to be advertised shortly.

Shift Engineers, Bexhill Urban District Council, 30s. per week, May 9. Details in our advertisement columns.

Assistant Electrical Engineer, Sculcoates-lane generating station, Hull, £78 per annum. Full particulars in our advertisement columns.

Cable Jointer, used to working on live triple-concentric mains, Springsmire power station, Dudley. Full particulars in our advertisement columns.

Superintendent of engineering department, £400 per annum; three assistants in the physics department, £200 to £250 per annum; and junior assistantships, at salaries of from £100 to £150 per annum, National Physical Laboratory. Full details in our advertisement columns.

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NEW COMPANIES.

The following new companies have been registered since our last issue:

Electrical Supplies, Rubber, and Ebonite Company, Limited. Capital, £1,000. Object: to carry on the business of manufacturers of and dealers in electrical machinery, cables, and all accessories required for electric lighting, traction, and power, etc.

Gravesend and Northfleet Electric Tramways, Limited.—Capital, £80,000 Object: primarily, indicated by the title; and, further, as electricians and electrical engineers; as producers and suppliers of electricity for the purposes of light, heat, or power; to erect and maintain any plant, machinery, mills, factories, warehouses, and other conveniences, either for the above purposes or otherwise, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Wrexham.—Tenders are to be called for providing and fixing electric fire calls for the Corporation.

Bristol.—The Electrical Committee invite tenders for alternating-current transformers. Tenders by May 12. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the wiring of the new Council offices. Tenders by June 5. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the twelve months' supply of electricity meters. Tenders by May 6. Details in our advertisement columns.

Stirling.—The Town Council invite tenders for extensions to steam, drain, feed pipes, and feed heater. Tenders by May 10. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron curbs for tramway centre poles. Tenders by May 7. Details in our advertisement columns.

Motherwell.—The Electric Light Committee invite tenders for cast iron lamp columns, arc lamps, switches, fittings, etc. Tenders by May 18. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and erection of two-phase motor-alternators and switch gear. Tenders by May 15. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for steam and other piping, low-tension switchboard, 210-kw. continuous-current dynamo. Tenders by May 9. Details in advertisement columns.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the annual supply of stores and materials. Tenders by May 14. Details in our advertisement columns.

Lichfield.—The Corporation invite tenders for electrical communication to the members of the fire brigade from the police station. Tenders by May 17. Details in our advertisement columns.

Plymouth.—The Corporation invite tenders for overhead line construction, etc. Full particulars may be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by May 18

Dublin.—The Lighting Committee invite tenders for the supply and erection of main switchboards, sub-station switchboards, transformers, arc lamps, and arc lamp pillars. Tenders by June 3. Details in our advertisement columns.

Newcastle-upon-Tyne.—The Corporation invite tenders for supply of 800 tons of tramway rails, fishplates, etc. Particulars may be obtained at the office of the City Engineer, Town Hall, Newcastle upon-Tyne. Tenders by 19th inst.

Dundee.—The Gas Commissioners invite tenders for the supply and erection at the electrical power station, Dudhope-crescent-road, of one 700-h.p. triple-expansion steam engine and dynamo. Tenders by May 11. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of permanent-way construction over three miles of tramways. Specification, etc., can be obtained from Mr. Wm. L. Macindoe, town clerk, Kirkcaldy. Tenders by May 13.

Nottingham.—The City Council invite tenders for the construction and erection of a new tramway depôt near the Trent Bridge. Drawings, etc., may be seen by applying to Mr. Arthur Brown, M.I.C.E., city engineer, Guildhall, Nottingham. Tenders by May 6.

Oldham.—The Surveyor's and Tramways Committee of the Town Council invite tenders for the supply of from 2,500 to 3,000 tons of steel girder rails, fishplates, and soleplates. Specification, etc., may be obtained from the Borough Surveyor. Tenders by May 8.

Fulham.—The Council invite tenders for the supply of materials and goods required in connection with their electric light and dust destructor station at Townmead-road, Fulham, for the period ending March 31, 1902. Tenders by May 15. Details in our advertisement columns.

Rotherham.—The Corporation invite tenders for wiring the municipal buildings preparatory to a supply of electricity from the Corporation mains. Specifications, etc., may be obtained on application to the borough electrical engineer, Mr. E. Cross, Town Hall. Tenders by 17th inst.

Bermondsey.—The Borough Council invite tenders for the wiring, fittings, and other material required in connection with the installation at the Corporation's electricity supply station and stables, Neckinger, Bermondsey, S.E. Tenders by May 21. Details in our advertisement columns.

Christiania.—Tenders are invited by the Telegraph Department of the Norwegian Government for supply of copper wire, copper ribbon wire, and tinned soldering wire Specifications, etc., may be seen daily between 12 and 1 p.m. at the Rigstelegrafstyrelsens Kontor, Christiania. Tenders by May 9.

Long Eaton.—The Urban District Council invite tenders for the manufacture and delivery on seat of two steel Lancashire boilers, engines, dynamos, switchboard, and accessories. Tenders by May 20. Details in our advertisement columns.

Madrid.—Tenders are invited by the Spanish Post Office for a concession for the establishment and working of a telephone system at Denia. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by May 10.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works of two 412-kw. steam dynamos. Specification, etc, may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by 16th inst.

Madrid.—Tenders are invited by the Spanish Government for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p m. Tenders by June 3.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the supply of 6,250 tons of steel girder tramway rails and 190 tons of steel fishplates, and points, crossings, and filling pieces. Specification, etc., may be obtained from Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S.W. Tenders by May 13.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (Specification No. 1) water-tube boilers; (No. 2) plant of 15,000 i.h.p. in generating and sub-stations; Sections A, B, and C) steam-engines, with condensing and auxiliary plant; (D) three-phase generators; (E) motor-transformers. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by May 7.

Ashton under-Lyne.—The Corporation invite tenders for the manufacture and supply of the following materials—viz.: (Contract No. 1) about 445 tons of 7in. steel girder rails, 21 tons of fishplates, and 21 tons of soleplates; (2) 31 sets of points and crossings, 220cwt. of tie-bars, and 220cwt. of nuts, bolts, and washers. Plans may be seen at the office of Mr. J. T. Earnshaw, A.M.I.C.E., borough surveyor, from whom specifications and forms of tender may be obtained on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by 12 noon on 9th inst.

Ludlow.—The Corporation invite tenders for the supply and erection of one water-tube boiler to be erected and fitted for connection with a refuse destructor, with electric motor, injector, etc.; one ditto, ditto, for a coal-fired boiler, and furnace connected therewith; two quick-revolution compound two-crank self-lubricating engines, coupled direct to compound-wound dynamos, equal to an output of 35 kw. each, with motor-transformers and accessories; steam, exhaust, and feed pipes; overhead travelling crane (six tons); switchboard and instruments; accumulators; electricity supply mains; and public arc lighting and glow lamps, the latter on existing pillars. Tenders by May 20. Details in our advertisement columns.

Tenbridge (Kent).—The Urban District Council invite tenders for the supply and erection of (Section A) boiler-house plant—two Lancashire boilers and accessories, steam pump, injector, and economiser; (B) engine-house plant—two 50-kw. steam dynamos, motor-transformer, and accessories; (C) condensing apparatus and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) electricity supply mains; (H) public arc lighting; (I) house meters; (K) public incandescent lighting, for the municipal electricity works. The whole bound up in one specification. Specifications, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders by May 30.

Battersea.—The Borough Council are prepared to consider schemes for the wiring of consumers' premises for electric lighting, free of all initial cost to the Council or the consumer. The wiring rules and the general conditions under which the work would have to be carried out can be obtained on application to Mr. W. Marcus Wilkins, town clerk, Lavender-hill, S.W., upon the deposit of £1. 1s., to be returned on the receipt of a bona fide tender. The conditions admit of payment to the contractors for the work carried out by them in one or more of the following ways: (*a*) by one cash payment by the consumer; (*b*) by the easy payment system; (*c*) by a fixed rental per annum; (*d*) by a small extra charge per unit supplied to the consumer, to be collected by the Council and paid by them to the contractors. Tenders by May 14.

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RESULTS OF TENDERS

Bray.—La Société Anonyme des Moteurs a Grande Vitesse have secured the order for the 25-kw. alternator for the municipality.

Fulham.—The Council have accepted the tender of the National Electric Wiring Company for wiring the baths and wash-houses for electric current, at £1,439.

Manchester.—The Electricity Committee have accepted the tender of the Edison and Swan United Electric Lighting Company, Limited, for the supply of a switchboard, with all accessories, at Bloom-street station.

Poole.—The Town Council have received the following tenders for connecting the Parkstone section of the borough fire brigade with electric calls: Bayley and Sons, Poole, £28. 16s. (accepted); G. Bingham, Parkstone, £32. 10s.

Southwark.—Eleven tenders were received for the supply, delivery, and erection of incandescent lamp brackets, switches, and fittings for street lamps, and the tender of Verity's, Limited, 31, King-street, W.C., has been accepted at £880. 12s.

Farnworth (Lancs.).—The Urban District Council have accepted the tender of J. O. Hart, Manor Plumbing and Electrical Engineering Works, Bank-street, Bolton, at £68. for the wiring of the electricity works in Albert-road, Farnworth.

Burnley.—The Tramways Committee have accepted the tenders of R. Blackwell and Co. for the overhead equipment required in the construction of the tramways, at £10,201, and 24 electric cars from the British Thomson-Houston Company, at £765. 3s. each.

Nottingham.—The Standing Joint Committee have accepted the tender of W. J. Furse, Nottingham, to instal the electric light throughout the Shirehall, at £172. 5s., with special iron and bronze fittings at an additional cost of not exceeding £125 making a total of £297. 5s.

Derby.—The following tenders have been accepted by the Electric Lighting Committee: Ferranti, Limited, switchboard extension, £404; Babcock and Wilcox, chain grate stokers, £230. The contract for the brickwork for the boiler and economiser has been let to Radford and Greaves on a schedule of prices.

Aberdeen.—The Gas and Electric Lighting Committee have accepted the following tenders in connection with the new electric station and works at Dee Village: Babcock and Wilcox, six boilers, £10,175; G. Jamieson, Woodside joiner work, £2,190; W. Simpson, Aberdeen, plumber work, £698; J. Scott and Son, plaster work, £499; Adam and Co., slater work, £355.

Croydon.—The Town Council have received the following tenders for the excavation and making foundations for an engine and generator at the Corporation electricity works, Factory-lane, Croydon:

H. Windsor and Co., 61, Strathblaine-road, Clapham Junction (accepted)	£305
J. Smith and Sons, Junction Works, South Norwood	315
J. Westbrook, 59, Croydon-grove	420
S. Page, Borough-hill, Epsom-road, Croydon	397
W. Smith and Son, 202, London-road, Croydon	389
Foster Bros., St. Mary's-road, South Norwood	327

BUSINESS NOTES.

TRACTION.

Hull.—Three of the 10 new cars ordered for the Beverley-road tram route are now running.

Bury.—The Corporation Tramway Bill has been read a third time in the House of Commons.

Wrexham.—The work of converting the tramways from horse to electric traction has been started.

British Columbia Electric Railway.—The net earnings of this line for March show an increase of about £950.

Whitehaven.—A ratepayers' meeting has approved the decision of the Town Council to oppose the West Cumberland Tramways Bill.

Southport.—The loop on the electric car track, contemplated some time ago, at the junction of Hoghton-street and Morningtonroad, has been completed.

Derby.—The receipts from the Corporation's tramways for the four weeks ended April 20 amounted to £1,265, being an increase of £51 on the corresponding period last year.

Dundee.—Colonel Dunlop, Board of Trade inspector, inspected the new electric tramway route in Blackness road on Tuesday, and expressed satisfaction with the new portion of the system.

Private Bills.—In the House of Lords the following Bills have been read a third time: King's Norton and Northfield Urban District Tramways, and Watford and District Tramways.

Birmingham.—The 10th inst. has been fixed for the Board of Trade inspection of the Bristol-road electric tramway, and if reported as satisfactory it will be opened for traffic on the 11th.

Dewsbury.—The contracts for the British Electric Traction Company's undertaking in this locality are reported as having been got out, and the work in connection with the construction of the lines will be commenced as soon as possible.

Lowestoft.—The Town Council have confirmed their resolutions deciding to promote in the present session of Parliament a Bill to empower them to construct electric tramways in the borough, to supply electricity in bulk beyond the borough, to supply electrical fittings, etc.

New South Wales.—According to advices from Sydney, the tramway revenue for the quarter amounts to £131,688, compared with £113,099 for the corresponding quarter of last year, and an expenditure of £114,312, as compared with £85,929.

Ramsgate.—Owing to the popularity of the electric cars, experiments have been made with much larger vehicles than those hitherto used, but numerous difficulties in the direction of awkward curves and steep inclines still confront the company.

Liverpool.—Two telephone wires suddenly fell upon the trolley wires of the tramway system in Lime-street last week, and at once became charged with electricity. No casualties fortunately occurred. A breakdown gang was soon on the spot, and repairs were quickly effected.

London United Tramways Bill.—The Standing Orders Committee of the House of Commons on Tuesday declined, in the case of this Bill, to suspend the order requiring the assent of local authorities through whose areas two thirds of the proposed tramways should run.

Halifax.—The Board of Trade inspection, by Major Druitt, of the Halifax tramway extensions from Tuel-lane Top, Sowerby Bridge, to Luddendenfoot, from Stump Cross to Northowram, and from Stocks' Gates, near Ambler Thorn, to Queensbury, took place on Thursday week.

Nelson.—The Tramways Committee of the Corporation are considering the advisability of substituting wood for the granite setts in the main road when the roadway is up for the laying of the new electric tramways, and have instructed Mr. B. Ball, the borough surveyor, to report on the matter.

Newcastle.—At the last meeting of the Finance Committee the Chairman of the Tramways Committee said he thought that, according to present circumstances and the progress that was being made, the electric trams would be running by October, and revenue from that source would immediately accrue.

A Large Order.—We are informed that Messrs. Geoffroy and Delore have obtained the order for the whole of the underground cable required for the Cheltenham light railway at present under construction. This cable is of their fibrous insulation type lead-covered and armoured, and the length of same is about 5½ miles.

Dunstable.—At the last meeting of the Town Council the possibility of having an electric tramway laid down between Dunstable and Luton was talked of. It was stated that a number of surveyors were in the town and neighbourhood recently taking levels and obtaining information in connection with such a scheme.

Lancaster.—At the monthly meeting of the Town Council the town clerk reported that in his opinion the Corporation can repair the parts of the tramway and road in the added areas and charge the same to the Lancaster and District Tramway Company, under the agreement of July 26, 1889, as extended by the Lancaster Order, 1900.

Paisley.—It is reported in the local Press that Messrs. Atherton, of Liverpool, have submitted to the Corporation an offer to the effect that if the Paisley District Tramways Bill is unsuccessful in Parliament this session they will introduce a Bill in October embracing those provisions in the District Company's Bill which are generally acceptable.

Salford.—The lease of the tramways company expired on Monday last, and the Corporation have arranged to take over the system as a going concern until their own electric system is ready. There was some dispute over terms, however, and a definite conclusion was not reached until Wednesday afternoon. The price to be paid for the undertaking is £42,000.

Newport (Mon.).—The committee of the Corporation having charge of the arrangements for the equipment of the tramways for electric traction and the erection of the power station have recommended a number of tenders for acceptance, which amount in the aggregate to £55,056. 10s. 4d., but this does not represent the full amount necessary to be expended.

Southend.—A memorial is being formulated against the Sunday running of the electric trams, which, it is expected, will be placed on the rails early this month. The feeling, however, is fairly general that the wishes of excursionists ought to be studied in the matter, as upon their patronage it mainly depends whether the venture will be profitable or otherwise.

An Electric Omnibus Company.—The Electric Railway Omnibus Company, Limited, has been formed with a capital of £5,000 in £1 shares to acquire the business carried on as the Electric Railway Omnibus Company, and to carry on the business of omnibus, cab, and vehicle proprietors, makers of electrical, oil, and other motor vehicles, etc. No initial public issue will be made.

Chester.—The Corporation Tramways Bill came before Lord Morley's Committee on Monday last as unopposed. Mr. S. Smith, town clerk proved the preamble of the Bill, but the report stage was withheld to allow certain proofs to be submitted as to the number of councillors who voted for the Bill, and also to produce the consent of the Local Government Board to the promotion of the Bill.

Leeds.—A tramcar had just passed the bottom of Albion-street on its way to Briggate, when with a sudden snap, a trolley wire broke away from its fastening on the arm projecting from the electric light standard in the centre of the thoroughfare, and hung downwards. Beyond causing some little inconvenience the occurrence led to no serious results, and the service was practically uninterrupted.

Darlington.—The Corporation, who have been seeking to purchase the present tramways in order to establish an electric system in the borough, have offered £7,500 to take over the company's

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undertaking, and also the provisional order which they have secured from the Light Railway Commissioners. The company at first asked £12,000, but it is understood they will now accept the terms of the Corporation.

Barrow.—According to the local Press, an arrangement has practically been made between the Corporation and the British Electric Traction Company for the leasing of the tramways to the company for 28 years. So soon as the Town Council have approved of the new terms a complete system of electric traction will be laid down, which it is expected will be completed in 12 or 18 months. There will then be a service of electric trams to the docks, Roose, and Furness Abbey.

Motors for the Fire Brigade.—The London County Council have decided, on the recommendation of the Fire Brigade Committee, to purchase an experimental motorcar at a cost of £250. It was explained in the report that for some time past the question of the means of traction of fire appliances has been under careful consideration, and the committee have come to the conclusion that in the near future it will be found expedient to adopt some more rapid method than is afforded by horse power.

Imperial Tramways Co.—We are asked to state that this Company is raising further capital for the purpose of paying up its investments in the London United Electric Tramways. Holders of the debenture stock, preference shares, and ordinary shares of the Imperial Tramways Company have been offered the opportunity of making application for a further issue of 10,000 Imperial 6 per cent. cumulative preference shares of £10 each, ranking *pari passu* with the existing preference shares. The issue price is £12. 10s. per share.

Portsmouth.—A new difficulty is reported to have arisen in connection with the laying of the electric tramlines beyond the radius of the borough. The Government authorities have written to the Tramways Committee asking them to make a contribution towards the cost of strengthening Porte bridge and the bridge over the Hilsea moats in view of the running of the cars over it. The matter was discussed at considerable length last week, and it was decided before making any reply to the letter to look up the deeds on the question.

New York Elevated Railway.—The General Electric Company of New York, the allied company of the British Thomson-Houston Company, have secured the contract for the train equipments of the Manhattan Railway (New York Elevated), including 1,600 large motors of over 100 h.p. each. The trains are to be equipped with their train system of control, which is the same as the British Thomson-Houston Company are supplying to the Central London Railway for their experimental train, as recently noted in these columns.

Birkenhead.—The traffic receipts on the New Ferry route for the four weeks ended April 21 amounted to £879, as against £788 for the previous four weeks. We understand that it is proposed to construct double tracks in place of single tracks on certain routes, at an estimated total cost of £21,693. Arrangements have been concluded securing to the Tramways Committee the use of land on the north side of Woodside Ferry approach for the erection of tramway offices. It is further proposed to increase the salary of the borough electrical engineer (Mr. William Bates) by £200.

Glasgow.—In addition to those sections of the Corporation tramways which have been converted from horse to electric traction, and on which cars were running at the beginning of last week, electric cars have now begun to run for passenger traffic from underneath the Caledonian Railway Bridge in Argyle-street, by way of Main-street, Anderston, and Dumbarton-road to Overnewton and back. This service was augmented on Sunday by the running of main cars on the main east and west route—namely, from London-road and Dalmarnock-road to Whiteinch. Further augmentations have been made each day this week, and it is hoped that by to-day all lines converging on the exhibition will be in operation, including what is known as the horseshoe route from St. Vincent-place to the foot of Queen-street.

Manchester.—The special joint sub committee of the City Council, in their report presented to the Council on Wednesday last, stated that they had resolved to instruct the town clerk to inform the National Telephone Company that they are authorised to proceed, under the direction of the city surveyor, with the work of removing their overhead wires which now pass over Cross-street and adjoining streets and placing the same underground, upon the terms of the agreement between the Corporation and the National Telephone Company dated July 24, 1894, and that in the opinion of the joint sub-committee all telephone wires crossing over streets used or intended to be used for tramway purposes within the area now comprised in the existing agreements with the National Telephone Company should be placed underground.

Gateshead.—The question of overhead wires and the precautions necessary to prevent accidents from such, were considered at a special meeting of the Town Council last Friday. The Parliamentary Committee submitted a report, stating that Mr. Robt. C. Quin, consulting engineer, of Blackpool, had made an inspection of the tramways on April 17, and that he had spoken of the danger to life of falling trolley wires. He had also mentioned that a protective device existed. The tramway company and the Board of Trade had been communicated with, the letter to the former stating that the Council would object to the use of electrical power until a protective device was provided. The assistance of the Board of Trade had been invoked to bring this about. Although Colonel Von Donop has carried out the official inspection of the new system, the Corporation have protested against any public service until some device is adopted as a protection against breaking wires.

Sheffield.—The Tinsley car-shed is now almost completed, and holds about 100 cars. The cost up to date has been considerably over £20,000. It is proposed to provide additional workshops, a sand furnace, and other buildings, at a further cost of £7,000 or £8,000. Although there are no more new routes of the Corporation tramways ready for opening at present, the Fulham-road to Nether Green and the City-road sections are very much advanced. The Tramways Committee at their meeting on Tuesday decided upon the following recommendations: (1) that the route from Shalesmoor to Hillfoot Bridge be deferred until further orders; (2) that the Clarkehouse-road route be deferred until the city surveyor reports that he is in a position to widen the road, by pulling down the property purchased by the Corporation; and (3) that a section of double tramrails be laid from the present Heeley terminus to Derbyshire-lane, after the other work already agreed upon has been completed, with the exceptions above mentioned.

Holborn.—At the last week's meeting of the Borough Council the Law and Parliamentary Committee reported that in consequence of the refusal of the Council to consent to the introduction of the London County Council's Tramways and Street Widenings Bill, the whole of the tramways proposed within the borough had been struck out of it, with the exception of the line intended to traverse Farringdon-road from Vine-street bridge to the City boundary at Charterhouse-street. The committee had had before them a memorial from the owners and frontagers of the section of the thoroughfares which would be affected by the proposed tramways, which alleged that the scheme would be most prejudicial to their interests and to the carrying on of their businesses, and would tend to decrease the value of their property. The Council decided to take steps to oppose the Bill so far as it relates to the proposed tramway in Farringdon-road. The Council also decided to oppose the Bill of the Charing Cross, Euston, and Hampstead Railway Company.

Middlesex.—At the County Council meeting last week the Parliamentary Committee, reporting with reference to the Finchley and Hendon tramways, stated that the road which this tramway proposed to run along would in all probability be one which the Commissioners would be asked to sanction a county line along. It was stated that, although the District Council could promote a Bill in Parliament, the County Council could not, and therefore they proposed to go under the Light Railways Act. They were not hostile to the other scheme, but the Parliamentary Committee thought their scheme the best. It was decided to oppose the Bill in Parliament. With regard to the County Council's tramway schemes, the total cost of which will exceed half a million sterling, the Council have now entered into a contract with the North Metropolitan Tramways Company to work the whole system. One of the important extensions will be in the form of a spur line from Highgate railway station to the Muswell Hill entrance of the Alexandra Palace and Park.

The Liverpool "Overhead" Accident.—At the Town Council meeting on Wednesday, attention was called to the report of Mr. Trotter, the Government inspector, on the recent overhead wire accident in Pembroke-place, by which two men were killed and several injured, and it was urged that the report ought to be made public, all the more so as it was of a reassuring character, so far as the city tramway system was concerned. The Government inspector put down no less than eight causes as having contributed to the accident. These were the snowfall, the failure of the wood guard, the large number of telephone wires, the length of the span the salt slush in the streets, the darkness and the invisibility of the wires, the failure of the telephone service, and the delay in cutting off the electric current. The inspector said the absence of any one of these causes might have prevented the loss of human life. On the other hand, it was pointed out that the Tramway Committee had not yet fully considered the report, and that it would be inadvisable to discuss the matter at this stage in view of the claims arising out of the accident. It was further stated that the committee were dealing with the whole matter, and that the Telephone Company were expeditiously putting their wires underground. We understand that the Corporation are also providing wire guards above the trolley wires at different points of the system.

Metropolitan District Railway.—Notification has been given by the Metropolitan District Railway Company of an intended application this session, by petition, for leave to introduce into the Bill which has been presented to Parliament clauses or amendments to confirm an agreement for the electrification and equipment of their system, together with that of the Metropolitan Company, the Whitechapel and Bow Railway, and portions of the London and South-Western Railway; to mortgage, lease, or transfer the lands they are authorised to use as a generating station in Lot's-road, Chelsea; and to empower them to take a lease of these lands from the transferee or lessee thereof. With the consent of the South-Western Company, they will also ask to be empowered to lay and maintain along so much of the former's railway as lies between Studland-road junction and the junction of the South-Western Railway with the company's Ealing Extension Railway five chains westward of Turnham-green Station, this station and Richmond Station, and the termination of the company's Fulham Extension Railway five chains southward of Putney Bridge Station and the Wimbledon Station of the South-Western Company, cables, conducting rails, etc., and to execute all works necessary for adapting such railways to being worked by electrical power and for transmitting along them electrical energy from the company's generating station. Authority will further be asked to constitute the generating station which the company are empowered to construct at Lot's-road into a separate undertaking.

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New Issue.—The directors of the British Columbia Electric Railway Company announce an issue at par of 6,400 non-cumulative 5 per cent. preference shares of £10 each, ranking for additional dividend ratably with the ordinary shares after such ordinary shares have received 7 per cent. These shares are preferential as to capital as well as dividend, and, in addition, entitled, ratably with all other shares, to any surplus profits which may be available for dividend in any year after the payment of the above 5 per cent., and also of 7 per cent. on the ordinary shares. The company has an authorised share capital of £450,000 in 25,000 ordinary and 20,000 preference shares of £10 each, of which 20,000 ordinary and 13,600 preference shares have been issued. There is also an issue of £250,000 4½ per cent. first mortgage debentures. The company carries on the regular business of an electric railway company in the cities of Vancouver, Victoria, and New Westminster, and the suburbs, and between Vancouver and New Westminster, and between Victoria and Esquimault forts and dockyards, the headquarters of the British Pacific Fleet. On April 1, 1901, it was operating 47 miles of fully-equipped railway. The company also carries on an electric light business in Victoria and Vancouver, supplying the Parliament Houses and the principal Government and business buildings and private residences of both cities, and the municipal buildings and street-lighting of the city of Vancouver. The present issue is made for the purpose of providing funds to discharge liabilities incurred and to be incurred in the purchase of rolling-stock and electrical machinery, etc., in anticipation of a further considerable increase both in the railway and lighting business.

London County Council.—On Monday the Tramways and Street Widenings Bill of the London County Council came before the Court of Referees of the House of Commons, the *locus standi* of no fewer than six sets of petitioners being objected to by the Council. Some of the proposals to which objection was taken by petitioners are of an important character. In one particular instance the *locus standi* of the South-Eastern and Chatham and Dover Railway Companies against the Southwark-street portion of the proposed new line was objected to by the County Council. It was urged on their behalf that while the proposed new line would be useless to the general public it would lead to the blocking of Southwark-street and of the entrances to their Blackfriars goods station, to and from which no fewer than 13,000 wagons proceeded daily. They also alleged that the new line would produce serious competition with their local traffic between London Bridge and Charing Cross Stations *viâ* Waterloo Junction, while in connection with a line to Lordship-lane it would compete with their suburban traffic. Ultimately the court decided to allow the petitioners' *locus* as frontagers in regard to one of the proposals of the Council, and with reference to competition in connection with another proposal. Among the other petitions discussed was one by the owners of the land on which is built the Catholic Apostolic Church in the Camberwell New-road. In this petition it was stated that though the land was not really touched by the County Council's proposed work in connection with an electric generating station, the Council would have to make large excavations, that the soil was full of water which would have to be pumped away, and that the result might be the fall of the church. It was also alleged that the generating station would produce a vast amount of noise and vibration, and that it would be impossible if it were constructed to carry on the services of the church. In this case, however, the court disallowed the *locus*. At the meeting of the Council on Tuesday, the Highways Committee recommended that the resolution of the Council authorising them to arrange for the construction of the new tramways in Crowndale-road, St. Pancras, be not further acted upon until the work can be carried out in connection with the reconstruction for electric traction of the tramways with which they will be connected. The Parliamentary Committee recommended that in consideration of the Bexley Urban District Council omitting from their Tramways Bill the powers to authorise the construction of tramway lines within the county of London, and subject to the Bill as amended becoming law, the London County Council do undertake to promote legislation next session for the purpose of constructing such lines. Acting upon the advice of Dr. Kennedy, the Council have allowed the Stirling Boiler Company to sub-let to Messrs. Bruce and Sons, of Edinburgh, the brickwork specified in the company's contract for the supply of boilers required for the electricity generating station to be erected by the Council at the Camberwell tramways depôt.

Wolverhampton.—A meeting of the Town Council was held on Monday to consider the proposals of the Corporation Tramways Committee as to the construction of an experimental line of tramways on the Brown underground surface-contact system. The chairman of the Tramways Committee explained the merits of the system, and contended that there was less danger than attended the using of the overhead trolley system. The committee, however, were divided as to the advisability of adopting this contact system. After considerable discussion the matter was adjourned for a week. The *Express and Star* publishes a statement which Alderman Mander has issued showing the "estimated cost of construction, car miles run, and operating costs per car mile for various routes." The statement is addressed to the members of the Tramway Committee, and runs: "Gentlemen,—Herewith I beg to hand you figures in connection with the working of electric traction, and I hope to prove that the question of an additional cost of £1,000 or so per mile of track is not of much moment when compared with the total working costs. The costs per car mile must be divided into three classes—viz.: (*a*) Interest and sinking fund on old undertaking, and on new car-shed and management. This amounts to £1,833. 15s. per annum, and has to be paid whatever may be the length of track or number of miles run. It is evident that under this head the cost per car mile will *decrease* in direct proportion to the increase of car miles run, *e.g.*, the *a* costs for a 10 minutes' service of 159,120 car miles = 2·76, but on 607,838 car miles = ·72, or a decrease of over 2d. per car mile. (*b*) Interest and sinking fund on the costs of track and electrical equipment. The cost varies inversely as the service is augmented, *e.g.*, if under this head it costs 3d. per car mile for a 15 minutes' service, it would be 2d. per car mile for a 10 minutes' service, and only 1d. per car mile for a five minutes' service. (*c*) Interest and sinking fund of cars ·15d., cost of electricity 2·00d., cost of maintenance 1·35d., wages of drivers, conductors, etc., ·95d., or a total cost per car mile of 4·45d. This cost is a constant charge for each car mile, and will not vary whether you run 1,000 or 1,000,000 car miles, with this exception, that the charge for electricity may be lowered after a certain minimum has been reached, say 500,000 units. Turning to the schedule it will be noticed that the running costs (*c*) are more than 50 per cent. of the total costs for a 10 minutes' service, or four miles of route, but they are 59 per cent. on 9½ miles of route; with a five minutes' service the running costs are 64 per cent. and 73 per cent. respectively. An extra capital charge of £1,000 per mile of route would cost ·176d. per car mile for 10 minutes' service, or 0·88d. per car mile for five minutes' service. An extra £2,777 per mile of route would therefore cost ½d. or ¼d. respectively per car mile, or an increase of only 5 per cent. to the working costs. Surely it is worth while substituting a surface-contact system for the trolley system with all its disadvantages, if it can be laid down and worked at so small an increase to the working costs. (Signed) CHARLES T. MANDER, chairman." A meeting of local tradesmen has unanimously adopted the following resolution: "This meeting of Wolverhampton tradesmen views with the greatest concern and regret the present isolated position of this borough with regard to the tramway services, and respectfully urges upon the Tramways Committee the urgent necessity of some immediate arrangement being made to restore communication with the outlying districts."

LIGHTING AND GENERAL.

Rotherham.—The electric light will be switched on in three weeks' time.

Ascension Cable.—The cable between Ascension and Sierra Leone has been completed.

Lancaster.—The electricity mains are to be extended in the Skerton direction at a cost of £773.

Ludlow.—It is proposed to apply for a loan of £7,000 for electric lighting and dust destructor.

Rothwell.—The District Council intend to support the Yorkshire Electric Power Company's Bill.

Adelaide-Cape Railway.—The work of laying the new cable from Adelaide to the Cape has been begun.

Malvern.—An electric lighting and dust destructor scheme, estimated to cost £17,000, is being discussed.

Uxbridge.—It is understood that the Northwood and Ruislip electric lighting order is to be proceeded with.

Birstall.—The District Council's Electric Lighting Bill has been reported to the House of Commons for second reading.

Hull.—An enquiry is to be held shortly into the application of the Corporation to borrow £17,000 for electric lighting purposes.

Farnsfield.—The Parish Council are supporting a petition in favour of the Notts and Derbyshire electric power supply scheme.

Personal.—The salary of Mr. E. M. Hollingsworth, assistant electrical engineer at St. Helens, has been increased by £30 per annum.

Hyde.—The question of site for the proposed generating station is still the bone of contention between the Hyde and Stalybridge Councils.

Mexborough.—Messrs. Carruthers, Gothwaite, and Platt have been appointed an Emergency Committee for electric lighting purposes.

Ilkeston.—The Town Council have decided to endeavour to come to terms with the promoters of the Derbyshire and Notts Electric Power Bill.

Middlesbrough.—It is considered that the Town Council is drifting in the direction of the establishment of a municipal system of telephones.

Frome.—The order of the Board of Trade empowering the Urban District Council to supply electricity has passed the examiners of the House of Commons.

Trowbridge.—The order of the Board of Trade empowering the Urban District Council to supply electricity has passed the Examiners of the House of Commons.

Barnstaple.—Mr. Trentham has been asked to make a survey of the district and prepare and submit a complete report as to the lighting of the borough generally with electricity.

Aylesbury.—It has been decided that the whole Council form the Electric Lighting Committee. Advertisements for tenders have been issued, but no site has been secured at present.

Rickmansworth.—The Urban District Council have elected the following members to be the Electric Lighting Committee: Messrs. Barton, Smith, Rankin, and White; *ex-officio*, Messrs. Yorke and Taylor.

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Newark.—The Urban District Council do not consider it advisable to petition in favour of the Derby and Notts Electric Power Bill.

British Insulated Wire Co.—It is stated that the £250,000 4½ per cent. first mortgage debenture stock has been largely over applied for.

Cuba Submarine Telegraph Co.—The directors after providing for the dividend on the preference shares, recommend a dividend of 4 per cent. per annum on the ordinary shares for the half-year ended Dec. 31 last.

Bournemouth.—Mr. Peers, of Manchester, estimates the cost of an electric lighting installation for the workhouse and cottage homes at a total of £2,242. This estimate has been sent to the Local Government Board.

St. Marylebone.—The Council have decided to petition against the Marylebone Electric Supply Company's provisional order. The improvement of the lighting of Glentworth-street and New-street is being considered.

South Shields.—The resignation of Mr. J. A. Jeckell, the borough electrical engineer, is reported. An electrical engineer will be advertised for at a salary commencing at £350 per annum, and rising annually £50 to £500.

West Bromwich.—At Wednesday's meeting of the Town Council sanction was given to the borrowing of a loan of £30,000 from the Alliance Assurance Company, London, for the purposes of the borough electrical undertaking.

Ripon.—The Bill to confirm the electric lighting provisional order, granted by the Board of Trade empowering the Corporation of Ripon to supply electricity within their area, has passed the examiners of the House of Commons.

Worksop.—We learn that the Urban District Council will require, instead of £5,000, as previously intended, the whole of the balance of £10,000 on the electric lighting scheme, and arrangements have been made to borrow the same.

Stourbridge.—The Destructor and Electric Powers Committee have presented a report pointing out the necessity for the early commencement of the refuse destructor and generating station required in connection with the town electrical installation.

Leeds.—The electric launch "Mary Gordon," recently placed on the Waterloo Lake at Roundhay Park, was formally inspected by a representative of the Board of Trade on the 26th ult. In a few days' time the new vessel is to be officially "christened."

Electrical and General Contract Corporation.—A petition by Mr. G. Singer has been granted under the Companies Acts, 1862 to 1900, for leave to restore the name of the Electric and General Corporation, Limited, to the register of joint-stock companies.

Melbourne.—The Postmaster-General of Victoria has decided to ask the Federal Postmaster-General to sanction the expenditure of £150 000, of which £100 000 is to be spent placing underground the telephone cables in the city and installing a metallic circuit system.

Borough Polytechnic Institute, S.E.—Two special summer courses of lectures, with laboratory work, will be given by John Henderson D.Sc., F.R.S., on "Electrical Measurements" and on "Magnetic Measurements." Details in our advertisement columns.

Copper.—A Reuter's telegram from Boston announces that sufficient of the stockholders of the companies concerned in the proposed copper combine have assented to the Amalgamated Copper Company's proposition to ensure the success of the consolidation.

St. Martin's.—The staff at the Central Telegraph Office, St Martin's-le-Grand, last year worked 747,775 hours overtime, the ordinary hours of work being eight a day. The staff has frequently protested against having to do overtime, which probably might be avoided if more telegraphists were employed.

Rotherham.—The electric lighting works are approaching completion. The expenditure on capital account to March 25 amounted to £16 275. 5s 9d. When the electric light is ready to be switched on by Mr. Winter, the chairman of the Electric Lighting Committee, 31 consumers will take a supply.

City of London.—At last week's meeting of the Court of Common Council it was decided to instruct the City Lands Committee to endeavour to obtain from the City of London Electric Lighting Company the same reduction in price of electric current used by the Corporation as they allow to other large consumers.

Hucknall Torkard.—The District Council having decided against the Derbyshire and Nottinghamshire Electric Power Bill, a town's meeting was held last week for the further consideration of the matter. A resolution that the measure be opposed, and that the expenses be borne by the parish, was passed unanimously.

Brighton Telephone.—At the meeting of the Town Council on Thursday last week it was agreed, after a debate lasting nearly three hours, to engage Mr. Bennett as engineer for the proposed municipal telephones, and to apply for sanction to a loan of £40,000 to cover the expenditure connected with such an installation.

Nottingham.—At Tuesday's meeting of the County Council the Parliamentary Committee reported that they had been in communication with the promoters of the Derbyshire and Notts Electric Power Bill, and had obtained an assurance that clauses would be inserted to protect the County Council in regard to main roads.

Share Market.—Metropolitan Electric shares were a feature of the market on the withdrawal of the Marylebone Vestry Bill. There was a demand for the best electric debentures, including Kensington and Kensington and Notting Hill joint debentures London preference, St. James, Chelsea, Charing Cross, and Westminster improved.

Electricity as Applied to Industries.—This was the title of a lecture given on Saturday evening at the room of the Dewsbury branch of the Yorkshire Engineers' and Firemen's Association by Mr. Mitchell, of the firm of Newton, Bean, and Mitchell Bradford, before a good attendance. Mr. Sam Lyles, president of the Dewsbury Chamber of Commerce presided.

Wimbledon.—The last report of the electrical engineer gives the position of the undertaking to date as follows: Private lamps applied for (in 8-c.p. equivalent), 26,016; street lamps connected, 4,128; street lamps to equip electrically, 452; total lamps to provide for, 30,596; number of consumers on books, 463; maximum load reached during the month, 364 kw.

Colchester.—A plant for charging motor batteries for electrically-driven vehicles, estimated at £30, is to be obtained. The output of electricity during the last month was 11,324 units, as compared with 6 047 in March of last year. The total number of lamps now connected is 10 540. The borough accountant's report states the net profit on the electric light undertaking for the year ended March 31, 1901, to be £364. 2s. 5d.

A Storm in a Teacup.—It appears that the night staff of operators at the Gerrard telephone exchange went out on strike one night last week because they were ordered to beat the office carpet. If the information supplied to the morning papers is correct, the result was that on arriving the next evening two of them found an intimation that they were suspended until further notice and the other six also left off work, and three girls were engaged in their stead.

Aberdeen Telephones.—The Telephone Committee of the Corporation have received the report of Mr. A. R. Bennett, M.I.C.E., in which he recommends that a license be obtained by the Corporation for municipal telephones. He estimates that an annual revenue of £11 328. 12s. could be obtained with a capital expenditure of £45,320, which would provide for the construction of 62 public telephones and 2 000 subscribers' lines completed and 510 partially completed lines.

Bath.—At the last meeting of the City Council (sitting as Urban Sanitary Authority) it was mentioned with regard to Mr. Teague's report with reference to the state of the works that, in his opinion, they had a reserve of electrical energy amounting to something like 45 per cent. They would not require to extend their works, but they had sufficient power to meet all demands likely to be made upon them. The report will be considered at the next meeting of the committee.

Liverpool.—The salary of Mr. John A. Brodie, city engineer and surveyor to the urban sanitary authority, has been increased by £400. This is quite an exceptional case, as the Health Committee had recommended an increase of £200 only, but considering Mr. Brodie's brilliant services and energy, especially connected with tramway construction, the Council agreed to an amendment that the increase should be £400. A large number of members paid high tributes to Mr. Brodie's ability.

Aberdeen.—A portion of the electric culvert in front of the Town and County Buildings Castle-street, was damaged by an explosion which occurred last week. Six of the manholes were dislodged, two of them being broken, and the pavement was ripped up to the extent of about 12ft. Fortunately no one was injured. It is believed that the accident occurred through an electric spark from a failure in the cable coming in contact with and igniting a quantity of gas that had accumulated in the culvert.

Blackpool.—Some of the local papers make a fuss over the loss of £334 in the electricity department. Seeing that the total coal bill for the year was £7,697, making an increase of £4,344 on the figures of the year before, this is easily accounted for. The department is progressing, as the following figures show: the income from private lighting was £14,662, an increase of £1 956 on the preceding year; tramway current, at 2d. per unit, was supplied at a cost of £3 120, an increase of £1 215 on the year before; while the public lighting receipts were £3,408, an increase of £965.

Electric Lighting (London) Bill.—This Bill has passed the Examiners of Standing Order proofs of the House of Commons. This Bill will affect small detached areas of supply of the following electric lighting companies outside the limits of the new municipal bodies: the County of London and Brush Provincial Electric Lighting Company Limited, the Chelsea Electricity Supply Company, the London Electric Supply Corporation, the Metropolitan Electric Supply Company, Limited, the City of London Electric Lighting Company Limited, and the Blackheath and Greenwich District Electric Lighting Company, Limited.

Manchester.—Mr. H. P. Boulnois will hold an enquiry at the Town Hall, Manchester, on Tuesday next, as to the proposals of the Corporation to borrow £843 000. This great sum includes two items of £310,000 and £500,000 for the supply of electricity. Messrs. C. S. Allott and Son have been appointed to prepare specifications for the buildings required at Stuart-street station. A large proportion of the plant is expected to be ready for providing current by May of next year. A deputation, to consist of the chairman of the Electricity Committee, the vice-chairman (Mr. Phythian), Mr. Johnston, and Mr. Bowes has been appointed to visit the Continent and to enquire into the manufacture of three-phase plant which is to be ordered by the Corporation. We trust they will have a good time of it.

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Rochdale.—The Gas and Electricity Committee of the Corporation have decided to recommend the Council to reduce the scale of charges for electricity in vogue in the borough. The chief feature about the proposed change is that it will give consumers an opportunity of paying a uniform price of 4½d. per unit for electricity for lighting purposes if they prefer this to the graduated scale.

Bo'ness.—Mr. Purvis, C.E., Edinburgh, agent for Messrs. Crompton and Company, visited Bo'ness last week on the invitation of the Town Council, and inspected the places where it is proposed to put up electric lamps. Mr. Purvis subsequently reported favourably on the proposal to adopt the electric lighting system in the burgh, and further decision was postponed pending Messrs. Crompton's reply and further report.

Liverpool Telephone.—The following notice of motion was on the agenda for the monthly meeting of the City Council on Wednesday: "That in the opinion of this Council it is advisable to establish a municipal system of public telephone communication, and that the Finance Committee be instructed to obtain a license from the Postmaster General to provide such system pursuant to the provisions of the Telegraph Act, 1889."

Conradty's Carbons.—We are informed that Conradty's carbons for arc lamps, as supplied by the Sloan Electrical Company, 15, Forest-avenue, E.C., will be used by the Brockie-Pell Arc Lamp Company for their arc lamps at the Glasgow Exhibition this year. The carbons are made in various qualities, such as "C" quality for street, factory, railway, and dock lighting; "Crown" quality for indoor lighting; and "Vacuum" for enclosed arc lamps.

Indo-European Telegraph Co.—Mr. J. H. Tritton, the chairman, said at Tuesday's meeting that they were aware there had been a strong agitation in this country and India for a reduction of rates, and this had been encouraged by the Company. They had latterly introduced an improvement by which they had been enabled to transmit messages to Teheran at the rate of 80 to 100 words a minute, and this would be of great advantage to them.

Cleveland Electric Power Bill.—Petitions have been deposited in the House of Commons by Messrs. Rees and Frere (parliamentary agents) in favour of the Cleveland and Durham County Electric Power Bill by the Cleveland Ironmasters' Association, the East Pontop Coal Company, the North of England Iron and Steel Manufacturers' Association, the Ormesby Urban District Council, A. Craggs and Sons, Sir Raylton Dixon and Co., and the Tees-side Bridge and Engineering Company. John Davison, Milburn, and others have withdrawn their petition against the Bill.

Poole.—At the last monthly meeting of the Harbour Commissioners, a letter was read from the local manager of the National Telephone Company applying for permission to erect two or three poles on the sandbanks, under the control of the Harbour Commissioners. The poles were required in connection with the line to Brownsea Island. It being stated that the poles had already been erected, the Commissioners contended that they ought to have had some voice in the matter before the erection of the poles was proceeded with, and the clerk was directed to obtain the number of poles and submit a plan of their situations.

Selby.—At the annual meeting of the Rural District Council the Chairman reported that he attended the conference held at Leeds in reference to the Yorkshire Power Bills, and he did not think that it affected them very materially. There were two companies seeking powers, and it was thought that competition would be beneficial. No action was taken in the matter. At a meeting of the Urban District Council the Clerk stated that he had received letters from the two promoters of the Electric Power Bills, giving them an undertaking that they would not supply electric power within the Council's area without the authority to do so.

Londonderry.—The Corporation decided at a special meeting on Friday that Mr. Macrory prepare, for the purpose of submission to Sir William Preece or other eminent engineer, a full electric scheme, with plans and specification, etc., to accompany the application for the loan of £35,000. What is meant by the full scheme is evident from the fact that Sir William Preece, in his "further report" to the Corporation, mentioned that it was quite certain that for an expenditure of £35,000 the Corporation of Londonderry would be in a position to supply the whole of the ratepayers with electric energy for light, motor, or tramway purposes when they demanded it by requisition under the clauses of the provisional order.

Grimsby.—The Chairman stated at the last meeting of the Public Lighting Committee that another application had been received from the National Telephone Company for permission to place their wires underground. The committee had had an interview with Mr. Chambers, the manager, and asked him if the company would offer the Corporation any concession in return for the privilege, but they were informed that they were not prepared to do so. The manager said the company could not possibly reduce the charge for calls, which was £3. 10s. per annum; further, that they would require a twin-wire system. It was decided that the Corporation should not grant a monopoly to the company of the streets unless they were prepared to give them a cheaper service.

Kingston.—The report of the Building Committee, which was adopted by the Guardians last week, stated that the architect reported that he had communicated with the makers of the electric lift, and had had an interview with them upon the subject of the current to be supplied to work the machine. He stated that current as supplied by the Kingston Corporation should be used to drive a motor-generator and dynamo in connection with a storage battery of sufficient capacity to work the lift for, say, one week without recharging. As an alternative to this, the current could be obtained either by gas or steam engine with similar dynamo and battery. The committee recommended that alternative estimates be obtained by the architect from several firms of electrical engineers for the provision of the plant suggested by him, and at the same time to report in writing upon the merits of either scheme.

St. Helens.—On Friday the members of the Town Council, at the invitation of the Mayor (Alderman J. Forster) and the chairman of the Electric Supply and Tramways Committee (Alderman J. Beecham), made an inspection of the recent extension at the power station at Cropper's-hill, the principal improvement being the addition of a 600 h.p. steam generator by Messrs. Willans and Robinson. The Mayor, who started the engine, which he christened the "Beecham," stated that during the year the demand for electricity for lighting purposes had doubled, while that for traction purposes had trebled. The electrical engineer's report on the working of the dust destructor gives the total amount of refuse destroyed during the past year as 9,778 tons, at an average cost, including wages, repairs, light, and power, of £1. 5s. 1d. per ton. The steam supplied generated 329,716 units of electricity, which reduces the cost of burning to £1. 1s. 8d. per ton. The weight of coal saved by using the destructor was 687 tons per annum.

Sheffield Chamber of Commerce.—We have already referred to a resolution passed by this chamber in favour of the Yorkshire Electric Power Company's Bill, it being understood that Clause 40 satisfied the Sheffield Corporation as to the protection of their interests. At the meeting on the 25th ult. a letter was read, stating that the Corporation did not consider the clause sufficient, and intended to oppose the Bill as strenuously as possible. The local solicitors for the promoters of the Bill submitted that the company would not be entitled to bring power into the area of the Corporation, except as regarded railways and canals. "The mains," they said, "will all we understand, be laid within the private property of the railway and canal companies respectively. In all other respects the company will not be in a position to supply energy within the area of the Corporation without the consent of the Corporation." The council discussed the matter, and, coming to the conclusion that it was better, in the interests of the trading community of Sheffield, that there should be competition, decided to confirm the resolution already passed, and appointed Mr. W. Chesterman to give evidence in favour of the Bill on behalf of the chamber.

Parliament.—In the House of Lords the following Bills have been read a second time (since publication of our last list): West and South London Junction Railway, and City and North-East Suburban Electric Railway. The following were read a third time: Northfield Urban District Tramways, Sheffield District Railway, and Bournemouth Corporation. The Central London Railway Bill has been divided into two parts, and the reports of the examiners on the Bill will apply to both parts. In the House of Commons the Bury Corporation Tramways Bill has been read a third time. The Gateshead and District Tramways Bill has been considered and ordered for third reading. Sir W. Arrol, Mr. Ashton, Mr. Cawley, Sir M. Foster, and Sir J. Dickson-Poynder have been appointed a Select Committee to join the committee of the Lords on London Underground Railways. The order for the second reading of the Electric Lighting Provisional Orders (No. 1) Bill has been postponed by arrangement until May 9, so that an opportunity may be afforded for considering whether the provisions of the Lands Clauses Act as to expropriation cannot be embodied in the measure for dealing with the case of the Metropolitan Electric Supply Company.

Exeter.—At last week's meeting of the City Council the Electric Lighting Committee presented an abstract of accounts and the electrical engineer's report for the past year. The latter stated that the accounts were less favourable than in previous years, owing principally to the high price which had had to be paid for coal, and to a lesser extent to the circumstance that, in view of the approaching removal to a new station at the Basin, many items originally chargeable to capital had been paid out of the current revenue account. The total expenditure was £770 more than in 1899, and fully £600 of the increase was due to the enhanced price of coal in the latter half of the year. The wages account increased by £170, partly through additional running hours on Saturday nights and Sunday mornings. The receipts show an increase of 10 per cent. on 1899, and this despite the fact that no addition was made to the charge for current as a consequence of the cost of coal, as was done in many other places. The general result was a profit on the year's working of £2 322, leaving, after payment of interest and sinking fund charges in respect of borrowed capital, a net profit of £377. The accumulated net profits since the Council acquired the undertaking now exceed £2,700. The report, which was adopted, was considered satisfactory, as had it not been for the high price of coal the profit would have been over £1,000.

Islington.—At the meeting of the Council to night it will be proposed that application be made to the London County Council for sanction to the borrowing of the undermentioned sums, and also that the various works be proceeded with when sanction has been obtained: £3 835 for supply to houses in Aberdeen-park, Tollington-park, and Duncan-terrace; £1,518 for distributing mains in Camden-road, Caledonian-road, Essex-road and St. Paul's-road, Highbury-grove, Holloway-road, New Wharf-road, Highbury-park, and Seven Sisters-road; £3,100 for extension of mains authorised by the late vestry in York-road and Carleton-road, and

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for the erection of an arc lamp in Wynford-road; £92 for the erection of arc lamps at the corner of Wellington-road and George's-road, and at the corner of Wellington-road and Rhodes-street; £2,212 for the purchase of various meters, indicators, terminal boxes, etc., required during the ensuing 12 months; and £500 for a trial of two new types of stoker with a view of economising the consumption of coal and reducing the quantity of dust passing into the flues and stack. A report will be submitted by the Finance Committee with regard to the financial bearings of the above estimates, stating, with regard to the extension of mains in Tollington-park, Aberdeen-park, and Duncan-terrace (£3,885), that although statutory requisitions have been received from owners or occupiers in these roads for a supply of electricity, the committee are of opinion that, if practicable, the carrying out of the work should be delayed pending the decision of the Board of Trade with regard to suggested alterations in the system of laying the mains. As the consumption guaranteed amounts to 20 per cent. per annum upon the capital outlay upon these mains, it is difficult to see how the Council will be able to decline to comply with these statutory applications if they are pressed.

Electrical Exhibition.—The Twentieth Century Electrical Exhibition will be held at the Royal Aquarium, Westminster, from Monday, Dec. 16, 1901, to Saturday, Jan. 26, 1902. The president and managing director is Mr. J. Ritchie, and Mr. J. W. Wilkinson is the secretary. The exhibition will be devoted to showing (in the largest centrally-situated place of amusement in London, with an area space of nearly three acres) all the latest inventions regarding electric lighting, power, locomotion, motors, telegraphy, heating, accessories to the foregoing, and electro-chemistry. A minor hall, specially adapted, will be available for showing machinery in actual work, and for firms desiring power in connection with their stands in the main hall—where possible machinery in working will also be allowed in the latter. It is proposed to make the showing of the different kinds of machinery and apparatus in actual work the leading feature of the exhibition. The Westminster Electric Supply Corporation is in connection with the building. A special feature will be made of electric lighting in all its branches and accessories, including dynamos, gas and other engines for working same, the equipment for private houses and factories, art metal work for electroliers and fittings, lamps and globes, etc. The building is well adapted for showing illuminations of all kinds to great advantage. We are asked to call special attention to the fountains (non-working) as affording an excellent means for artistic decoration and advertisement. In the electric traction section motors adapted for railway and tramway work may be shown, also motors for all kinds of vehicles, launch and river work, and accessories, including batteries and accumulators. Space is set aside for apparatus used in X-ray photography, telegraphic and telephonic apparatus, meters, heating, cooking, and ventilating apparatus, and it is proposed to hold lectures and experiments dealing with interesting electrical subjects.

Bury St. Edmund's.—Mr. W. O. E. Meade-King has held an enquiry into the Town Council's application for sanction to borrow £12,000 for the purposes of electric lighting. The Town Clerk said as the result of opposition the previous application to borrow £20,000 for carrying out works connected with public and private lighting was refused by the Local Government Board, who, however, approved a modified scheme for private lighting. He also explained that in consequence of the borough magistrates having quashed the scheme which the Town Council proposed for making up the roads on the Brown Estate, the Council were not in a position to spend £800, which had been sanctioned by the Local Government Board for lighting that part of the borough by electricity. They therefore obtained permission of the Local Government Board for that amount being spent in lighting the centre of the borough with electricity. Applications for electricity for private lighting were increasing. The mains had been laid in all the streets included in the compulsory area, with the exception of St. John's-street and St. Andrew's-street (North). The chief electrical engineer (Mr. A. H. Roe) was unable through illness to attend the enquiry, and Mr. Greig (assistant engineer) explained the system upon which the mains were laid. He said the present system was capable of supplying 4,000 8-c.p. lamps. They were now supplying 3,025 8-c.p. lamps. There were eight arc lamps. It was proposed to increase the present power by having more machinery at the generating station, and the buildings would be extended. The proposal was to make the additional power capable of supplying 4,000 8-c.p. for both public and private lighting. It was proposed to install 400 incandescent lamps of 25 c.p. each, for street lighting. The use of gas for public lighting purposes would be discontinued. The Borough Surveyor (Mr. J. C. Smith) also gave evidence, stating that two cottages for the workmen had been erected on the Corporation land, near the site of the generating works, the cost being £431.

Barnsley.—Mr. H. H. Law has held an enquiry with respect to the application of the Town Council to borrow the sum of £20,000 for electric light extensions. Mr. S. E. Bastow, electrical engineer, stated that a provisional order was granted in 1890. This order was carried into effect in 1899, when the present works were designed and erected under the advice and supervision of Mr. T. L. Miller, M.I.E.E., of Liverpool. The supply of electricity was commenced in February, and had been continued without interruption since that date. Power to borrow the sum of £25,000 was granted for carrying out the original scheme, but the applications for the supply were so numerous that additional powers were sought and granted in 1899 for borrowing £3,500 for the purchase of another steam dynamo, which was installed before the original scheme was completed and extensions of buildings to accommodate the same. The continued increase in the number of consumers of electricity had been so rapid that some alarm was felt as to the power of the Corporation to fulfil their obligations during the past winter season, and consequently it was thought advisable to instal temporary plant, and to place a provisional contract for permanent plant pending the decision of the Board on this application. Tenders were therefore obtained, and accepted provisionally, for the supply and erection of one steam dynamo for the sum of £3,450, the said plant to be delivered in July next, but no money has been paid to the contractors on account of this set. The Corporation felt the necessity of increasing the generating works and of considerably extending the electricity mains. Taking the average rate of rise only, they had estimated the future progress to be: September, 1901—consumers 260, lamps (8 c.p.) 19,900; March 1, 1902—consumers 320, lamps (8-c.p.) 25,300; Sept. 1, 1902—consumers 380, lamps (8-c.p.) 30,700—and this was a very moderate estimate of what might be expected. A considerable demand for electricity for power purposes was springing up, and there were already 18 consumers taking about 100 h.p. altogether. The capacity of the present generating plant was equal to 12,500 8 c.p. lamps in use at one time, without any reserve of plant. The proposed new generating set would bring up the capacity of the generating works to 22,500 lamps of 8 c.p. burning at once (without reserve). It was proposed to instal steam-condensing plant at an estimated cost of £1,250 in connection with the proposed new generator and also for the existing plant. This would be divided into two sets, each capable of condensing 13,300lb. of steam per hour. As there is no circulating water supply available except from the town water-mains, it was proposed to instal a water-cooling plant at an approximate cost of £1,250. This plant would be capable of dealing with the steam from the whole of the existing generating sets and also from the proposed new set. It was proposed to instal two more steel Lancashire boilers at an estimated cost of £1,450 on similar lines to those already in use, and to fit them with mechanical stokers, and also to extend the existing coal conveyor at an estimated cost of £35. An extra electric motor would be required for driving the additional stokers, the estimated cost of which is £95. The necessary switch gear for the new generating plant and provision for immediate extension of the feeder system and mains is estimated to cost £480. It is proposed to extend the distribution and feeder mains and arc lighting mains in the streets, in each case sufficient electricity having been demanded in each of the streets to warrant the expenditure. The Borough Surveyor (Mr. J. H. Taylor) explained that the new works would cover 739 square yards on the same site as the present electric station.

London County Council.—The Council on Tuesday agreed to lend the Battersea Borough Council £10,600 for electric light installation, and the St. Pancras Borough Council £830 for lighting of public buildings by electricity. The Highways Committee recommended: "That the Highways Committee be authorised to invite the Corporation of the city of London, and the Councils of the city of Westminster and of the several metropolitan boroughs, to appoint representatives to confer with that committee upon the questions arising consequent upon the establishment of generating stations for the supply of electrical energy in bulk within the county of London, by which the powers conferred upon the local authorities by the Electric Lighting Acts, for the purchase of undertakings within their respective areas, will be affected." The Bridges Committee reported as follows: "The Council of the metropolitan borough of Poplar has enquired whether the borough electric service could supply current to the Greenwich Tunnel, and made a formal offer to supply electricity at 1·8d. per unit upon an estimated minimum quantity of 100,000 units per annum. We find that the amount of current required for the lighting of the tunnel is so small that we think that the Council could not hope to produce it by a special installation worked by the Council's staff at such a price as mentioned by the Borough Council. We have also considered the possibility of obtaining the current required from the Council's generating station at Blackwall Tunnel, but certain technical consideration, and the cost of laying 7,000ft. of cable, have led us to reject the idea. The price named by the Borough Council for lighting the tunnel is, in our opinion, very reasonable, and we think that the Council should accept it, subject to an agreement being entered into embodying the terms. We recommend that the offer of the Council of the metropolitan borough of Poplar to supply electricity to the Greenwich Tunnel at 1·8d. per unit upon an estimated minimum quantity of 100,000 units per annum, be accepted; that the solicitor of the Council be instructed to prepare an agreement embodying such terms, and that the seal of the Council be affixed to the same when ready." The Council in February last agreed to advance to the Council of the metropolitan borough of St. Pancras a loan of £830 for the lighting of public buildings by electricity. The Borough Council have now withdrawn this application. The Council have been informed by the Board of Trade that the application of the North Metropolitan Electrical Power Distribution Company for an electric lighting order in respect of the metropolitan borough of Stoke Newington will not be proceeded with. Notices under Electric Lighting Acts and orders have been agreed to as follows: Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, to lay high-tension mains along King George-street, Hyde-vale, Royal-hill, Blissett-street, South-street, and across Blackheath-road; Charing Cross and Strand Electricity Supply Corporation, under the St. Martin's District Order, 1889, to lay mains along a portion of St. Martin's-place and across Duncannon-street; County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay low-tension mains along both sides of Beauville-road and Wandle-road, and under

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the Southwark Order, 1892, to lay low-tension mains along a portion of Upper Grange-road; Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains along a portion of Empress-gate; London Electric Supply Corporation, under the company's order, 1889, to lay high-tension mains along and across Langdale-road, Greenwich; Metropolitan Electric Supply Company, under the Paddington Order, 1890, to lay high-tension mains across Fernhead-road, and along a portion of Walterton-road; St. Pancras Metropolitan Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along Croftdown-road and Chalton-street; also an application from the Kensington and Knightsbridge Electric Lighting Company for the Council's approval of some alterations of the position and the method of laying of such portion of the mains referred to in the company's notice (already approved of) as will be within the metropolitan borough of Kensington. Further notices by the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, to lay low-tension mains along a portion of Blackheath-road; Charing Cross and Strand Electricity Supply Corporation, under the Strand District Order, 1896, to lay mains across the Strand at Catherine-street; County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay mains of low, high, and extra-high tension from Yukon-road, along Balham-hill, Bedford-hill, Garrod's-road, and Tooting Bec-road, as far as Mitcham-lane; Metropolitan Electric Supply Company, under the Mid-London Order, 1889, to lay low-tension mains along Russell-square (east side), Bernard-street, Kenton-street, Handel-street, and Hunter-mews; St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains (*a*) along a portion of Houghton-place, and (*b*) along Stibbington-street and Camden-crescent. The receipt of the following notices, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of the works, was also acknowledged: From the Hampstead Borough Council, under the Hampstead Order, 1893, to lay mains along Cecilia-road, Sandwell-crescent, Sarre-road, and Wadham-gardens and Elsworthy-road; from the Poplar Borough Council, under the Poplar District Order, 1893, to lay mains along Parnell-road, Managers-street, and Cold-harbour, and along a portion of Bow Common-lane; and from the South London Electric Supply Corporation, under the Lambeth Order, 1892, to lay mains of high and low tension along both sides of Fentiman-road.

PROVISIONAL PATENTS, 1901.

APRIL 22.

8227. An improved apparatus for localising with the aid of the Roentgen rays and fluorescent screen metallic objects in the human body or other bodies. John Phillip Bennett, 2, Anglesea-place, Cork.

8230. Improvements in or relating to accumulators or secondary batteries. Ricardo Fortun and Eduardo Semprun, 111, Hatton-garden, London. (Complete specification.)

APRIL 23.

8280. The "Woodward-Torr" patent convex roller, electrical power transmitter for overhead or surface systems of electrically-propelled traffic. Thomas Oulton Woodward and Ernest Henry Torr, 42, Makin-street, Walton, Liverpool.

8295. Improvements in telephone transmitters. Charles C. Hughes, 70, Chancery-lane, London. (Complete specification.)

APRIL 24.

8402. A new or improved combined system of electric lighting and fire alarms, and appliances connected therewith. Charles Cartwright Metcalfe, 50, Oldfield-road, Sale, Cheshire. (Harry Cecil Blackwell, Russia.)

8437. Improvements in the manufacture of vulcanised electric cables. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

8467. Improvements in electric battery jars. Arthur Ford-Lloyd, Boswell-court Works, Devonshire-street, London.

APRIL 25.

8475. Improvements in brush-holders for dynamo-electric machinery. The Lancashire Dynamo and Motor Company, Limited, and Arthur Pemberton Wood, 34, Castle-street, Liverpool.

8478. An automatic shunt for protecting electric arc lamps, August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

8495. An improved form of field magnets for dynamos and electric meters. Arthur Burgess Soar, 8, Phipp-street, London.

8508. Improvements in insulating watches, compasses, or other instruments. Joseph Gurdon Leycester Stephenson, 4, Dordrecht-mansions, Brook Green, London.

8513. Improvements in electric meters. Vittorio Arcioni, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8550. An improved electric arc lamp. Robert O'Brien, Clun House, Surrey-street, Strand, London.

8535. Improvements in electrically lighting railway carriages and the like. James Ernest Spagnoletti, 70, Palace-chambers, Westminster, London.

APRIL 26.

8568. Improvements in intercommunication telephone systems. Bertil Brander, 82, Henry-road, Bridgford, Nottingham.

8593. Improvements in or relating to accumulators or secondary batteries. Georg Friederich Wilhelm Kloth, Otto Hinrich Gustav Bünning, and Jacob Georg Ludwig David Kunhardt, 111, Hatton-garden, London. (Complete specification.)

8615. Improvements in electric arc lamps. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

8629. Improved means applicable for use with overhead electric conductors for the prevention of danger in case of fracture. Reginald Page Wilson, Clun House, Surrey-street, Strand, London.

8648. Improved automatic electric exchange apparatus. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The American Machine Telephone Company, United States.)

APRIL 27.

8653. Improvements in starters for electric motors. William Reginald Ridings and Veritys, Limited, 165, Queen Victoria-street, London.

8677. Improvements in or connected with trolley heads or electric current collectors. Richard Myers Tyrer, 71, Lord-street, Liverpool.

8716. An improvement in continuous-current dynamo-electric machines. Oscar Alfred Zander and Bengt Ingeström, 46, Lincoln's-inn-fields London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 12, 1900, being date of application in Sweden.) (Complete specification.)

8717. Improvements in or relating to secondary cells or batteries. Waldemar Fiitsche, 46, Lincoln's-inn-fields, London.

8720. Improvements in differential alternating-current arc lamps. Wilhelm Mathiesen, 18, Buckingham-street, Strand, London. (Complete specification.)

8724. Improvements in and connected with controlling switches for use in electric light systems and for analogous purposes. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, Stamford Hill, London.

8727. Improved gripper for electric or other cables or ropes. W. T. Henley's Telegraph Works Company, Limited, and Richard Oliver Wright, 53, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on May 13.

1900.

3600. Switches or cut-outs for overhead electric wires, Ellis and Smith.

7392. Electrometers of optional speed. Lehner and Dauber.

7668. Production of electric arc light. Rasch.

7675. Electrical time-distributing apparatus. Lake. (Cuénod.)

7989. Electric switches. Jones.

8207. Insulated electric conductors and process of and apparatus for making the same. British Thomson-Houston Company, Limited. (Clark and Rupley.)

8781. Electric cash register tills. Snelgrove.

9084. Electric arc lamps. Stockwell.

9533. Method of exciting alternating-current machines, Boucherot.

9567. Electric traction on a road contact or like system, Thompson. (Partly by Walker.)

9746. Electricity meters of the electrolytic type. Wright and Reason Manufacturing Company, Limited.

9975. Electrical transformers. Grisson.

9982. Electric incandescent lampholders. Sheppard and Nernst Electric Light, Limited.

10426. Electric safety appliances for lifts. Garside, Carter, and Hydraulic Engineering Company, Limited.

10543. Arrangement for limiting the length of the fuse of electric cut-outs. Oppenheimer. (Actiengesellschaft Mix und Genest.)

10560. Electric furnaces of great power. Imray. (Morani.)

11263. Electric lamps and fittings therefor. Hirst.

11506. Arc lamps. Spies.

11609. Means for protecting electrical apparatus from abrupt changes in static potential. Thomas. (Date applied for under International Convention, Nov. 27, 1899.)

11610. Means for protecting electrical apparatus from abrupt changes in static potential. Thomas. (Date applied for under International Convention, Nov. 27, 1899.)

12074. Static voltmeters. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

13810. Trolleys for electric traction having three wires for three-phase or other currents. Bosshardt. (Gerard.)

15419. Supply of current to electric vehicles by inductive means, Haddan. (Sussmann-Kellborn.)

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23487. Electro-mechanical emergency brake for tramcars driven by electricity. Von Planta. (Date applied for under International Convention, June 23, 1900.)

23733. Test indicators for fire-alarm telegraphs. Woolley. 1901.

507. Electric switches. Ely.

2490. Storage batteries. Edison.

4508. Electric accumulator plates. Pickard and Evans.

5510. Commutator brushes and brush-holders for electric motors or dynamo-electric machines. Lundell.

5966. Electrical heating apparatus. Boyd.

5986. Armature core for electric generators. Koppelmann.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	Apl. 27	631	567	+ 64	—	—
Birmingham Trams.	,, 27	4,473	4,219	+ 254	69,241	—
Blackburn Corp'rat'n	,, 26	552	457	+ 95	7,291	6,582b
Blackpool Corporatn.	,, 25	380	353	+ 27	1,913	1,626
Blackpool-Fleetwood	,, 27	347	393	— 46	3 589	3 919
Bolton Corporation..	,, 28	1,414	1.035	+ 379	22 856	14,835
Bradford City Trams	Mar. 24	800	350	+ 450	9,167	4,189
Bristol Tramways Co.	Apl. 26	4,648	3 021	+ 1,627	—	—
Carlisle Tr'mw'ys Co	,, 27	190	—	—	2,181	—
Central London Ry.	,, 27	6,611	—	—	104 595	—
City & South London	,, 28	1,841	1,274	+ 567	33,861	20,963
Cork E. T. and L. Co.	,, 25	511	429	+ 82	5,990	5 366
Dover Tramways ...	,, 27	203	166	+ 37	2 871	2,653
Dublin & Lucan E.R	,, 27	97	100	— 3	1,376	1,274
Dublin U.T., elec. cars	,, 26	3,613	4,078	— *465	—	—
Dublin S.D. Electric	,, 26	856	1,176	— *320	—	—
Dundee Tram Co. ...	,, 24	608	391	+ 217	—	—
Glasgow Corporation	,, 27 1	0,112	8,960	+ 1,152	—	—
Halifax Corporation	Mar. 11	776	598	+ 178	37 247	29,269
Huddersfield Corp'n.	Apl. 27	781	580	+ 201	2 318	2,903
Hull Corporat'n E.S.	,, 27	1,572	911	+ 661	—	—
Liverpool Corporat'n	,, 20	8,566	8,435	+ 131	120 054	110 463
Liverpool Overhead	,, 28	1,591	1,433	+ 158	25,919	23,903
Portsmouth Corpn...	,, 27	594	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	,, 25	3,515	—	—	—	—
Southampton Trams	,, 25	752	497	+ 255	—	—
Southport Corporat'n	,, 13	a665	—	—	—	—
Swansea Tramways..	Feb. 22	381	244	+ 137	2,766	1,784

a Fortnightly. b Since April 1 1900.
* Review in Phœnix Park and Queen's visit, 1900.

MISCELLANEOUS.

The following traffic returns are also reported :

Anglo-Argentine (to April 1), £926 increase.

Barcelona, £463 increase.

Barcelona Ensanche y Gracia, £14 decrease.

Brisbane (week ended Feb. 27); £42 decrease, (week ended March 6) £361 increase.

Buenos Ayres and Belgrano Electric (to March 31), £1,582 increase.

Calcutta, £233 increase.

Cape Town (month of February), receipts, £13,594 ; expenditure, £5,712.

Mexico Electric (month of March), receipts, £17,150 ; expenditure, £9,900.

Perth Electric, £306 increase.

Port Elizabeth (month of February), receipts, £3,043 ; expenditure, £1,803.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Electric Railways.—			
Central London, Ordinary	10	—	9½-9¾
—— Pref. Half-Shares	5	—	4¾-5¼
—— deferred	5	—	4¼-5
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100	..	113-118
City and South London, Consolidated Ordinary	100	—	50-53
—— Ordinary	10	—	5-5½
—— 4 per cent. Debenture Stock	100	—	113-118
—— 5 per cent. Pref. Stock '91	100	—	132-137
—— ,, ,, '96	100	—	122-127
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
—— Ordinary, 1-50,000	—	..	7¾-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700 ..	—	..	102-104
Waterloo and City, Ordinary	100	—	94-97
Telephones.—			
National Telephone, Ordinary	5	—	2¾-3¼
—— 6 per cent. Cum. First Pref.	10	..	10-12
—— 6 per cent. Cum. Second Pref.	10	..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	3½-5½
—— 4 per cent. Deb. Stock, Red.	100	..	96-98
—— 3½ per cent. Deb. Stock, Red.	100	—	87-90
Oriental Telephone and Electric Company	1	—	¾-1¼
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	—	8/16-5/16
—— 4½ per cent. First Mortgage Debentures	103	—	85-90
British Insulated Wire, Ord., 1-70,000	5	—	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5
Brush Electrical Engineering, Ordinary	2	—	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	103-106
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	109-113
—— Ordinary	5	—	14¾-15¼
—— 5 per cent. Pref.	5	—	5¼-6
Crompton and Co.	3	—	3¾-4
—— 5 per cent. Debentures	—	—	101-104
Edison and Swan United, Ordinary	3	—	1¾-2
—— 5 per cent. Debentures	5	—	3-4
—— 4 per cent. Deb. Stock, Red.	100	—	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	—	94-96
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-180,000	1	—	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	—	15-16
—— 4½ per cent. Preference	5	—	5¼-6
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	36-40
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10¾-11¼
—— 5 per cent. Cum. Pref.	5	—	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	—	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	¾-⅞
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	—	70-75
Bournemouth and Poole, Ordinary	10	—	11¼-12½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7¾-8¼
—— 7 per cent. Preference	5	—	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5	—	7-7¼
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5-5¼
Chelsea Electricity Supply	5	—	5¾-6¼
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	8¾-9¼
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	—	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	—	101-103
County of London and Brush Provincial, Ordinary	10	—	8-9
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	5-5¼
—— 6 per cent. Cum. Pref.	5	—	5¼ 6 xd
—— 4½ per cent. First Mort. Deb.	100	—	103-106
Electric Ls. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	—	4¼-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5-5¼
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7-8
Kensington and Knightsbridge and Notting Hill	100	—	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	3	—	1¾-1¾
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	11¼-12½
—— ,, 85,001-98,769	5	—	8¾-9¼
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15¾-16¼
Oriental, 1879	1	—	1¼-1¾
—— £5 Shares	5	—	7-7¼
—— £4½ Shares, New	4½	—	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	—	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2¼
—— 4 per cent. Debenture Stock	100	—	80-90
South London, Ordinary	5	—	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15
—— 7 per cent. Pref.	5	—	8¼-9¼
—— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	3¾-4¼ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	124-129
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	—	2¼-2¾
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	..	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-30,000	10	—	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	..	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	..	98-100
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	—	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	119-122
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5¼-5¾ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	100	—	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	—	1¼-1¾
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	98-102
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	—	103-104
New General Traction, Ordinary	5	—	2-2¼
—— 6 per cent. Cum. Pref.	10	—	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10¾-10¾
—— 5 per cent. Cum. Pref.	10	—	11¼-12¼
Potteries Electric Traction, Ordinary, 28,667-40,000	10	—	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	107-109

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NOTES.

The American Institute.—The March number of the *Transactions* of the American Institute of Electrical Engineers has just reached us. This issue contains a report of the proceedings of the joint meeting in Paris of the English Institution and the American Institute in August last, including the "topical discussion" on "The Relative Advantages of Alternating and Continuous Current for a General Supply of Electricity, especially with regard to interference with other interests." The report of the institute delegation to the international electrical congress at Paris also appears in this issue.

The Massachusetts Institute of Technology.—This institute, which has its headquarters in Boston, is arranging to hold entrance examinations this year in London on June 7 and 28 for the benefit of English students who wish to study abroad. At present, out of 1,277 students at the institute, 33 are from other countries than the States. The entrance examination can only be undertaken by those who are over 17 years of age, and will include papers on algebra, geometry, English, history, and either French or German. Full particulars can be obtained from Mr. R. S. Ball, 5, Cross-street, Manchester. The next session of the institute opens on Oct. 2 this year.

Institution of Civil Engineers.—The council have made their awards for the papers read and discussed before this institution during the past session as follows: George Stephenson Medal and Telford Premium to Mr. Harry E. Jones; Telford Premiums and Medals to Messrs. G. A. Hobson and E. Wragge; a Watt Medal and a Telford Premium to Mr. Joseph Husband; Telford Premiums to Messrs. J. T. Ford, L. L. Buck, W. H. Stanger, B. Blount, W. J. Doak, B.E; a Crampton prize to Mr. E. Sandeman. The awards for papers which have not been subject to discussion will be announced later on, and the presentation of both sets of awards will take place at the inaugural meeting of the new session.

Overhead Wires.—It is interesting to read in the report of the Fire Brigade Committee of the London County Council certain remarks as to the equipment of new fire alarms which the committee wish to connect to the fire stations by means of overhead wires. In view of the way in which the Council has condemned the use of overhead wires, as "obstructing the free air of heaven," we are not surprised to find that their proposals in this direction are objected to by the local authorities affected. The Fire Brigade Committee, however, feel that they cannot press the local authorities to agree to the wires being carried overhead, and, in consequence, advise a larger expenditure for underground connection. Personally we think the extra expense is more than compensated for by the security obtained.

Huddersfield Telephones.—The Huddersfield Board of Guardians recently had to discuss a letter from Mr. A. B. Mottntain asking if the Board would become subscribers to the proposed municipal telephone exchange. One of the Guardians, in opposing the suggestion, did so on the grounds that if the municipal telephone proved cheaper than that of the company, it would only be so at the expense of the poor. He also objected to the Board helping to maintain the Huddersfield Corporation on the down grade. We regret to find the whole matter was deferred for six months, partly in consequence of the speech of the gentleman above referred to, who plainly stated his opinion that telephones were a luxury. The sooner such ideas are interred in the municipal burying ground at Huddersfield the better.

London County Council Tramways.—The Board of Trade have approved of the plan submitted by the London County Council for the first three lines which are to be converted to electric traction. We understand that the Board has also approved of the general system to be used in the distribution, but that they require further information respecting the details of the apparatus to be used in the high-voltage transmission, which is to be carried out at 6,500 volts. The London County Council has now before it the question of the purchase of 4¾ miles of tramway from the South London Tramway Company, and a further 4¾ miles owned by the Woolwich and South-East London Tramway Company. The matter is to come up before a special meeting of the Council to be held on June 18. In the latter case, the gauge of the line to be purchased is not the same as that of the tramways through Greenwich, in consequence of which a through service of cars cannot be run at the present time. We trust that this will be rectified when the purchase has been effected.

Glasgow Telephones.—The telephone exchange in Glasgow, now being organised by the Corporation under the supervision of Mr. A. R. Bennett, is connecting subscribers as quickly as possible. The underground cables are now complete in most of the districts in Glasgow, but the work of connecting up which remains to be done is considerable. One very good feature in connection with this undertaking is the large number of subscribers who have already applied for connection. They have reached practically 5,000 in number, but, of course, service is not being given to anything like that number at the present time. One point of interest in connection with the opening of the exchanges is the large number of applications from stallholders in the Glasgow Exhibition. Mr. Bennett has advised the committee to give these stallholders a service while the exhibition is on for an inclusive sum of £3. 3s., which is wonderfully reasonable, seeing that the telephones have to be installed and moved again within the year. Full details of the equipment of the exchange we hope to give before long, when the system has been officially inaugurated by the Corporation.

Glasgow Local Section.—The following gentlemen have been elected as officers of the Glasgow Local Section of the Institution of Electrical Engineers for the ensuing year: president—Prof. Magnus Maclean; vice-president—Mr. Henry Mavor; ordinary members of council—Messrs. A. R. Bennett, W. A Chamen, J. D. Cormack, M. B. Field, W. W. Lackie, William M'Whirter, J. M Munro, W. B. Sayers, and Thomas Young. The annual general meeting of the section was held on the 1st inst., and after business matters had been disposed of, Mr. Walter Jamieson gave a demonstration, with experiments, on high-frequency currents. The author first compared the laws governing continuous and alternating current circuits, and proceeded to demonstrate Henry's experiments on Leyden-jar discharges, and also the nature of the conditions governing the production of oscillatory discharges. Mr. Jamieson then turned his attention to pulsating currents, showing the effect of resistance on circuit, the effect of altering the spark gap, the electromagnetic induction, factors determining the duration of oscillations, heating effect of high-frequency currents, etc. He further showed the application of high-frequency currents for power transmission purposes, the possibilities of transmission, including a reference to Tesla's experiments, and concluded with a few notes on the future of high-frequency currents from a practical point of view.

Royal Institution.—The annual meeting of the members of this institution was held on the 1st inst., when Sir J. Crichton-Browne occupied the chair. The report of

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the Committee of Visitors for 1900, testifying to the continued prosperity and efficient management of the institution, was read and adopted, and the report on the Davy-Faraday research laboratory of the Royal Institution, which accompanied it, was also read. It was shown that 47 new members were elected in 1900. The following gentlemen were unanimously elected as officers for the ensuing year: President—the Duke of Northumberland; treasurer—Sir James Crichton-Browne; secretary—Sir William Crookes; managers—Sir Frederick Abel, Bart., Sir William de W. Abney, Sir James Blyth, Bart., Sir Frederick Bramwell, Bart., Dr. Thomas Buzzard, Viscount Gort, Dr. Donald William Charles Hood, the Right Hon. Lord Kelvin, Sir Francis Henry Laking, Mr. Hugh Leonard, Dr. Frank McClean, Mr. James Mansergh, Mr. George Matthey, Mr. William Hugh Spottiswoode, and the Right Hon. Sir James Stirling; visitors—Sir Andrew Noel Agnew, Bart., Dr. Charles Edward Beevor, Mr. William Henry Bennett, Dr. Francis Elgar, Mr. Joseph G. Gordon, Dr. James Dundas Grant, Lord Greenock, Mr. Maures Horner, Mr. Henry Francis Makins, Sir Thomas Henry Sanderson, Mr. William Stevens Squire, Mr. Harold Swithinbank, Mr. John Jewell Vesey, Mr. Roger William Wallace, and Mr. James Wimshurst.

Motor Vehicles for Heavy Traffic.—Mr. E. Shrapnell Smith, the hon. secretary of the Liverpool Self-Propelled Traffic Association, addressed the general meeting of the Liverpool Chamber of Commerce last Monday on the subject of motor vehicles for heavy traffic. In the course of his address Mr. Smith stated that the average daily mileage of a motor wagon when upon straightforward work was from 35 to 40 miles. This range of action opened up great possibilities for Liverpool and a few other ports in particular. In the self-propelled lorry they had an inoffensive means of conveying raw materials or merchandise from point to point without the intervention of any handling or breaking of bulk, in addition to which cartages were absorbed into the one journey and terminal delays were avoided. Another important consideration was that neither parliamentary powers nor permanent way were required. Mr. Smith then gave an estimate for Lancashire of the average annual working cost of motor wagons. A vehicle capable of carrying four tons weight would entail a primary cost of £600, while the total cost of upkeep per annum would be £381, calculated on the basis of 70 hours under steam per week of 5½ days. For a motor wagon and trailer with a freight capacity of seven tons these figures were increased to £675 and £496 respectively. The trials of these vehicles for heavy traffic will be held from the 3rd to the 7th of next month, and it will be most interesting to watch the results obtained.

Incandescent Vapour Lamps.—Mr. P. Cooper Hewitt exhibited at the recent conversazione of the American Institute of Electrical Engineers, held at the Columbia University on April 12, a somewhat novel type of vacuum-tube lighting Unfortunately, Mr. Cooper does does not give in any publication we have yet seen any concise description of the means employed by him. We gather, however, that he employs the mercury vapour in a partially-exhausted tube, and that he finds he can get this vapour to conduct continuous currents at comparatively low voltages. He also succeeds in obtaining very high candle-power. To give an example of this from the author's own curves, a lamp on a 135-volt circuit gave 1,050 c.p. with a current of only five amperes. This works out at an efficiency of 0·65 watt per candle. The same lamp on a 110-volt circuit took 4·7 amperes and gave about 900 c.p. We believe that the colour of the light obtained is somewhat objectionable, but, perhaps, this can be overcome. We have no particulars of the dimensions of the lamps exhibited, but a reference is made to one lamp, the tube of which was 54in. long and ⅜in. inside diameter. It would seem at first sight to be surprising that a continuous current could be sent through a vapour of this length and section with so low a voltage as 130. The specific resistance of the gas would seem to be abnormally low. We trust that at an early date the author will give before some society more particulars of the device which he has exhibited so recently.

The Incandescent Lamp—We notice in the *Zeitschrift für Elektrotechnik* a reprint of an article on "The Light of the Future," read before the Vienna Association of Electrical Engineers. The light which in the writer's opinion is entitled to this distinction is not clearly stated in the first instalment of the article before us, though we infer electric light is the favoured illuminant. Speaking of the economy of an incandescent lamp, the writer points out that this depends upon the temperature of the incandesced portion or filament. In a 100-volt lamp, consuming about 3½ watts per candle, the temperature of the filament reaches approximately 1,500deg. C. But if we increase the pressure at the lamp terminals by 12 volts, the temperature of the filament will then be about 1,600deg. C., while the lamp will consume scarcely more than 2½ watts per candle. It is therefore obvious that if we succeeded by the use of rare earths in imparting to the filament greater heat-resisting qualities, we should, at the same time, effect a considerable saving of energy. Attempts have already been made to produce 1½-watt lamps, but the temperature to which the filament is subjected in this case borders upon the melting point of the material used, and the life is extremely short. Perhaps, suggests the writer, we shall content ourselves in the future with lamps having a short average life, say of 30 to 50 hours. This, however, is conceivable only if the price of the new lamp is reduced to a fifth of the price which now has to be paid. The future must be left to decide what developments in this direction will take place, but, meanwhile, we are all agreed that there is ample room for increasing the economy of the incandescent lamp.

Patent Law Reform.—The *Journal* of the Society of Arts publishes a letter from Mr. Reginald Wood on this subject, in which he expresses the opinion that Mr. Siemens's paper is an admirable exposition of the state of the patent law question, and will, no doubt, be generally accepted as such if the drastic proposals with regard to the inventor as opposed to the maker be withdrawn. "No wonder the inventor," he proceeds, "finds difficulty in collecting royalty if the representative of such good workmen as Messrs. Siemens takes up this attitude. The trouble is that the power of collecting the increase of wealth created by an invention is frittered away by manufacturers combining against a patent or not combining in its favour." Mr. Wood's idea of a perfect patent law basis is this: the inventor shows how to make capital; the patentee creates the means of collecting the capital; the user makes the capital; the manufacturer makes the instrument. All that the patentee demands is that the capital which he shows how to make should be utilised in the most reproductive way—namely, first in enabling the inventor to continue inventing and creating capital. The inventor recognises that his work is the result of many men's work, and he recognises that it is to his interest, and to that of the community, to encourage the manufacture. For the purpose he is quite prepared to allow the *bonâ fide* manufacturer a large share in the profits. Mr. Wood regards this to be the basis of a sound patent law, and commends the principle to Mr. Siemens as one upon which

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to act. He concludes: "A bad patent law worked and administered in the true spirit is much better than a good law badly worked."

Accumulators for Automobiles.—The forthcoming trials of accumulators by the Automobile Club of France, will serve to show what progress has been made within the last few years in the manufacture of storage batteries for this purpose. In the meanwhile, it is somewhat discouraging to note that electric cab companies in America have gone the way of the Electric Cab Company of London. As regards the Boston Company, however, we notice that Dr. Louis Bell, writing in the *Electrical Review* of New York, holds that the accumulators were by no means wholly to blame for the failure. In fact, he considers that in connection with the Boston vehicles the storage batteries were quite as much sinned against as sinning. He adds that when the gearing of an electric cab can be distinctly heard for a quarter of a mile buzzing and whirring like a cyclopean mosquito, it is not unreasonable to assume that there is energy lost elsewhere than in the battery. We quite agree that in far too many electrical vehicles there is not enough attention paid to the mechanical design, or even to the method of controlling the vehicle in order to save waste of energy, as there should be. Dr. Bell goes on to criticise the general design of electrical automobiles as being faulty, because the accumulators are too often placed in inaccessible positions. The designer's sole aim seems to be to get a compact vehicle, and, in consequence, he arranges his accumulators so that they can be either inspected or overhauled without much trouble. Without wasting space unduly, a good deal could be gained by more careful design on the part of the carriage builders, who must remember that they are not designing a carriage to which a horse is to be attached.

Improved Lamps.—The introduction of the Nernst lamp, which is now reaching a commercial form, and the great improvements which have been made in ordinary incandescent lamps, raises the question as to how far these lamps will affect the earnings of electric lighting undertakings. We are surprised to find that the *Electrical Review* of New York takes an exceedingly pessimistic view of the effects of these lamps on the prospects of electric lighting undertakings. Its argument is that if the Nernst lamp gives the same light for half the energy, it follows that the electric lighting company loses in one swoop half its income, or has to connect a very much larger number of lamps in order to maintain it. This opens up in our contemporary a discussion as to whether the consumer should be charged for electrical energy or for light. The editorial view of the case is that it is light which is wanted, and that the meter should actually give a reading in candle-power hours. We have yet to see any practical suggestion as to how candle-power hours are to be measured, and even the measurement of lamp hours would be an exceedingly difficult matter. It would almost mean a reversion to old methods of charging as in the early days, when no energy or current meters were on the market, and when uniform rates were charged per lamp per annnm. If comparisons were needed to prove how erroneous the conclusions as to the effect of the improved lamps are, we have only to turn to the gas industry, which has received a new lease of life from the introduction of the Welsbach mantle. A reduction of cost is always followed by a large increase in consumption, and we are sure that, even if the present rates for current be maintained, higher efficiency of lamps means equal or higher profits for all electrical undertakings.

The Liverpool Accident.—The Tramways Committee of Liverpool have received Mr. A. P. Trotter's report respecting the overhead wire accident in Pembroke-place. Owing to legal actions arising out of the accident, the report is not being made public at the present time. We gather, however, from an abstract in one of the Liverpool papers that the Government inspector mentioned no fewer than eight contributory causes to the accident. These were: the heavy fall of snow, the failure of the wood guard over the trolley wire, the large number of telephone wires which fell and the length of the span, the salt slush which was in the streets at the time, the darkness which prevailed just after the accident, which rendered the wires practically invisible, the failure of the telephone service to protect itself, the delay in cutting off the electric current, and, finally, the inadequate length of the wood guard. We believe that the opinion was also expressed that if one or more of the eight contributory causes had not been present, loss of life would not have occurred. Mr. Trotter gives it as his opinion that the Tramway Committee should see that certain of the contributory causes should no longer be allowed to exist. We had hoped to give the full wording of this report, as the accident has caused a great stir in the tramway world. It is a curious thing to reflect that if the same number of people had been killed in Liverpool by heavy bales of goods falling off a lorry in the street, the accident would not have been heard of outside the town. Thus, while we should be the last to deprecate any suggestion that due precaution should not be observed to avoid such accidents, we think that undue prominence has been given to this particular accident, which tends to prejudice the extension of electric traction in other places.

Glasgow Exhibition Catalogue.—The official catalogue of the Glasgow International Exhibition redounds considerable credit on Mr. Chas. P. Watson, who is responsible for the compilation of the volume. But we are afraid that it will be found to share the all too common fault of being choked with advertisements, which, however pleasing these may be from the point of view of profit, do not tend to guide the visitor in his endeavours to ascertain the whereabouts of the different exhibits. For this, however, no blame can be thrown on Mr. Watson, who has certainly shown considerable ability in giving all the useful information possible. For instance, at the beginning of the catalogue, we have a complete list of the committees governing the different sections of the exhibition, and this is followed by a good map, the different colourings of which denote the locality of the various departments. Then come the names of the exhibitors in the order of the class to which they belong, so that we do not find, for instance, all the electrical exhibits under one heading. At the top of each page, however, is printed the court or location in which the exhibits described in that page are placed. Class III. deals solely with machinery, motive power, electricity, and labour-saving appliances in motors, and here we notice many familiar names. Class IV. is devoted to locomotion and transport, where will also be found some electrical exhibits. At the extreme end of the catalogue is given a general index in alphabetical order, while just before this a "subject" index of exhibits affords a good idea of the extent of the electrical firms represented at the exhibition under "Electricity," which includes electric lighting, telegraphs, telephones, and motors. Under the heading "Railway and Tramway Construction" figure some well-known tramway contracting firms, and by a reference to this index one may easily turn up the description of any particular exhibit in the front part of the catalogue. On the whole the catalogue may be described as compact, and after a little study will no doubt prove of great value to the visitor.

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Electrolytic Production of Bleaching Liquor.—Mr. Ernest L. Harris, United States consular agent at Elbenstock, in Germany, has issued a report on the subject of the application of electrolytic bleaching methods in textile manufacture. In this report Mr. Harris describes an apparatus invented by Dr. Oettel, a German professor, together with Haas and Stahl, electricians in Aue, Saxony, for producing "chemic," or bleaching liquor, out of ordinary brine, the product being sodium hypochlorite. The main feature of the apparatus is a trough of slate swung on trunnions in a suitable frame. There is an inlet at one end for the brine and an outlet at the other for the sodium hypochlorite, which results from the passage of a current of electricity through the brine as it passes along the trough. The electrodes are placed at either end of the trough, and thermometers are suspended at these points, which indicate at a glance the strength of the sodium hypochlorite, every rise of 5deg. Celsius corresponding to 1grm. of free chlorine per litre, equal to 62 grains per gallon. These electrodes will do service for about 12 months, at the end of which time they may be easily replaced. The apparatus is constructed in three sizes, to produce respectively 350, 650, and 1,000 gallons of the solution per 10 hours containing 3grm. per litre, equal to 186 grains per gallon, of active chlorine prepared from brine of a strength of 6deg. Baumé. Among the many advantages claimed for this system over others are these: the electrolysed solution possesses the highest decolorising or bleaching power; lime or magnesia salts are not deposited on the cloth, thereby eliminating any possible trouble in subsequent dyeing and printing; constant strength of liquor, which can be used as fast as made if desired; and economy in cost of production. The solution is also said to produce a whiteness superior to that of the English bleaching liquor.

Maintaining Synchronism in Alternators in Parallel.—It is well known that when two or more alternators are driven by independent engines there is a tendency for the machines to get out of synchronism, especially if the generators are of large size. The *Electrical World* records a patent recently granted to Mr. C. J. Young for a device which is said to have the effect of counteracting this tendency. We gather from the note in question that the inventor proposes to employ a combination of centrifugal and inertia governors in such manner that the former will tend to maintain the speed of its engine uniform without regard to the other units, and the latter will control variations from synchronism in speed. The first-mentioned governor may be of the usual type which acts to shift the engine eccentric, and thereby vary the valve lead. The eccentric strap connects to one arm of a bell crank, the other arm of which has a curved slot in which is mounted the pin of a connecting rod giving motion to the valve stem. On the shaft of the engine is also mounted an inertia governor, which acts upon a link, the outer end of the link being pivoted to the valve connecting rod. Assuming that there are two engines and two generators, if the machines start to go out of synchronism there is a succession of jerks forward on the slow machine and a corresponding succession of jerks backward on the faster machine. Now, the constant jerk forward of the slower machine will cause the weight of the inertia governor to act, the result of which will be to raise the valve connecting-rod pin in the curved slot, thus increasing the lead of the valve motion and speeding up the engine. On the other hand, the jerk backward on the fast machine will, through its governing means, act oppositely on the valve rod of its engine, and thus decrease the lead of the valve motion and reduce the speed of the engine. As soon as the jerks stop, the inertia governors tend to move back to the former position slowly on account of the dashpots, and the main work of regulation is then taken care of by the centrifugal governors.

A London Conference.—The London County Council has called a conference of the representatives from the Corporation of the city of London and the Councils of the city of Westminster and of the various metropolitan boroughs within the London County Council area, in order to consider the general question of the legislation affecting generating stations for the supply of electricity in bulk. We gather from the agenda of the London County Council that the Parliamentary Committees have not been eager to accept the opinions of the London County Council respecting these supply stations, or that the opinion expressed by the Council is really that of the various local authorities affected. The real point at issue is as to how far these large stations for the supply of electricity in bulk affect the powers of the local authorities at the end of the periods of the electric lighting provisional orders. Without a doubt they render it exceedingly difficult for the local authorities to purchase, because they can only purchase under the terms of the provisional order—*i.e.*, at the then value of the plant—the actual materials and equipment inside the areas over which the provisional orders supply. It will readily be seen that when the bulk of the power is transmitted from a central supply station also supplying other areas, the local authority will not be able to purchase a complete undertaking. There will be nothing, however, to prevent them purchasing, under the favourable terms of the provisional orders, the distributing systems within their area, and continuing to buy the electricity in bulk from these central stations. This seems to us to be a reasonable outcome of the situation, as it is impossible to construct the large stations required in the centre of London, and even where sufficiently large sites are obtained, the economic conditions would be unsurmountable. It would seem, therefore, that the local authorities even when they have already a local station in their areas will, in the long run, have to buy a supply in bulk from outside. We trust that at the conference of the above authorities, which is to be held on Thursday, the 16th inst., the representatives will take a reasonable view of the situation, and not attempt to stem progress in order that old and obsolete conditions of supply may be perpetuated.

The American Institute Conversazione.—The first conversazione of the American Institute of Electrical Engineers, held at Columbia University on the 12th ult., seems from all accounts to have been a great success. We have received a copy of the catalogue distributed amongst the members attending the conversazione, and note that a large number of experiments were actually carried out while the conversazione was going on. Amongst these were the tests of the high candle-power lamps by Mr. P. C. Hewitt, which are described in another note in this issue. Another interesting exhibit was made by Mr. Otto T. Lewis of an electric furnace, in which a spiral of platinum wire wound round a terra-cotta cylinder was used as the source of heat. Of course, the temperature of this furnace could not be raised to anything abnormal, as otherwise the platinum wires would be melted. The arrangements for controlling the temperature by switching certain sections of the wire into and out of circuit were fully described. Mr. Nikola Tesla performed some experiments with electric oscillators which attracted considerable attention. He exhibited what he calls a dynamo static machine, which consists of a small direct-current motor,

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the windings of which are tapped and connected to two rings giving a primary alternating current for the operation of a step-up transformer which gives a secondary current of about 20,000 volts, being capable, however, of regulation through a wide range. The tops of the alternating-current waves of high potential obtained from this secondary transformer are used to charge a number of glass plate condensers in parallel. The rotating frame synchronously driven with the motor makes the connection to the condenser periodically and in synchronism with the alternating current. The connection by the rotating frame is alternately in parallel and in series, condenser plates being charged to 15,000 volts and with 10 in parallel, giving 150,000 volts when connected in series. The machine therefore furnishes from low-pressure direct current high-potential discharges of definite polarity at the discharged terminals. He also showed a new rotary apparatus, consisting of an iron sphere heavily electroplated with copper and mounted so that it may revolve on any axis or in any plane. Surrounding this sphere are three coils in planes at right angles to each other. By suitably energising these coils with polyphase current the sphere may be made to revolve on any axis or in any direction, or it may be said to illustrate a three dimension polyphase system. This apparatus illustrates the principles of the gyroscope and Bohnenberger sphere.

Aberdeen Municipal Telephone Proposals.—The Telephone Committee of the Aberdeen Town Council are at present engaged in considering a report by Mr. A. R. Bennett on the proposed municipal telephone exchange in that city. The report deals with the question in an exhaustive and comprehensive way, and contains some important recommendations which are of particular interest. For instance, Mr. Bennett points out that to give effect to a scheme for 2,000 subscribers, it is necessary to provide a margin for public telephone call offices and junction lines to the outlying switchrooms, and also, in order to avoid reopening of streets, for a number of partially-constructed lines, which could be brought into use from time to time with little trouble or expense. He therefore proposes to provide lines of three different descriptions—viz.: subscribers' lines completed, 2,000 lines; public telephones completed, 62; and partially completed lines, 510. Mr. Bennett has estimated the cost of constructing a system of this nature and extent at £41,240 for the 2,062 completed lines (including junction lines), and £4,080 for the 510 partially-completed lines, making a total cost of £45,320, while he puts the annual revenue from such a system at £11,328. 12s. One of the most important points touched on in this report is the question of the period of license. The National Telephone Company's license expires on Dec. 31, 1911, and Mr. Bennett shows that if Aberdeen takes a license, say, for 25 years from 1901, the company, on complying with certain requirements of the Telegraph Act of 1899, could have their own license extended also to the year 1926. In the case of Portsmouth, the Postmaster-General, while expressing willingness to give a 25-year period, recommended a shorter period, and in view of these facts Mr. Bennett thinks that the decision come to by the Glasgow Corporation to take a license to Dec. 31, 1913, would probably be the best policy to follow. A further point which has apparently weighed with Mr. Bennett in coming to this conclusion is the fact that the States of Guernsey and the Corporations of Glasgow and Tunbridge Wells have been informed that, if they give a service satisfactory to their customers, the question of Post Office purchase may never arise. Turning to the question of trunk-line communication, the engineer states that an Aberdeen Corporation subscriber would be able to communicate with a Glasgow Corporation subscriber or a Newcastle or London Post Office subscriber for the bare trunk fees, and terminal fees would only be imposed on calls to National Telephone subscribers in other towns, and *vice versâ*. In conclusion, Mr. Bennett unhesitatingly recommends the Corporation of Aberdeen to apply for a license to construct and work a telephone system of their own. With the wires placed underground, as it is proposed shall be the case in Aberdeen, the risks from storms, fires, and other accidents would be negligible; and with the other advantages of underground construction, doubt as to the thorough success of the undertaking could not be reasonably entertained.

A New Welding Process.—At Westminster last week, before a large company of leading engineering experts and others, a demonstration of the commercial applications of Dr. Hans Goldschmidt's process of welding by the production of high temperatures by the combustion of aluminium, was given by the Allgemeine-Thermit Gesellschaft, of Essen, the owners of the patent. Dr. Goldschmidt first introduced the process to the scientific world two years ago, since when he has been working out the practical applications of his invention, with what success may be gathered from the effectual manner and the rapidity with which several pipes and one or two lengths of steel tramway rails were welded together on this occasion. The thermite consists of aluminium and oxide of iron in about the proportions of 1 to 3, and it is by the combustion of this mixture that a sufficiently high temperature is obtained to effect the welding operation. The ends to be welded are first clamped together, and then surrounded by a sheet-iron casing. The whole is covered with moist sand, which is kept in place by a box surrounding it. The thermite is prepared in a crucible lined with alumina or with magnesia, and is ignited by the addition of a small quantity of superoxide of barium, to which a match is applied. The flare thus produced is extremely brilliant, and in a very short time the whole mixture becomes a molten mass. This is poured into the mould. The aluminium immediately forms a thin coating round the joint, which prevents the iron following being welded to it. The required temperature having been reached, the clamps are tightened up, and in the case of pipe welding the process is complete within a very few minutes. When, however, the process is applied to such things as tramway rails, some 50 minutes or so must elapse before the slag may be removed from the joint. The process, as witnessed by us on Wednesday week, is really exceedingly simple, and the most satisfactory results were obtained. We were informed that the cost of welding two lengths of ordinary steel tramway rails is just under £1, but that this is slightly increased in the case of electric tramrails. The cost of welding two 2in. tubes or pipes varies from 2s. to 4s., according to the thickness. The makers further claim that a 3in. pipe 0·16in. thick can be welded with 5lb. of the mixture used. Other applications of the process claimed are the manufacture of special classes of steel, softening armour plates, repairing steel castings, etc. In the event of the iron from the mixture being required to weld on to the joint, a simple modification of the method will suffice, consisting of having an opening at the bottom of the crucible and covering it by a piece of sheet iron. In this case, instead of pouring the molten mass into the mould, the crucible is placed over the mould. When the reaction is in progress this piece of sheet iron is melted, thus reaching the joint before the slag. The process will no doubt chiefly recommend itself to electrical engineers as a reliable and rapid method of welding rails already in position for electric tramways.

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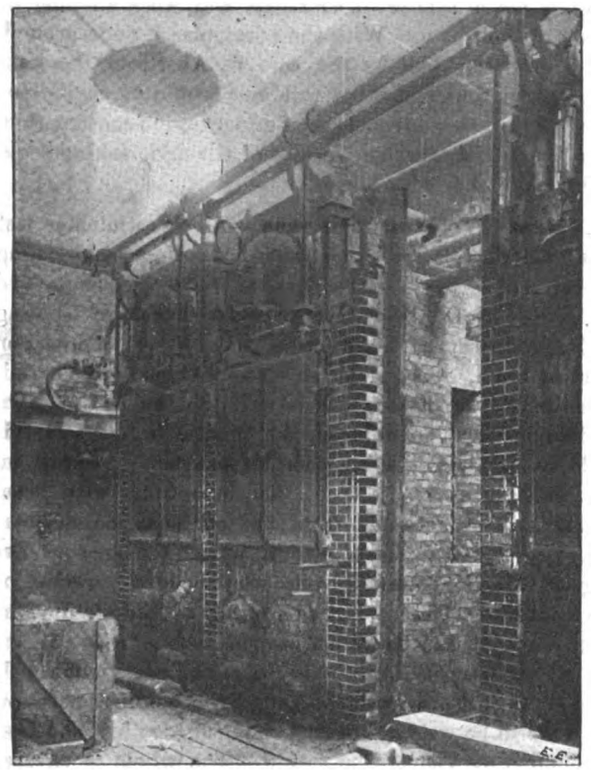
BARNES AND MORTLAKE ELECTRICITY WORKS.

(Concluded from page 624.)

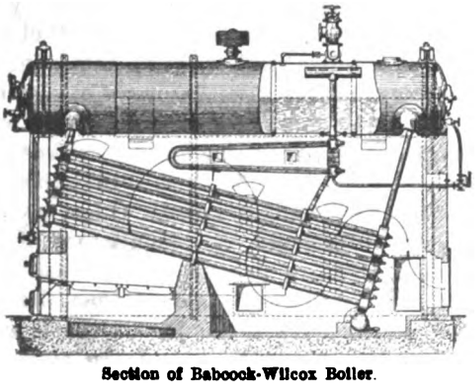
Boilers.

The steam generating plant consists of three Babcock and Wilcox patent water-tube boilers of the type now



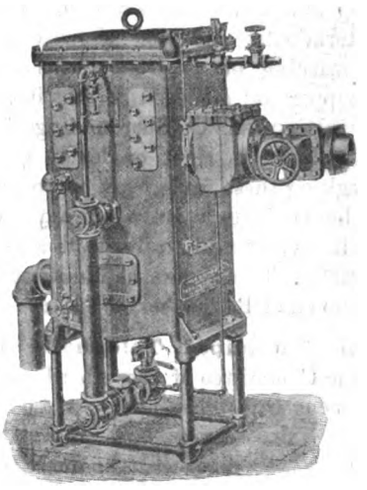
Interior of Boiler-House, Barnes.

used in many electric light and power stations throughout the country. Each boiler is constructed to evaporate 5,000lb. of water per hour from feed water at a temperature of 50deg. F., and is constructed for a working pressure of 160lb. per square inch. The factor of safety used in determining dimensions, thickness of plates, etc., is 5. Each boiler has 1,605 square feet of heating surface, and consists of eight independent sections of 4in. mild-steel tubes, each section having a wrought-steel continuous and staggered header, into which 10 tubes, composing the section, are expanded, thus making a perfectly steamtight joint. The openings in the headers to the ends of the tubes, both front and rear, are sealed by handhole fittings, making strong metal-to-metal joints, but enabling easy inspection. The tubes in this staggered form, it is claimed, more effectually break up and mix the heated gases and air, and assist in the complete combustion of the fuel.



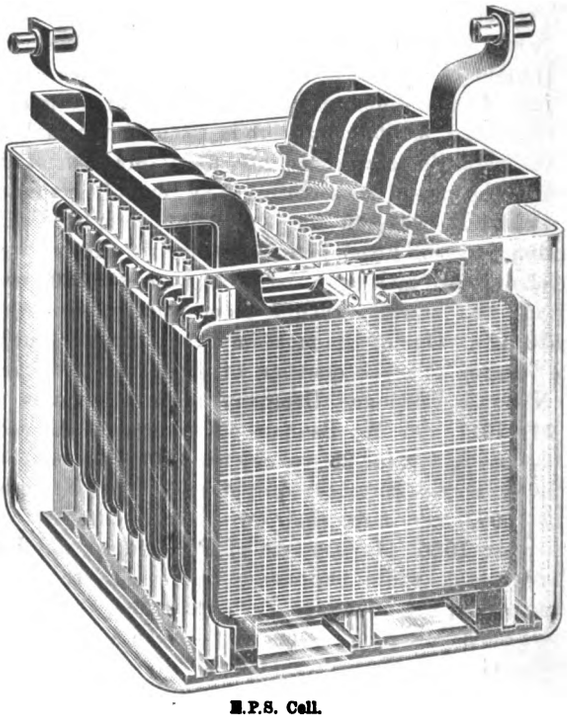
Section of Babcock-Wilcox Boiler.

The steam and water drum, above the tubes, is 42in. in diameter and 21ft. 4in. long, and is formed of mild-steel plates $\frac{7}{16}$in. diameter. The headers are connected by circulating tubes at front and rear, expanded into a specially constructed cross-box fixed on the steam-drum, from which the whole set of tubes is suspended, being entirely free from the brickwork, thus allowing for expansion. The mud-drum, of special cast metal, is also connected at the rear to the down-take headers, and the blow-off pipe from the mud-drum is brought to the front of the boiler. The arrangement of the tubes and drum is such as to provide for continuous circulation in one direction, together with the largest exposure of the heating surface to the action of the heated gases, minimising the risk of explosion. The ends of the tubes can be inspected by opening the large tube door at the front of the boiler, while access doors for ash and cleaning are also provided in the brickwork. The dampers are swivel dampers, worked by rod and lever from the front of the boiler. The boiler fittings are of the highest class of manufacture, the principal valves being of the well-known Hopkinson's make, and the low-water alarm of Messrs. Probert and Bridge's type. Fitted to each boiler is one of the Babcock and Wilcox patent superheaters. This occupies the space immediately above



Feed-Water Heater.

the top row of tubes and underneath the steam and water drum, which is probably the best position for utilising the heated gases, while not actually exposing the tubes of the superheater to the action of the fire. The superheater is



E.P.S. Cell.

provided with an equalising connection to the steam and water drum to admit of saturated steam, and a flooding arrangement to admit water from the drum into the superheater tubes when necessary. The boilers are provided with a soot-cleaning arrangement, by which any collection of soot on the tubes can be easily dispersed, thus preserving a free heating surface. The space occupied by the three boilers over the brickwork is about 680 square feet.

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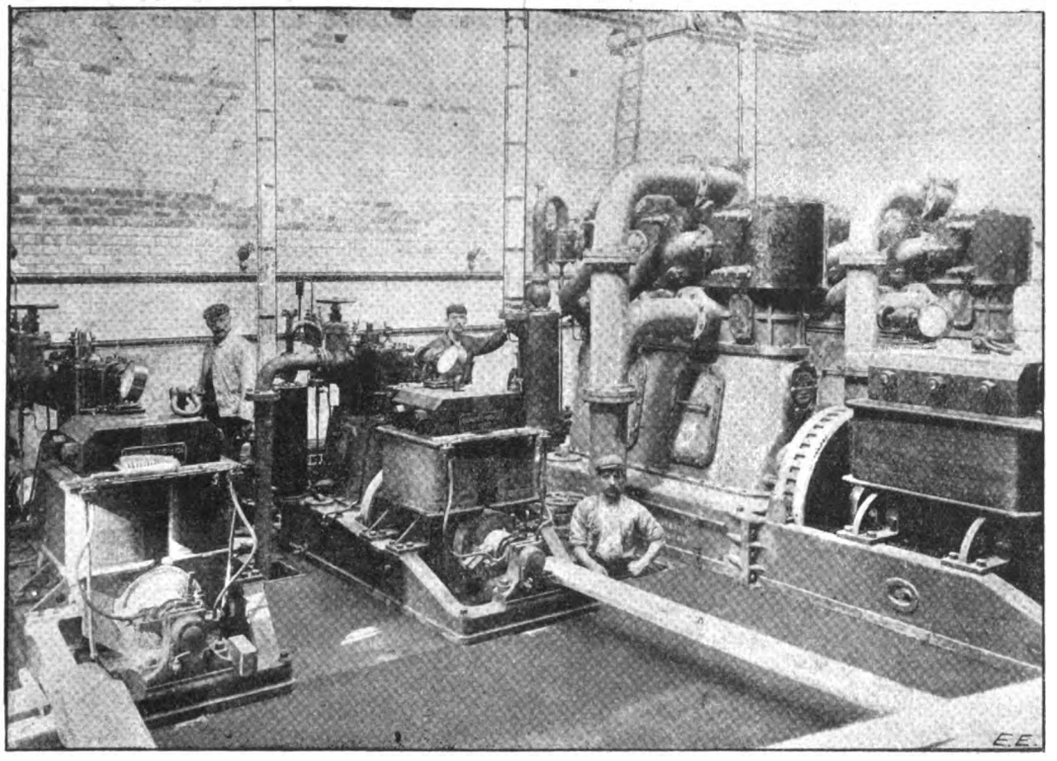
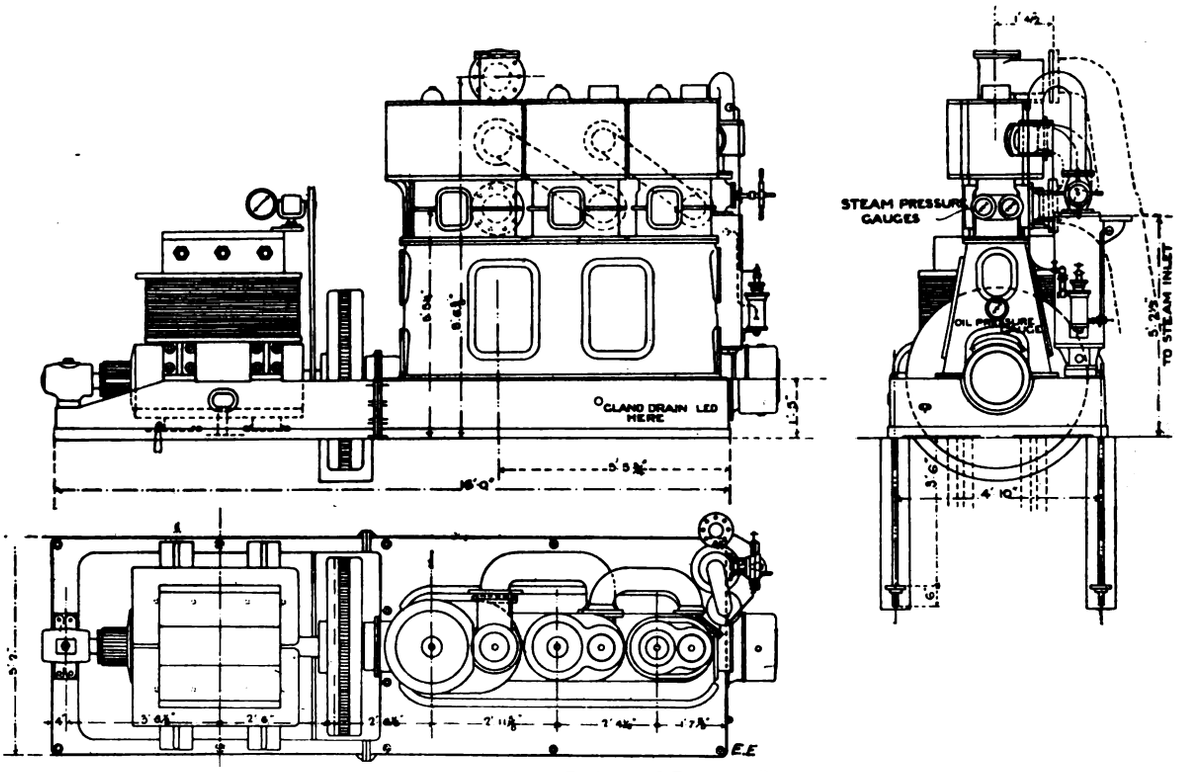
The steam, exhaust, feed, delivery, suction, drain, and condensing piping was also supplied and erected by Messrs. Babcock and Wilcox. The main and auxiliary steam-piping consists of 6, 4, 3, and 2 inch lap-welded steel piping with flanges. From the condenser engine to the feed heater the exhaust pipe is 3in. lap-welded wrought iron. The blow-off pipe consists of 3in. and 2in. diameter cast iron, and the drain piping of 2in., 1in., and ¾in. lap-welded



Interior of Engine-Room, Barnes.

mild-steel flanges, the arrangement being that of a ring main in the boiler-house, with branches connecting direct to the engines. The through-way and isolating valves are all of Hopkinson's make. The exhaust pipes consist of cast iron, 14in., 9in., and 3½in. in diameter. The sluice valves are of Messrs. Glenfield's make, the automatic relief valve of Messrs. Blakeborough's type.

The feed delivery piping consists of 3in. diameter cast-iron flanged piping, and the necessary tees, bends, and Glenfield's sluice valves, the suction feed piping being also 3in. in diameter, but of lap-welded wrought iron with cast wrought iron with cast flanges, the drain connections above the floor level to the engines being of copper. Geipel steam-traps are also connected to the above. The circulating, suction, and discharge piping consists of 10in. and 8in. cast-iron flanged piping, and the necessary



Details of Combined Engines and Dynamos, Barnes.

chequer plates are fixed to cover the feed, exhaust, and cable trenches. The steam and hot feed pipes are suitably lagged with sectional magnesia covering, and the pipes, where necessary, are supported by hangers. The hot-well is a galvanised wrought-iron tank 2ft. diameter by 4ft. by 3ft., fitted with ball-valve and connected to overhead tank.

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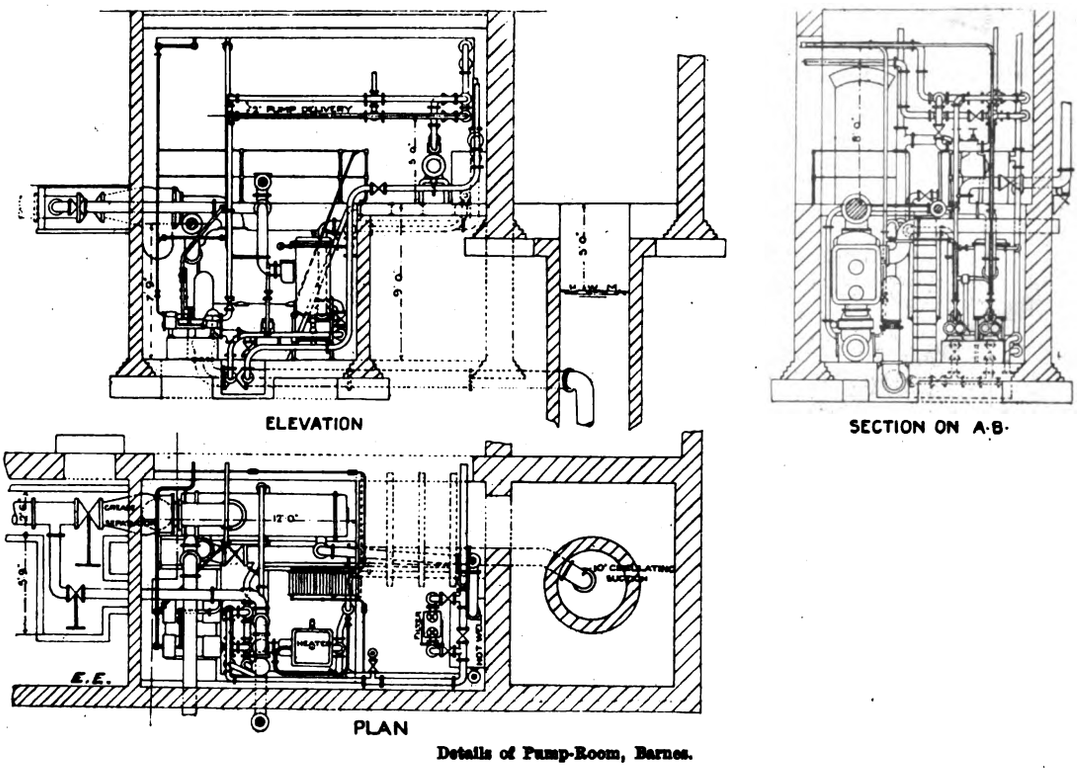
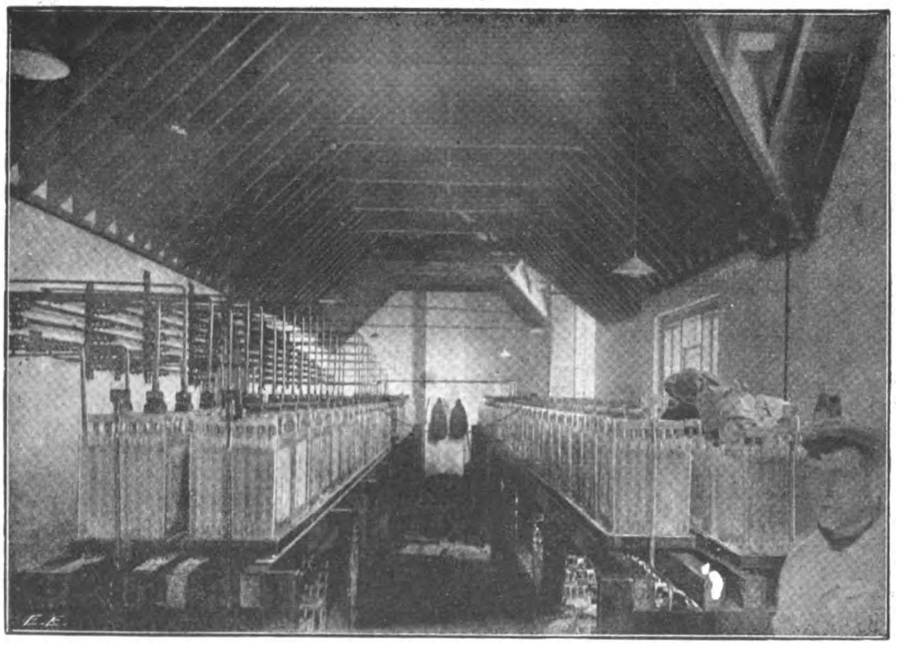
An oil separator 12in. in diameter is used, of the De Rycke type, for extracting the oil from the exhaust steam. The feed-water heater is of the Webster type, having a capacity of 12,000lb. of water per hour. The feed pumps consist of two 6in. by 4in. by 6in. Worthington duplex direct-acting feed pumps, brass fitted. The oil-filter has a capacity of 40 gallons per week. The surface condenser is capable of dealing with 12,000lb. of exhaust steam per hour, and producing a vacuum of 26in., and has 1,410 square feet cooling surface, being mounted upon combined air and circulating pumps having one 12in. steam-cylinder, one 14in. air-cylinder, one 14in. circulating cylinder, and 12in. stroke.



Details of Pump-Room, Barnes.

lubricating engines made by Messrs. Belliss and Morcom, of Birmingham, and are coupled direct to two-pole shunt-wound dynamos of the well-known Siemens H. B. type. The electrical pressure at the station is 420 to 490 volts across the outers of a three-wire system, and the steam pressure is 150lb. at the engine stop valves. The two large steam dynamos run at a speed of 420 revolutions per minute. The engines are triple-expansion, with three cranks and three cylinders. The dynamos are connected across the outers of the three-wire system. The two small steam dynamos run at a speed of 550 revolutions per minute. The engines are compound, with two cranks and two cylinders. The dynamos are connected between the



View of Accumulator-Room, Barnes.

Engine-Room Plant

The contract for the engine-room plant has been carried out by Messrs. Siemens Bros. and Co. There are four continuous-current steam dynamos, two of which give an output of 150 kw. each normal full load and 200 kw. emergency load, and the other two an output of 36 kw. each. The engines are enclosed quick-revolution self-

outers and middle wire, and are used as balancers and for charging the battery. The connections are arranged so that each half of the battery can be charged separately and from either dynamo.

Exhaustive tests of all the steam dynamos were made at Messrs. Belliss and Morcom's works before delivery. With a pressure of 150lb. steam at the engine stop valves and

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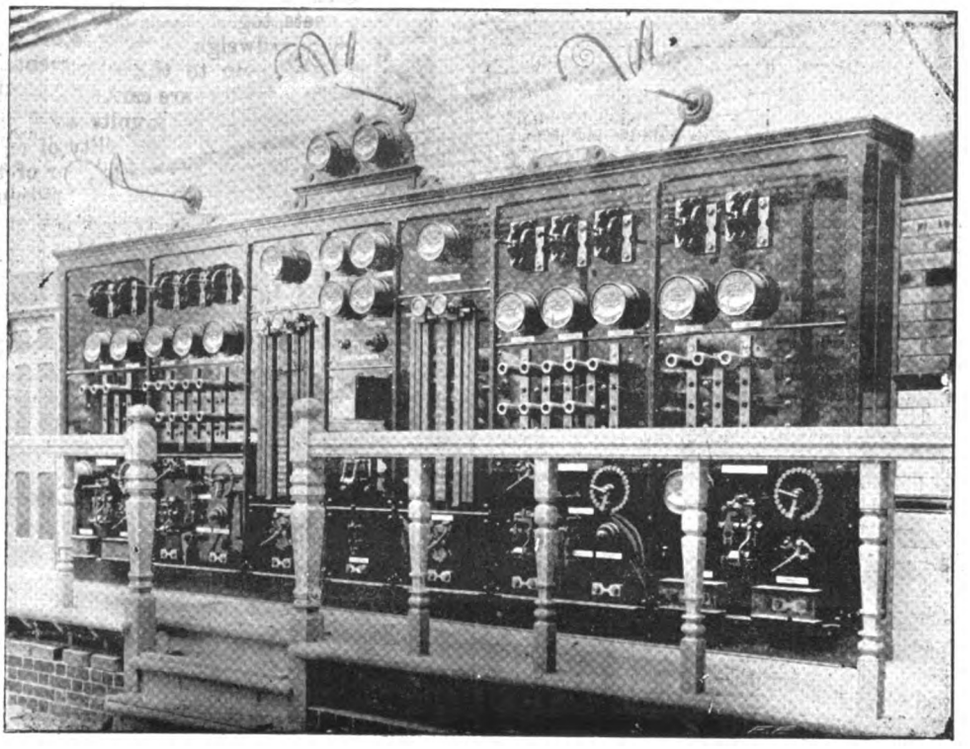
exhausting into a condenser with 27·5in. and 26in. vacuum respectively for large and small sets, the following results were obtained :

	Large sets.		Small sets.
Output in kilowatts	150	...	36
Revolutions per minute	420	..	550

a 25-way regulating switch is provided in the shunt circuit of each dynamo.

Accumulators.

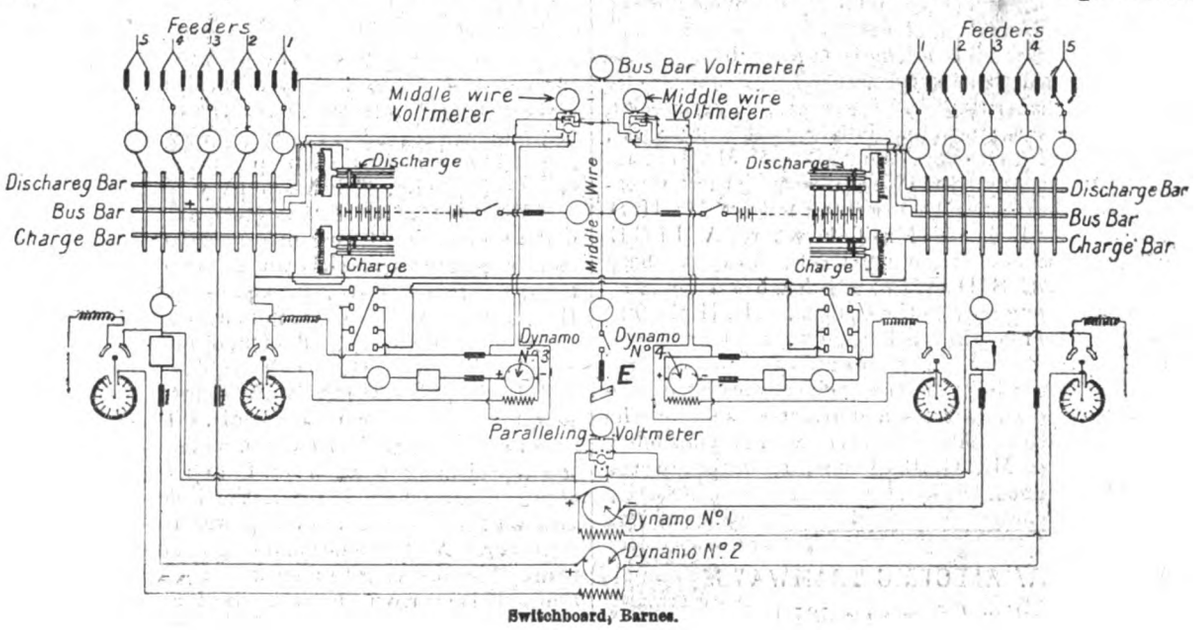
The battery of accumulators has been supplied by the Electrical Power Storage Company, Limited. It consists of 274 cells of their latest K^{WT} type in glass boxes. The



Switchboard, Barnes.

Steam consumption per kilowatt-hour.	Full load	25lb.	...	32·4lb.
	Three-quarter load	26 7lb.	...	35·3lb.
	Half-load	27·2lb.	..	37·6lb
Combined efficiency, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$	Full load	84 7 %	...	81·3 %
	Three-quarter load	81·8 %	...	80·2 %
	Half-load	80 0 %	...	77·2 %
Governing—increase of steady speed with whole load thrown off		2 %	...	2·7 %
Temperature rise of dynamo after six hours' run at full load.	Armature	61° F.	...	66° F.
	Field coils	45° F.	...	39° F.

cells are carried on varnished trays of seasoned pitch pine, supported on glass oil insulators, and the whole carried on strong pitch-pine stands. The working battery of 270 cells is capable of maintaining a discharge of 85 amperes continuously for 3½ hours, or of 50 amperes for seven hours, with a terminal E.M.F. of not less than 490 volts. It will also maintain a maximum discharge of 150 amperes for one hour. The connections between the battery and the switchboard are made with bare high-conductivity



Switchboard, Barnes.

The engines are provided with forced lubrication, and have no cooling coils for the crank chamber. Each engine is also fitted with a thermometer dial to check the amount of superheat in the steam. The outer bearings of the dynamos have ring lubrication. The leads from the dynamo main and shunt terminals are carried to the switchboard through underground wrought-iron pipes, and copper rod of ·34 square inch section, carried on porcelain insulators and painted with anti-sulphuric enamel. Twenty-five cells at each end of battery are connected to the regulating switches on the main switchboard.

Switchboard.

The switchboard has been supplied by Messrs. Siemens

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Bros. and Co. It is fixed on a platform about 2ft. above the floor level, and consists of three distinct but not separated portions. The centre board contains the battery and middle-wire apparatus, the left-hand board the positive feeder apparatus, and the right-hand board the negative feeder apparatus. The dynamo switches, etc., are fitted to the lower parts of the two side boards, and arranged symmetrically with regard to the centre panel. The panels are of slate 2in. thick, enamelled front and back, and carried in an iron framework neatly cased on the outside with varnished teak. The type of apparatus on the board can be seen from the illustration, and needs no special description. Ample space has been left at the back of the board, and care has been taken to make the arrangement of the leads neat and convenient. All connections are coloured for easy distinction between positive, negative, and neutral. Fixed behind the board are also the regulating resistances, the watt-hour meters for the dynamo circuits, and reversible ampere-hour meters for the batteries. The middle wire is earthed at the station through a Kelvin recording ampere-meter. In addition to the main switchboard, a pilot wire switchboard has been provided, and is fixed in the engineer's office. An ordinary and a recording voltmeter are provided for each side of the three-wire system, and by means of multiple-way switches they can be used to read or record the pressure at any feeding point. A very complete set of testing instruments has also been provided.

Feeder and Distributing Cables

The whole of the cables have been manufactured and laid by Callender's, and are insulated with impregnated jute fibre. There are five feeders of a total length of about five miles, and about 5½ miles of distributing main. The feeder cables are of the concentric and triple-concentric type, lead-cased, braided, and drawn into earthenware conduits, spare ways being left for the addition of new feeders when required. The feeder junction boxes consist of cast-iron pillar boxes erected on the footpaths, provided with lock-up hinged doors front and back, and arranged for the separate and convenient disconnection of feeder, pilot wire, and four sets of distributors. A three-core lead-cased and armoured pilot wire, with $^{7}/_{20}$ L.S.G. conductors, is laid from the generating station to each of the feeding points. The distributing cables are of the three-core lead-cased and armoured type, laid directly in the ground. Two conductors are of 0·1 square inch section, and one conductor of 0·05 square inch section. The house service boxes are of cast iron, and arranged so that two services can be taken from each box, one on each side of the three-wire system. The house service cables are twin rubber-insulated, lead-cased, and armoured.

The whole scheme, including building, chimney shaft, etc., has been carried out from the designs of Mr. William Fairley, consulting engineer, Westminster. In the construction of the work he has been assisted by Mr. H. S. Russell, B.Sc., M.I.E.E., and Mr. T. Pritchard, A.M.I.C.E. The laying of mains and erection of plant has been supervised by Mr. C. S. Davidson, who has been appointed resident electrical engineer to the Council. Mr. H. Cottrell has acted as clerk of works on the buildings. It must be remembered that the laying of mains always throws a great deal of extra responsibility on the engineer entrusted with the maintenance of the streets and pavements within the area of supply, and in this case this extra responsibility has devolved upon Mr. G. B. Tomes, surveyor to the Urban District Council.

GLASGOW ELECTRIC TRAMWAYS.

(Continued from page 585.)

The steel framework of the buildings, it may be mentioned, is strong enough of itself to carry the roof and the travelling cranes, the brick walls being only a clothing for the steel. This type of building is better known in America than in this country, and it has the great advantage of allowing the foundations to be laid down for the plant, and the plant installed to a certain extent, while the brick walls of the station are being built. It is evident that a building built only of brick or stone would not admit of this being done. The foundations for the main engines are exceedingly massive, but it seems to us that these very heavy units might with advantage have been placed nearer the ground level. As will be seen from the section of the station, the main engines are placed nearly 20ft. above the ground level. The four main generating sets, together with the two large auxiliary sets, represent a deadweight of over 3,500 tons, and all this weight is raised up to the above-mentioned height. Of course, the foundations are carried right down to the solid rock, but with such heavy units as those at Glasgow the question of vibration and stability of foundation must be of paramount importance The floor of the boiler-house is at an elevation of about 15ft. above ground level, but this is necessary to give space for the stoker apparatus and ash-handling arrangements. In the case of the engine-room, however, the plant might have been placed at a lower elevation without contracting the space required for exhaust piping and draining arrangements to an undue extent.

The coaling arrangements are of a very complete nature. The outside bunkers have a capacity of about 40,000 tons. They are built outside the south end wall of the boiler-house, and are arranged on different levels to suit the two different railway companies' lines. The North British line is on a level with the floor of the station, while the Caledonian line is 15ft. higher. Electric locomotives and cranes are to be used for handling and tipping the wagons. From the outside bunkers the coal passes through shoots into a tunnel underneath the bunkers, where it is taken away by means of two mechanical bucket elevators to the bunkers placed immediately over the boilers. These bucket elevators are driven by electric motors, which are placed on a level with the overhead bunkers. They were supplied by the Mirrlees, Watson, and Yaryan Company, Glasgow, and each conveyor is capable of dealing with 50 tons of coal per hour, running at a speed of 45ft. per minute. The buckets are automatically filled from the coal shoots by a revolving drum, which has baffle plates so arranged inside that the right quantity of coal is dropped into each bucket just as it passes underneath the shoot. These coal conveyors are also used for the removal of the ashes from the boilers, the line of buckets passing underneath the boiler-room floor a little below the level of the ashpits. The conveyors carry the ashes up to an ash shoot, discharging into an ash bunker situated conveniently for the removal of the ashes either by rail or canal. The buckets are supported on either side by short spindles, which pass through the chain on the one hand, and enter sockets in brackets attached to the side of the buckets on the other, and are suspended in such a way that the loaded or empty bucket retains its proper position in virtue of the action of gravity. The accompanying illustration (Fig. 3) gives a good idea of how this is brought about, and it also shows the arrangement of the driving gear. The motive power in each case is supplied by a powerful four-pole continuous-current shunt-wound motor by Messrs. Hall, of Oldham. These motors are connected to a 500-volt circuit, and run at a speed of 200 revolutions per minute. This speed is reduced to suit the conveyor by a series of spur wheels, the last of which is connected up to the driving cant wheels by a common spindle. These driving wheels are of cast steel with 10 cants, and have steel reinforced teeth projecting from their faces at such a pitch as to engage steel rollers between the links of each chain, by means of which the motive power is transmitted to the conveyor. An ingenious and original design of tilting gear is used for emptying the buckets at any point along the line. This gear, which can be fixed at any point where it is desired to unload, consists in a couple of levers with a small roller on the end of each. These rollers enter pockets in the bucket side plates, which are steadily rotated until they have emptied, after which they are released and left free to continue their course. This process takes place in a smooth and satisfactory manner, without in any way interfering with the steady and continuous motion of the conveyor. The tension gear consists of two plummer blocks, with a screw attachment to pull them along slides in a cast-

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iron base. The conveyor chain passes over two cant wheels keyed to a shaft, with these plummer blocks as bearings. In this way the conveyor chain is kept as taut as is found necessary for its proper working. A new and novel method of distribution is introduced to fill the buckets while in motion. This consists in a revolving-box shaped contrivance driven by a spur wheel, which engages the moving chain, and is so designed that it is open only when the bucket is in a position to receive the coal or ash, as the case might be. This distributing box is fed by a shoot from the side.

The total length of each conveyor is about 860ft., including a vertical lift of 107ft. The buckets move at a speed of 45ft. per minute. The whole arrangement of the boilers, bunkers, shoots, and conveyors reduces manual labour in this department to a minimum. The railway trucks containing the coal are run into position over a series of bunkers, into which they are emptied direct. The conveyor passing underneath is fed by allowing the coal to pass from the bunkers into the distributing box described above. The tunnel under the bunkers is about 110ft. in length, and when filled the buckets pass over guide cant wheels travelling back its extreme length, passing around another couple of guide cant wheels, and rise vertically through a distance of about 33ft. to ground level. The conveyor assumes a horizontal motion for some 215ft. along the bottom of the boiler-house. It then rises 74ft. to the top of the building In traversing the 210ft. along the top of the boiler-house, the buckets are emptied at various points into the coal hoppers over the boilers by means of the tilting gear already mentioned. The empty buckets descend the other side of the boiler-house back to the tunnel, where they may once more be filled, and thus complete their cycle of operations. The coal in the hoppers passes to weighing machines, and thence by shoots on to the mechanical stokers of the boilers.

Coming now to the boiler-house equipment, this consists of 16 Babcock and Wilcox horizontal water-tube boilers, arranged in eight batteries of two boilers each, and in two rows, eight boilers in each row. The tubes are 18ft. long by 4in. in diameter. Each boiler has a heating surface of 5,173 square feet, and is capable of generating 20,000lb. of steam per hour at a pressure of 160lb. per square inch; the grate is 10ft. 10in. wide between the furnace walls. A superheater is attached to each boiler, with by-pass and valves for flooding the superheater when it is not desired to be in use. The stoking is carried out by Babcock and Wilcox chain grate mechanical stokers, in which the firebars are constantly moving backwards, carrying in the coal which is fed in from the hopper at the front of the boiler, and discharging the ashes at the back of the furnace. These stokers are driven from two shafts placed underneath the floor of the boiler-room, one for each row of boilers. Each shaft is of steel, 4in. in diameter, and is driven by two Westinghouse enclosed motors, one at each end. These motors are of 12 h.p. each, and are geared to the stoker shafts, which run at 25ft. per minute, by double-reduction spur gearing enclosed in dustproof boxes, so arranged that the worm and gear wheel run in oil. The coal passing into the hoppers of the stokers is automatically weighed and registered by means of the attendant filling the hopper. This is done by merely pulling a chain, which at the same time actuates the weighing gear, so that all the coal used is accounted for. The boilers are supplied with feed water from the public supply through two storage tanks placed on girders between the chimneys. Each of these tanks is 25ft. by 12ft. by 10ft., and holds 18,000 gallons. The feed water does not require to be treated in any way, as it is practically pure. Four motor-driven feed pumps, supplied by the Mirrlees, Watson, and Yaryan Company, are capable of delivering 8,000 gallons per hour against a pressure of 180lb. per square inch. These pumps are of the vertical three-throw type, and are driven by slow-speed motors (by D. Bruce Peebles and Co.) of 8 h.p. each. In addition to the electrically-driven pumps, there is a steam-driven compound feed pump capable of delivering 16,000 gallons per hour. This pump was supplied by Messrs. G. and J. Weir, Catheart, Glasgow. This steam-driven pump for feeding the boilers is of the twin compound type, designed with a view of attaining a high degree of economy in the matter of steam consumption. It consists of two separate direct-acting pumps of the well-known Weir type, connected together in such a way that either pump may be used independently, or, as an ordinary service, the steam from the cylinder of the one pump exhausts into the steam-cylinder of the other pump. In addition to this, the steam is used expansively in each steam-cylinder, the object being to slow down the speed of the piston towards the end of the stroke. The dimensions of the pumps are 9½in. by 24in. stroke, having a capacity of 16,000 gallons of water per hour collectively, delivering against a pressure of 180lb. per square inch, and running at a normal speed of 12 double strokes per minute. Should occasion demand it, however, the pumps may easily be run at a considerably higher speed in order to make up any abnormal deficiency in the feed supply. A number of tests were made on the steam consumption of these pumps, and they were found to be extremely economical, whether working as simple pumps or as compound, and it should be interesting to compare the working of these with the other pumps fitted in the station, which are operated by electricity.

The feed water is pumped through two feed-water heaters (supplied by the Clay Cross Company, Derby), each capable of dealing with 12,000 gallons of feed water per hour, raising its temperature from 90deg. to 160deg. F. The tubes are kept clean by scraper gear driven by electric motors. These economisers are placed in the two main flues, which are of steel, and carried on steel girders above the two rows of boilers, each of which

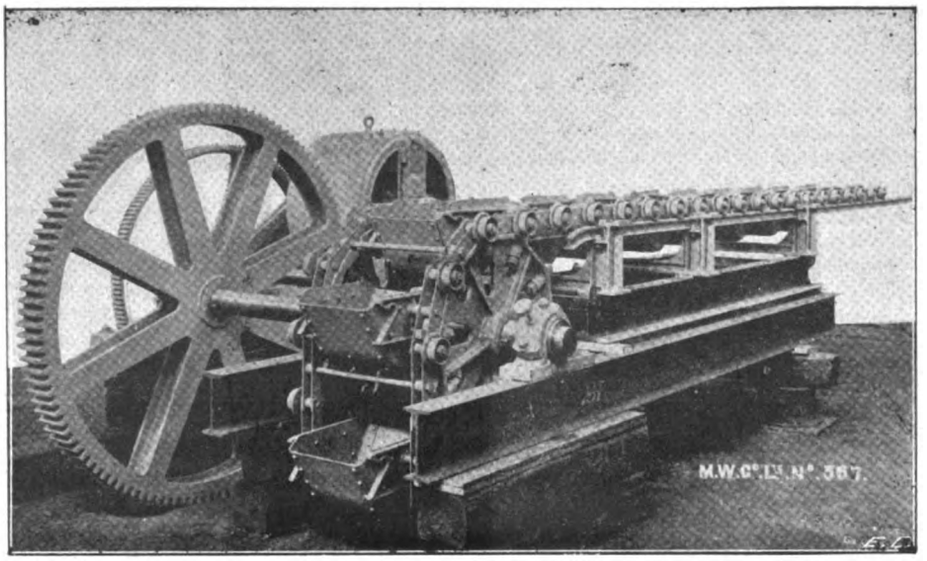

FIG. 8.—View of Driving Gear for the Mirrlees, Watson and Yaryan Coal Conveyor.

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is connected to the main flue immediately above it by means of an uptake made of steel plates, and are placed in two groups in each main flue (Fig. 1), and the economisers rest on girders about 60ft. above ground level. Each main flue has four soot-doors made of $\frac{3}{8}$in. steel plate, each opening being 18in. wide and 21in. high.

The steam-piping is arranged on the simplest possible system, and aims at giving the shortest and most direct passage to the steam from the boilers to the engine. After some of the complicated systems of ring mains and duplicate ring mains which have become associated with central-station practice, it is a pleasure to see the simplicity of the pipe arrangements at Pinkston. Each pair of boilers is connected by a 7in. pipe into a 9in. cross main. This 9in. main leads directly into the main header, which is 16in. in diameter, and which runs along the whole length of the boiler-house. It is in two sections, united by two copper expansion bends. All the steam-piping is of lap-welded steel. The steam-pipes from the main header to the engines are overhead, as the distance between the boiler-house wall and the steam-valves of the main and auxiliary engines is short. Two of the main engines (the Allis) are supplied by 14in. pipes, and the other two (Musgrave) by 15in. pipes. The steam-boiler blow-off, safety valve vapour escape; indeed, the whole of the space below the floor levels in the different sections is a mass of piping, but all arranged to carefully-drawn-out plans, and erected to secure accessibility and ease of repair. The steam-piping was supplied and erected by the contractors for the boilers. Most of the valves in the station are of Hopkinson's make.

In the engine-room there are at present completed two main three-phase generating sets, each of 2,500 kw. output; two auxiliary direct-current generating sets, each of 600 kw. output; and six exciter sets, each of 50 kw. output. In course of erection are two additional 2,500-kw. three-phase main generating sets, and there is space allowed for two similar sets to be put down when extensions in the system make undue demands on the present engines. The main engines are normally rated to work at 4,000 i.h.p., but are capable of working at 5,000 i.h.p. as a maximum, running at the normal speed of 75 revolutions per minute. Two of these engines, which are the largest which have been installed in this country (and, until very recently, in any country) for electric traction work, have been supplied by the E. P. Allis Company, Milwaukee, and two by Messrs. Musgrave and Sons, Bolton. As they are placed side by side (Fig. 1) there will be an excellent opportunity

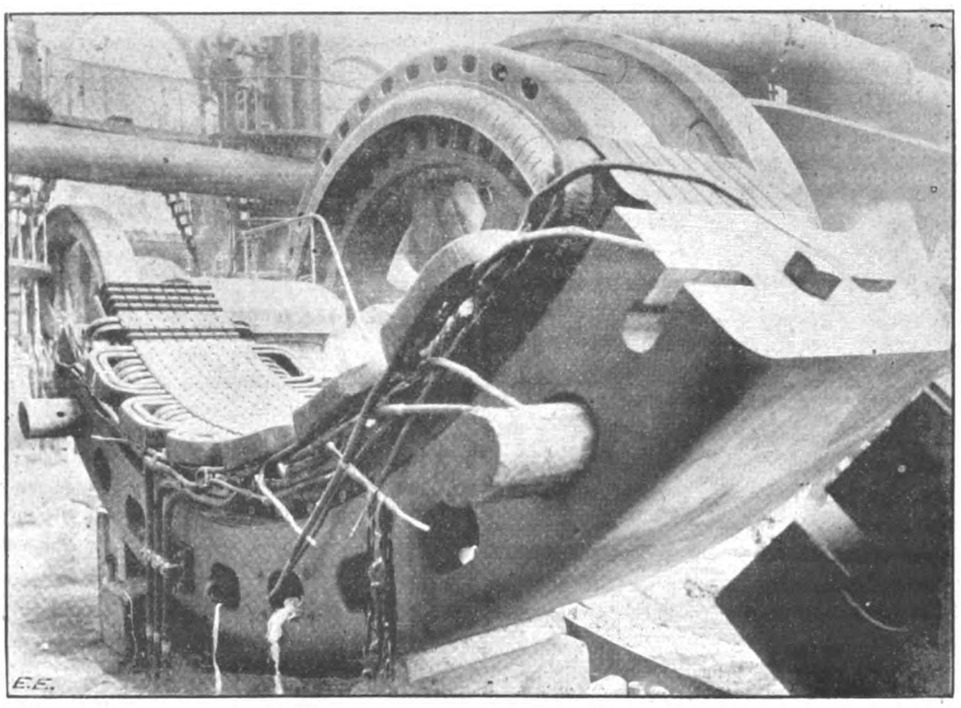

FIG. 4.—A Segment of the 2,500-kw. Three-Phase Alternator Armature in course of Winding.

piping for the auxiliary plant is all connected to an auxiliary steam-main, which is led underneath the engine-room floor and feeds the auxiliary (Stewart) engines, the exciter sets, and the Weir feed pump. The feed piping is arranged on a double ring system, so that the boilers can be supplied by either the steam feed pump or by the electrically-driven feed pumps. The exhaust pipes from the main and auxiliary engines are led underneath the engine-room floor. Each main engine exhausts either into its condenser, or into a 30in. exhaust pipe, which leads to the atmosphere. A most complete system of drains pipes leads all the condensed water from the steam and exhaust piping into the hot-wells, one of which is provided for each condenser. The feed water is pumped directly from these hot-wells, which are arranged in three divisions in such a manner as to separate the oil from the condensed water. From the hot-wells the feed water passes through an oil-filter and a Kennedy water-meter to the economiser, and thence to the boiler. When the level of the water in the hot-wells becomes too low, a ball valve allows the cold water from the feed tanks between the chimneys to fill up the hot-well to its proper level. Each hot-well has an overflow connection to the sump outside the buildings. Complete services of pipes have been laid down for service water for cleaning out the boilers, economiser blow-off,

for comparing the work of American engineers with that of their British rivals. The engines are of the vertical inverted compound-condensing three-cylinder type, with Corliss valve gear. The Allis engines have tubular columns, and are of the semi-enclosed type; the Musgrave engines are of the square-column open type, and conform more closely to the marine build. Both makers have not stinted anything in weight and mass of metal, as the following particulars will indicate: The high-pressure cylinder is 42in., and each of the low-pressure cylinders 62in. in diameter, and the stroke 5ft. Starting from the high-pressure end, the first and second journals are 22in. in diameter by 36in. long, the third and fourth 24in. by 36in., and the fifth 32in. by 64in. The outer bearing outside the generator is 30in. by 48in. The shaft is 36in. in diameter where it passes through the hub of the flywheel. The sizes of the crank-pins are as follows: high-pressure, 20in. by 12in.; first low-pressure, 16in. by 12in.; second low-pressure, 12in. by 12in. The flywheel is very massive, being 24ft. in diameter, and weighing almost 115 tons; the rim is 26$\frac{1}{2}$in. by 26in., and is built in sections of special cast iron, dove-tailed together by means of H-shaped mild-steel bolts. The over-all measurements of the engine are: length 43ft., or 52ft. including the flywheel and generator; height, 34ft.; width back to

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front, 24ft. The weight of each engine is about 700 tons. The guaranteed steam consumption does not exceed 14lb. per brake horse-power per hour, which it is expected will be easily realised under working conditions. The engines are governed so as to keep the variation in the angular velocity within ½ per cent. during a revolution at any constant load, and the speed of the engine must not vary more than 1½ per cent. above or below the normal, under any fluctuations from no load to maximum. An emergency governor is also provided which cuts off the steam when the speed reaches more than 5 per cent. above the normal. The three-cylinder type was adopted to give an even turning moment, which is, of course, essential in three-phase work. The three cranks are set at 120deg. apart. The main bearings are cooled by water from the supply mains, which is kept constantly circulating round the same.

The main generators are built by the British Thomson-Houston Company, Limited, and are the largest machines which have been installed in the United Kingdom for electric traction. The normal output of each machine is 2,500 kw. at 6,500 volts when running at 75 revolutions per minute, but they will stand an overload of 25 per cent.

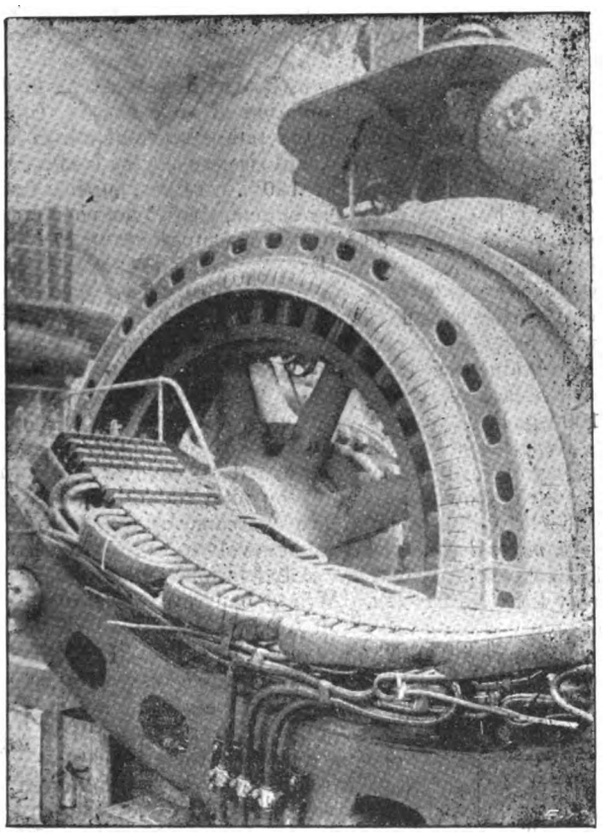

Fig. 5.—Another View of the same, with a 2,500 kw. Alternator in the background.

for two hours, or 50 per cent. for 15 minutes. The number of poles is 40, which are arranged on a revolving field frame 16ft. 8in. in diameter. The periodicity is 25 cycles per second. These generators are of what is known as the "outside" type—*i.e.*, they are outside of the engine altogether, on the end of the engine shaft, and not placed between two of the columns of the driving engine, or between two separate engines driving a common shaft. This latter arrangement is much more common for units of the above size, but it is evident that there is much to be gained by having the generator outside of its driving engine, as this arrangement admits of easy access for erection and repairs if necessary. The fixed armature frame is mounted on cast-iron foundation plates, and is provided with a screw sliding arrangement which enables the frame to be removed from the pole ring, giving easy access to either armature or field coils. The 40 field coils are all in series, and take an exciting current of 250 amperes at 100 volts. They are wound with 43 turns of copper strip on each coil, wound on edge, 1·625in. broad by ·17in. thick. The exciting current is led to cast-iron collecting rings by carbon brushes. The armature core is built in sections, and the coils were all put into place on the site. Figs. 4 and 5 show two segments of an armature in course of equipment. The slots are rectangular in section, with a shallow V groove near the point of each tooth to admit of thin wooden slips being driven in after the coils are in position to hold them in place. The number of coils on the armature is 120, one coil per pole per phase. These coils are composed of pressed stranded copper cable ·485in. by ·275in. over all, the section being rectangular. The conductor is triple-cotton covered, and the coils, each of which consists of 13 turns, are insulated as a whole. Each slot contains 36 turns of conductor, or two overlapping coils. The ventilation of the core is very liberally provided for, and each slot is very carefully insulated before the coils are placed in position. The three phases are connected on the "star" system. Each generator complete weighs fully 90 tons, the fields being about 33 tons and the armature and frame 44 tons. The outside diameter across the armature frame is 21ft. 6in. The guaranteed efficiency of the generators at full load is 96 per cent., at three-quarter load 95 per cent., and at half-load 93 per cent. The temperature rise after a 12 hours' full load run is not to exceed 54deg. F.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

375. Two 120-kw. and one 60-kw. alternators were running in parallel. The exciting circuit of the last named was broken, causing a dead short-circuit across the other two. The main switch on the 60-kw. set was opened and broke with a very small spark. Was this almost sparkless break due to the choking effect of the 60-kw. alternator armature, which was iron-cored? Working pressure, 2,100 volts.—R. W.

376. Discuss the advantages and disadvantages in the Lancashire and Galloway types of boilers of passing the flue gases first along the bottom of the boiler and then the sides, or *vice versâ*?—F. H. P.

ANSWERS.

Question No. 369.—What are the advantages and disadvantages in the use of superheated steam?

Best Answer to No. 369 (*awarded* 10*s.*).—Steam is said to be superheated when it possesses a higher temperature than that corresponding to its saturation pressure. The great enemy to economy in the steam-engine is the destruction of the initial steam by the comparatively cold cylinder metal. If there is any water in the cylinder, the tendency is for it to absorb heat from the metal of the cylinder and pass off as steam to the condenser, carrying with it, however, 1,000 or more units of heat absorbed in the act of vaporising. If the cylinder only contained dry steam there would be only a small weight of this, and the heat carried away would be only about one-third of a unit per pound, steam having a small specific heat. Moreover, dry steam being a gas would be a poor conductor and absorber of heat; hence to prevent loss of heat to the exhaust we must contrive to have a cylinder freed from water. There are two lines making for economy in the steam-engine—extra pressure and superheat. Higher pressure gives little additional total economy owing to necessary complications.

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Superheat can give small additional economy beyond the point where it renders a dry exhaust attainable, but up to that point will probably result in considerable economy.

The advantages in the use of superheated steam are the following: (1) An improved thermo-dynamic efficiency; (2) provision of heat to cylinder to prevent condensation of initial steam; (3) a minimum discharge of steam to the condenser, and demand for water for condensing; (4) reduction of the back pressure; (5) increase of boiler efficiency on the basis of some otherwise waste heat now appearing as superheat; (6) smaller quantity of steam used per indicated horse-power hour, resulting in increased boiler capacity from the same plant.

The disadvantages may be stated as follows: (1) lubrication—a better quality oil must be used and more of it; (2) packing—metallic packing must be adopted for all parts exposed to steam highly superheated; (3) possible increased wear and tear on piston rods, cylinder walls, glands, and valves; (4) the extra complication of the superheater and attendance thereon.

As regards thermo-dynamic efficiency, the gain here is probably slight, and the major portion of the resulting economy is no doubt due to prevention of initial condensation and the provision of a dry exhaust. The best results with superheating are always obtained from the worst engines, the simple engine, the slow-speed engine, and small isolated engines connected to comparatively long lengths of steam-piping generally reaping most advantage. The gain which may be expected in ordinary cases is shown in the following table:

Engine.	Pressure.	Per cent. of condensation.	Ratio of heat lost by condensation and expended on superheat.	Amount of superheat.
Simple	50 to 100	50 to 30	5 : 1	100° F.
Compound...	75 to 125	30 to 20	3 : 1	75° F.
Triple.....	125 to 180	20 to 10	2 : 1	50° F.

The mode of superheating and its application may vary. The Schmidt engine uses saturated *and* superheated steam in the same cylinder. The governor admits more or less superheated steam according to the position of the cut off, a late cut off and consequent smaller expansion requiring less superheated steam. The steam may be heated by a part of the heat from the boiler furnace, or a separate furnace may be used. The difference in temperature inside and outside the heater should be 400deg. F. If less than this, the area of superheater becomes large, and the general warming effect not so good. It is necessary to provide an efficient means of regulating the superheat.

The following extracts will give some idea of the economy which may be secured by the use of superheated steam. Test of a compound engine of about 700 h.p. and 85lb. steam pressure: Steam heated 42deg. C. to 222deg. C. gave 10·5 per cent. economy compared with superheat of 3deg. C. only, with saving of 8 per cent. in fuel. Superheated (84deg. C.), the two economies were 14·3 and 14·4, while with 100deg. C. superheat the economies were 19·3 and 20 per cent. The heat lost in steam-pipes was 17deg. C. at lowest heat and 21·5deg. C. at highest. The steam consumption fell from 16·5lb. to 13·2lb. as the superheat was increased to 100deg. C.

Trials on a 17-h.p. Schmidt motor, a single-acting simple non-condensing engine supplied from a Schmidt superheater, showed that an expenditure of 5, 10, and 15 per cent. of the furnace heat on superheating gave net gain of 12, 38, and 70 per cent. respectively of the work done for heat supplied.

Experiments were conducted by MM. Meunier and Ludwig on a triple-expansion engine using steam at 180lb. pressure; the cylinders were 22in., 31½in. and 45in. with 4½ft. stroke; 70 revolutions. A separate Uhler heater heated the steam to 228deg. C. at the engine, with a resulting economy of 14 per cent. steam and 5 per cent. coal; 22deg. C. heat was lost in pipes. Using a Schwoerer apparatus (which is placed in the boiler), heating surface 2,743 square feet in place of 1,635, the steam economy was 14·7 per cent. and coal economy 18·4 per cent., the superheat being 100deg. C. at the heater with 13deg. loss in pipes to the engine. Oil used without superheat in 11 hours was 8·8lb., *with* superheat 11·7lb. of a more expensive oil.

Tests made in Bavaria on a Sulzer engine have shown the daily supply of cylinder oil necessary for a compound engine was 4·3lb. *with* superheated and 3·8lb. with saturated steam. After five months' working with steam at 220deg. to 230deg. C. the cylinders and rods were in good order. Feed water used fell from 19·6lb. with saturated steam to 15·6lb. with 252deg. C. of superheat and 14·1lb. with 292deg. C. superheat.

Prof. Schroeter found a reduction from 13·4lb. of steam per indicated horse-power with jacketed cylinders to 12·1lb. with superheat. Tests with Schmidt steam at 675deg. F. showed only 10·2lb. per indicated horse-power, and a coal consumption of 1·28lb. only. Very generally from 1 to 5 per cent. of steam is condensed in the steam-pipes and valve chests, etc., the water being removed by separators. It has been found that 19deg. F. superheat will obviate a 1 per cent. condensation, while 100deg. F. superheat will prevent a 5 per cent. condensation. In one test 300deg. superheat at boiler gave 283deg. at the steam-chest. At the end of stroke the steam was dry, and steam per indicated horse-power hour was only 10·17lb., the pressure being 168lb.

Careful tests have shown that with a constant load on the engine very little regulation of superheat is required. When the load is reduced the temperature of steam in the superheater begins to fall, and rises as the load is increased. In one test with steam at 120lb. pressure, superheated to 674deg. F. on entering the engine, the steam consumption was reduced from 38·5lb. without superheat to 17·0lb. per indicated horse-power. Experiments showed that unless superheat was 200deg. F. with late cut-off, or even higher with earlier cut-off, the condition of steam at the exhaust was that of wet steam at the temperature of saturation. To obtain dry release, superheat of about 300deg. F. was necessary, the superheat at cut-off being 50deg. to 100deg. F.

Experience has shown that with ordinary care as to purity of feed water, superheated tubes after long periods of work show no signs of burning or scaling, while the difficulties of lubrication are overcome by the use of high-class *mineral* oils. The admission valves, being subject to the full superheat, should be nearly frictionless, so as to require very little lubrication. Where boilers prime badly, great economy is bound to result from superheating.—E. M.

Answer to No. 369 (*awarded* 5*s.*). — In order to scientifically appreciate the advantages arising from superheating, we must first examine the steam-engine considered purely as a heat-engine. The thermo-dynamical efficiency of a heat-engine depends upon the temperatures at which the gas is admitted to and rejected from the cylinder. In other words, the fall of temperature is the measure of the heat efficiency. If, therefore, we raise the temperature of the entering steam by superheating or any other means, we shall obtain a greater possible fall and a theoretically higher efficiency. In the steam-engine this has been effected of late years by raising the boiler pressure, and consequently the temperature of the steam. If in two hypothetical cases we admitted steam to the cylinder of an engine at the same temperature, but in one case by producing the steam at a lower boiler pressure than in the other case, and the difference made up by superheating, the thermo-dynamical efficiency would be the same in both cases; if, then, we keep within the ordinary range of boiler pressure, superheating has no thermo-dynamical value, as it neither raises the higher temperature of the steam nor depresses the lower temperature. In practice, however, there would probably be a gain to the superheated steam in cases referred to above for the following physical reasons:

The entering steam to the cylinder of an engine encounters the comparatively cool surfaces of the cylinder, piston body, cylinder cover, etc., whose temperatures have been reduced by the previously exhausting steam. The first efforts of the steam are directed to raise the temperature of this cool surface to its own temperature, and in doing this, since it is at the saturation temperature, some of the steam is condensed and remains in the cylinder as water. This phenomenon is known as initial condensation,

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and is the determining factor in engine economy. Now, if we raise the temperature of the steam above the temperature of saturation, there will be less condensed in the cylinder during admission, as the superheat will first disappear before the latent heat of the steam is drawn upon. Further, if the superheat is sufficient, it may lead to the complete extinction of initial condensation.

Whether we superheat or not, the cool surfaces have to be heated up each stroke, but if we can effect this without the presence of water in the cylinder there is a distinct gain, as when water is present it takes up heat at the end of the stroke by boiling at the lower pressure and thereby robs the steam of useful heat. In a compound or triple-expansion engine, of course, some of this heat appears as useful work in subsequent cylinders. However, it may be laid down that wet steam in the cylinder of an engine is a source of loss. The success of superheating is due to the fact that we are in a position to ensure that the steam in a cylinder remains dry. It is considered that about 100deg. F. of superheat will, in an average case, cause the entire disappearance of initial condensation, and will lead to an important gain in economy. Even 15deg. to 20deg. F. will produce a large gain. Prof. Thurston states that in an average of 52 cases observed by him the gain with 105deg. superheat was 26 per cent. The average gain for a compound engine under ordinary conditions may be taken at about 20 per cent.

In the early days of superheating great difficulty was experienced by the high temperature of the steam causing destruction of the packing and lubricant, and consequent cutting of the rubbing surfaces. The introduction of metallic packing of late years has, however, overcome the former difficulty, and with high-class lubricant we do not experience any trouble from the latter cause within the usual conditions of operation. The low temperature at which flue gases are to-day discharged necessitates a large area of superheating surface, and the real difficulties and disadvantages of superheating are met with at this stage. Obstruction to the boiler has been and still remains a difficulty of construction. The superheater requires to be designed to withstand the high temperature of the flue gases, and at the same time to have a satisfactorily long life. An insuperable difficulty is due to the fact that superheaters suitable for heavy loads may burn out at light loads.—E N. T.

Answer to No. 369 (*awarded* 5*s.*).—One of the most serious losses in a steam-engine—particularly in a slow-speed type—is the condensation of steam on first entering the cylinder. It is partly re-evaporated later in the stroke, but the energy expended in heating the cooled walls of the cylinder is not given out again to the same degree by them when, later on in the stroke, their temperature exceeds that of the steam in the cylinder. The object of superheating the steam is to raise it to such a temperature that the cooling action of the cylinder will not reduce it to the point at which water is formed—*i.e.*, the saturation point of steam at that pressure. It may be said, by the way, that the economy of superheating is not due to an increase in area of the boiler heating surface, or to an improved thermal efficiency, $\left(\frac{r_2 - r_1}{r_2}\right)$, as has been sometimes suggested. The advantage simply depends on the fact that the cylinder walls, when dry, absorb heat much more quickly than they will give it out again when covered with a layer of moisture. Hence, if the layer of moisture can be prevented from forming, there is a better chance of getting back the heat expended in heating the walls. This was recognised very early in the days of steam engineering. Penn, in 1857, fitted superheating apparatus into the steamship "Valetta," securing a 20 per cent. saving in coal consumption. The researches of Hirn and others demonstrate that for a 5 per cent. increase of energy expended in superheating the steam, about 20 per cent. can be saved from condensation losses.

As boiler pressures rose, the practice of superheating was dropped. This was due to the fact that gases at 400deg. F. had a destructive effect on the oils used to lubricate engines, and on engine packings. Now, the temperature of steam at 150lb. pressure (a common modern working pressure) is 366deg. F., leaving a very small margin for safety under these conditions. It is only recently that by the use of high-class mineral oils for lubricants and metallic packing, engineers have been able to revert to the old practice of superheating their steam.

The advantages of superheating under modern conditions may be briefly summarised as follows: (1) the cylinder walls of the engine being kept dry give back their heat more readily to the steam; (2) part of the heat of the waste gases from the boilers is utilised in heating the steam after it has left the surface of the water; (3) priming from the boiler is quite prevented.

The disadvantages, which, however, do not in the writer's opinion outweigh the advantages, are as follows: (1) More oil is required to lubricate the cylinders. Condensed water acts to a certain extent as a lubricant, both in virtue of its own fluidity and its property of carrying the oil with it. (2) Joints in steam-piping are much more difficult to keep tight, owing partly to the increased expansion and contraction due to larger ranges of temperature, and partly to the steam taking away the "virtue" of the jointing material. (3) The superheater tubes in the types now common on the market are difficult to clean. Soot or scale accumulating on the tubes may cause local overheating and consequent failure of the tubes. This is, however, merely a matter of design. (4) It is difficult to regulate the amount of superheat. This depends both on the amount of steam passing through the tubes and the temperature of the flue gases at that time. As both vary within wide limits, the resultant heat is difficult to keep steady. Messrs. Babcock and Wilcox supply a by-pass valve direct from the steam-drum to the steam-pipe end of the superheater, thus enabling one to mix a certain amount of wet steam with the superheated steam. Messrs. Schmidt secure regulation by having a damper and by-pass for the flue gases in their superheater, enabling one to adjust the flow of hot gas through the apparatus.

It may be mentioned, by the way, that the writer has found it very troublesome to read the temperature of superheat by means of ordinary high-reading thermometers. The mercury column breaks and leaves portions behind. As the thermometers are fixed in mercury pockets in the steam-pipe, it is an awkward matter to get a good reading. Probably the reason of the trouble is that at the high temperature of superheat in use the mercury tends to boil (in vacuum), and so breaks the column. For this reason it appears that a thermometer depending on the expansion of a metal under ordinary pressure (say, mercury acting on a Bourdon tube) would be preferable for reading superheat. J. A. S.

Question No. 370.—What would be the best way to calculate the exact difference of pull on armature core of two-pole and multiple-pole generators when they are fully excited, and the top pole or poles are nearer to the armature core than the bottom pole or poles?

Answer to No. 370 (*awarded* 7*s.* 6*d.*).—If the induction (C.G.S. lines per square centimetre) between two parallel magnetic surfaces be B, the total attractive force between them is, in dynes,

$$\frac{A\,B^2}{8\,\pi} = \frac{A\,B^2}{25{\cdot}12},$$

where A is the area in square centimetres of one surface.

If square inches be taken both for A and B, this becomes, in pounds,

$$\frac{A\,B^2}{72} \times 10^{-6}.$$

In a bipolar machine, with vertical magnet limbs, the polar arc is usually about 120deg. The resultant pull is then at an angle of 30deg. with the horizontal on each side (Fig. 1), and the upward or downward pull is one half of the total pull on the upper or lower side of the horizontal diameter. If B_1 is the average induction above and B_2 that below this diameter, the upward pull is

$$\tfrac{1}{2} \cdot \frac{A\,(B_1^2 - B_2^2)}{72} \times 10^{-6} \text{ pounds.}$$

In a multipolar machine the resultant upward force may pretty accurately be taken as $\frac{2}{\pi}$ times the total all-round

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pull of the upper poles, with a similar fraction downwards from the lower poles. The expression then becomes

$$\frac{2}{\pi}\left\{\frac{A\,(B_1^2 - B_2^2)}{72} \times 10^{-6}\right\} \text{ pounds.}$$

where B_1^2 and B_2^2 are the mean squares of the inductions under the upper and lower poles respectively, A being the total area of half the total number of pole-faces on the machine.

The values of B may be determined experimentally by placing a wire loop of known area close up to any pole-face, and completing its circuit through a calibrated ballistic galvanometer. The throw of the galvanometer when the field current is suddenly switched in then gives the total

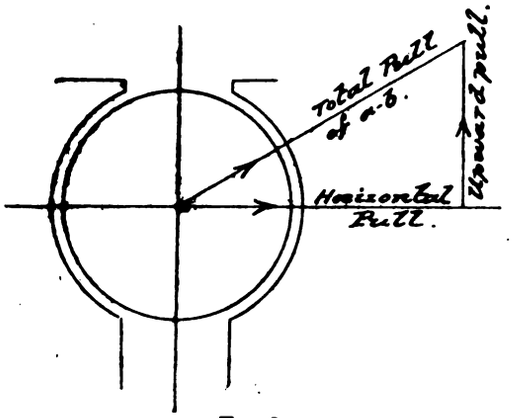

Fig. 1.

number of lines passing through the loop. A simpler plan is to make two sheet-metal brushes, clamping them so as to make contact with adjacent commutator segments. These are connected to a voltmeter or potentiometer, and the voltage is noted when they are on segments at the ends of an armature inductor under any required pole. If this voltage be V, the turns per commutator segment be n, the axial length of pole-face be L inches, the speed be N revolutions per minute, and the radius from centre of armature to the inductor be r inches,

$$V = \frac{2\pi r N n L B}{60} \times 10^{-8}$$

$$\text{B per square inch} = \frac{9\,55\ V}{r N n L} \times 10^{-8},$$

The value being thus found for each pole of the machine,

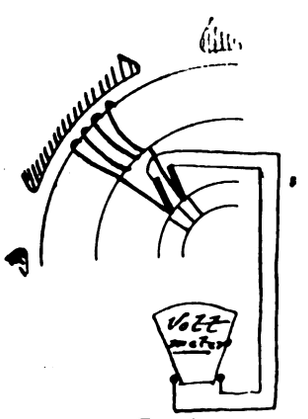

Fig. 2.

the mean of the upper squares and that of the lower ones is readily calculated, and the upward or downward pull found by the previously given formula.—ZIPHERN.

Answer to No. 370 (*awarded* 7*s.* 6d.).—A very good method to determine the exact pull exerted on an armature, when the opposite extremities of its diameter are not equidistant from the pole-pieces, is given by Fisher-Hinnen in his book on "Continuous Dynamos," published by Bigge and Co. For multipolar machines he takes, for example, a four-pole machine, and assumes that the armature is displaced through a small distance, x, as shown in Fig. 1. The first consequence of this will evidently be a modification of the flux, due to alterations of magnetic resistance in different parts of the circuit. In order to avoid unnecessary complications, we will suppose that the air-gaps of 2 and 4 are unaltered, and therefore occupy ourselves alone with poles 1 and 3.

Let B = the density of lines in the air-gap before displacement;
S = the section of the pole;
δ = the breadth of air-gap;
B_1 and B_3 the densities after the displacement of the armature.

The magnetic resistance of the iron which might be considered to be constant for a small variation in the lines

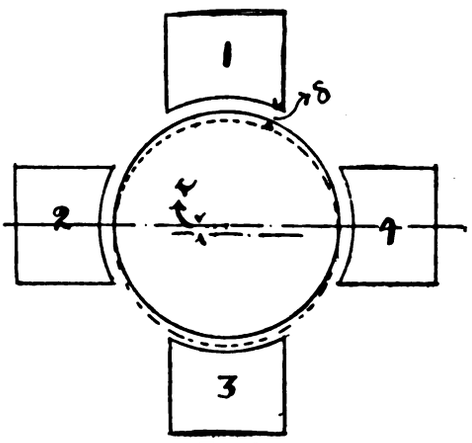

Fig. 1.

of force, could be expressed as a fraction of the resistance of the air by writing the total resistance = $a \times G$, resistance of air. We shall then have

$$B_1 = \frac{2\,\delta\,a}{2\,\delta\,a + x},$$

$$B_3 = \frac{2\,\delta\,a}{2\,\delta\,a - x}.$$

The force of magnetic traction will, therefore, be according to Maxwell's equation,

$$Z_1 = \frac{B^2\,S}{25 \times 10^6}\left(\frac{2\,\delta\,a}{2\,\delta\,a + x}\right)^2$$

$$Z_3 = \frac{B^2\,S}{25 \times 10^6}\left(\frac{2\,\delta\,a}{2\,\delta\,a - x}\right)^2$$

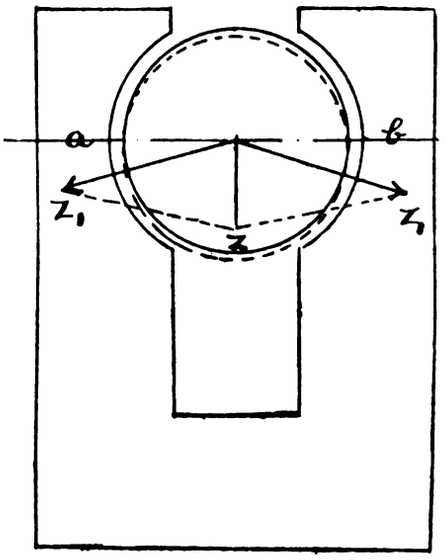

Fig. 2.

The downward force which will be exercised will consequently be (neglecting x^2 in comparison with $4\,\delta^2\,a^2$)

$$Z = Z_3 - Z_1 = \frac{B^2\,S}{25 \times 10^6}\,\frac{x}{\delta\,a}\,A \text{ kilogrammes.}$$

The constant, A, in the case we are now considering is equal to 2. In making a similar calculation for the case where the centre of the armature is displaced at an angle

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of 45deg. with respect to the axis of the field magnets, we should find A = 2·8. For a given number of poles we might make use of the following table:

Number of poles.				Remarks.
4	...	2	...	Displacement along axis of field magnets.
4	...	2·8	...	,, ,, neutral line.
6	...	6	...	,, ,, axis of field magnets.
8	...	9	...	,, ,, neutral line.
12	...	15	...	,, ,, ,,
16	...	20	...	,, ,, ,,

In the case of bipolar machines, if the armature is displaced as shown in Fig. 2, the magnetic axis is found to be situated a little below the horizontal line, A B, on account of the variable length of the lines of force. The downward traction force thus produced will be equal to

$$Z = 2 Z_1 \sin a.$$

In this formula it only remains to determine a. In this case a displacement of the centre of the armature parallel to the axis of the field magnets gives rise to no notable modification in the lines of force. Thus no tractive force is produced.—R. F. W.

Answer to No. 370 *(awarded* 5*s.).*—The exact difference of pull cannot be calculated, but a fair approximation can easily be obtained.

The formula for the approximate pull of a magnet upon its armature is—

$$p = \left(\frac{B}{1,000}\right)^2 \times 5 \quad . \quad . \quad . \quad . \quad (1)$$

where p = pull in pounds per square inch of the air-gap area;
B = density in C.G.S. lines per square centremetre.

As the excitation is considered constant, and the length of the metallic magnetic circuit is also constant, the only variables due to the position of the generator armature in the tunnel are the air-gap length and the density, B.

From the formula (1) it is evident that the pull varies as the square of the density, B. Taking a two-pole machine first, it is evident that, whatever the position of the armature, the sum of the lengths of the two air-gaps remains unaltered; the flux, therefore, is constant, as there is only one magnetic circuit through the armature and air-gaps.

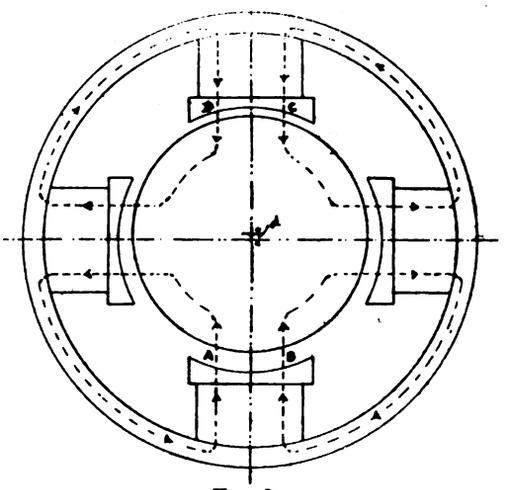

Fig. 1.

Therefore, with a two-pole machine, the vertical position of the armature does not affect the pull, which is equal above and below. Taking next a four-pole machine with two poles vertical and two poles horizontal: in this case we have four magnetic circuits through the armature, each crossing two air-gaps, and each circuit carrying part of the flux from two magnets. If the length of all the air-gaps are equal, the density of the flux will be equal, and the magnetic pull, from formula (1), will be equal and opposite on the vertical and horizontal diameters. When, however, the armature is displaced, say, d inches above the horizontal centre line, the conditions are altered. Calling the four magnetic circuits, A, B, C, D (Fig. 1), the bottom air-gap of circuit A is increased by d'', the upper air-gap of the same circuit, A, is increased by a very small amount (dependent upon the ratio of the polar arc to the circumference and to the value of d''), and its pull therefore slightly decreased, and the vertical downward component of the flux (proportional to the versed sine of the arc) is therefore less, but the amount is so small that it may be neglected. We have therefore the air-gap of A and B increased by d'', and of A and C decreased by the same amount. Assume the normal air-gap to be a'' long at each pole. The ampere-turns on the magnets remain constant: therefore, if the permeability of the metallic portion of the circuits be considered unaltered by the variation of the flux, we may take the reluctance of the metallic circuit as equivalent to that of an imaginary air-gap m'' long. This must be found by calculation from the characteristic of the machine.

We have now four magnetic paths as follows:

$$\left.\begin{array}{ll} \text{A. Length} & = m'' + 2a'' + d'' \\ \text{B.} \quad ,, & = m'' + 2a'' + d'' \end{array}\right\} = 2(m + 2a + d) \quad . \quad . \quad (3)$$

$$\left.\begin{array}{ll} \text{C.} \quad ,, & = m'' + 2a'' - d'' \\ \text{D.} \quad ,, & = m'' + 2a'' - d'' \end{array}\right\} = 2(m + 2a - d) \quad . \quad . \quad (4)$$

The total flux through A and B is proportional to (3).
,, ,, ,, C and D ,, ,, (4).

$$\text{Therefore} \quad \frac{\text{flux through A B}}{\text{flux through C D}} = \frac{m + 2a - d}{m + 2a + d}.$$

The total flux through all four circuits is known from the characteristic: therefore, by filling in the values of m, a, and d, the flux through the separate circuits can be easily found.

The pull downwards on the armature is then equal to

$$\left(\frac{\text{flux in A and B}}{1,000}\right)^2 \times 5,$$

and the pull upwards on the armature equal to

$$\left(\frac{\text{flux in C and D}}{1,000}\right)^2 \times 5.$$

The unbalanced pull is the difference of these two quantities multiplied by the area of one polar air-gap in square inches.

The above is based on the assumption that the generator is on open circuit. If the armature is generating a current the cross ampere-turns in the armature distort the magnetic

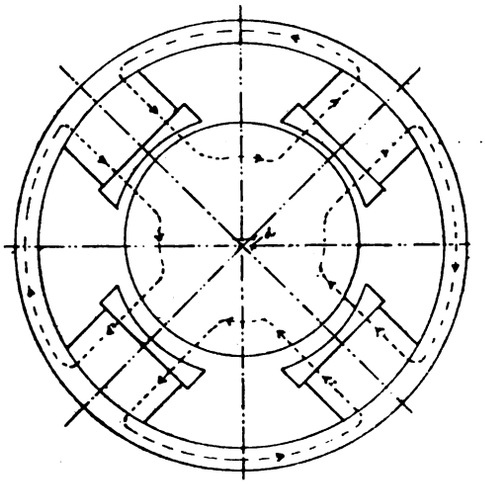

Fig. 2.

flux, and the conditions are somewhat altered. If a four-pole machine have the magnets placed at 45deg. to the vertical and horizontal (Fig. 2), the process is much the same, but the amount of variation of the path is not the amount d'' that the armature is raised, but is of a larger value, and depends upon the ratio of the polar arc to the circumference. An approximation to the exact figure is given by the following formula:

$$\text{Increase of each gap} = l = \sqrt{(r^2 + d^2 + \sqrt{2}\, r\, d)} - r;$$

where r = radius of the bore of tunnel in inches;
d = amount armature is raised in inches as before.

It must be remembered that all the gaps are affected to the above extent, the upper ones being shortened and the lower ones lengthened. Other multipolar machines can be worked out in the same way.—W. A.

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TRAMWAY PROMOTION.

Mr. J. Clifton Robinson's letter in the *Times* of April 29 was abstracted in a front note in our last issue. In it the treatment which tramway promoters have had to submit to from local authorities in order to get their schemes assented to was clearly explained, and in certain cases it amounts to blackmail. The letter has called forth two others from chairmen of councils more or less connected with the districts through which the tramways promoted by Mr. Robinson's company run. The first of these letters, from the chairman of the Surrey County Council, endorses Mr. Robinson's contention that tramway promoters are blackmailed by certain local authorities. He also expresses a view that this fact is one explanation of why joint tramway schemes by local authorities are not being carried out. This is because one or two of a group of local authorities who should combine to equip a large system of tramways prefer to get the immediate advantages they can extort from tramway promoters, rather than the ultimate benefit from the ownership of tramways. We quite agree with the writer in his statement, that any such burdens imposed on such undertakings are borne ultimately by the inhabitants of the district through which the lines run. We do not, however, think with him that the actual value of the tramways can be estimated by the blackmail which can be extorted from an unlucky promoter. It in certain cases comes to be a question as to whether such promoters can afford to sacrifice work and expense which has gone on for years rather than pay exorbitant sums, which ultimately may be a loss to shareholders. The amendment of Standing Order No. 22 would, if carried out, greatly prevent the extortion of such blackmail, and would in the long run tend to the advantage of all concerned. The real advantage of the inhabitants of the district would be much better served by local authorities if they would devote their energies to procuring clauses from tramway promoters which would ensure greater travelling facilities at low rates, with provisions for still further improving the public convenience in the event of the profits exceeding certain predetermined limits. It must be remembered that a tramway undertaking has only a limited life, and that, in consequence, any unproductive capital outlay has an exceedingly serious effect on its financial status. The most hopeful feature tending towards the wished-for amendment of the Standing Orders is that local authorities acting as tramway promoters feel the need for a change quite as much as those promoters who are connected with companies.

TRAMWAY ORGANISATION (?)

The tramway undertakings at Newcastle-on-Tyne are not in such a condition as redound to the credit of the Corporation of that city. For years the question of electric trams *versus* cable trams had been debated upon before any definite decision one way or another could be arrived at. From what we remember of its past history, the reasons brought

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forward against electric traction were exceedingly childish ones, and there was a great amount of time wasted over discussions which led absolutely nowhere. At last the Corporation decided to put down electric trams, and they then employed experts to design a complete system of tramways, which will in the long run prove of great benefit to the town. By the time that the Corporation had made up its mind to proceed, the lease of the tramway company had expired. As the alteration involved a complete reconstruction of the track—heavier rails being required—it then became necessary to arrange for the running of the trams while the conversion was still going on. The arrangement come to was one which could only end in dispute and inconvenience to all concerned. Instead of boldly closing the routes one at a time and carrying on the work of relaying the track with a large body of men, restrictions were made as to the length of track which could be worked at any one place and the distance apart between those lengths under conversion. In consequence, an inferior service of trams was continued for a year, but only at the expense of a vastly increased interruption in the general traffic through the public streets and long delay in the tramway schedules. These delays, of course, affected the tramway company, but the interruptions in the ordinary traffic upset everyone in the town. The public were not prepared for the total withdrawal of all trams until about three days before the expiration of the year for which the agreement had been made. This withdrawal was, however, carried out, and the public are now dependent on conveyances such as old omnibuses which have been discarded for years, and on any other vehicles on four wheels into which they can be crowded without absolute danger. To anyone conversant with the town of Newcastle and the distances between its business centre and its suburbs, the inconvenience now experienced will be easily realised. We can only hope that the promise of a complete tramway system in October will be fulfilled. At present, we believe that the average weight of the citizens of Newcastle is considerably reduced owing to enforced walking exercise.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WHAT IS EDUCATION?

SIR,—I have read your article entitled "Unsatisfactory Educational System" in your issue of the 19th April with much satisfaction, the more so as I have for some years now taken a great interest in the lives and difficulties of many of our former inventors, and am myself endeavouring in a small way to follow in their footsteps, having during the last two years devoted much attention to the phenomena of sunlight, electricity, and organic life in order to improve the Röntgen X-ray tube and the electric incandescent lamp, the former with most excellent results up to the present, and the latter with a fair amount of success, with, I hope, more success in the near future, after a more exhaustive study of the phenomena of sunlight. You very wisely say: "We may be altogether wrong, but appeal to history seems in our favour that scholastic training rather retards and trammels the inventive faculty, while it increases even when it does not create the power of perfecting what is obtained in a crude way," and to that expression of your opinion I cordially agree, and with your permission I will endeavour to give you one or two instances in my own experience as to the so-called wonderful benefits to be derived from the scientific education of the present day.

A young inventor who has a great ambition is most anxious to devote his time and thought to the solution of one or more of the most pressing electrical problems of the day, and whilst reading his daily newspapers he has the idea impressed upon his mind that the perfection of the electric incandescent lamp is one of the greatest needs at the present time. He also notes from his newspapers, etc., that though there are several inventors devoting their thoughts to the problem—prominently among them being Tesla, Nernst, Auer, and Moore—success is with them only to a very limited extent, and that so far the Tesla light is the best and most powerful, but for practical everyday use its initial cost is too great for universal use. The young inventor, knowing that sunlight is the best light in creation, would naturally think that if he procured the most up-to-date text-book on the sun he would get some assistance or hints to enable him to work at his problem more successfully, so he purchases a copy of Sir Norman Lockyer's book on "The Spectrum of the Sun," and studies it in earnest. From it he notes that sunlight *is said to be* a combination of red, yellow, green, blue, and violet rays—a maximum of the last three mentioned with a minimum of the first two mentioned. Whilst still further pursuing his studies, he finds that the electric carbon arc light *is said to be* the nearest approach to that of sunlight. He goes out into the sunlight on a fine summer's day, and notes with satisfaction that vegetation grows in great abundance quickly in the sunshine, and that all forms of organic life, from the two-winged insects up to the horses and the cows—and including, of course, the human being—especially the last mentioned, are all delightfully happy and active in the sunshine, and that they are, as it were, all aglow with warmth and contentment. He also notes that the shadows produced by the sunlight are very slight and only just discernible, and that every nook and corner is lighted up more or less. He also knows that the photographic plate can be worked upon practically instantaneously in the sunlight, and be made to give most excellent photographs. The inventor also finds out that the various ailments and diseases of the body fly from the body when exposed to the sunlight for some time.

The inventor, still pursuing his investigations, goes out into the street on a dark winter's night and sees the electric arc lamps burning, and *which light is said* to be a very close imitation of sunlight, and he therefore endeavours to compare it with sunlight. He first notices that the light of the arc lamp is dazzlingly blue, and that the light instead of producing that satisfaction in the human body which one gets from sunlight, he finds the light cold, cheerless, tiring, and very distasteful to the eyes. Going further, he notices that the arc light does not cause vegetation to grow like sunlight does, but that if it does grow, it is only to a trifling extent. He also finds that the arc light is very destructive to the eyesight unless shielded by thick glass, but in vain can the inventor find any record that sunlight does produce such bad effects on the eyes. Drapers and others who deal in cotton goods freely admit that it is impossible to match colours by the arc light like they can by sunlight. The inventor also notes that, excepting in the case of lupus, the arc light cannot be used to advantage to cure bodily ailments as sunlight can. Moreover, he finds that snapshots cannot be worked in the arc light. Wherever the similarity between sunlight and arc light comes in the inventor fails to find it, sunlight and carbon arc light appearing to be irreconcilable one with another, so that the more the inventor pursues his studies and investigations, the more contradictory they become; but, nothing daunted, he goes forward and notes that in the production of gaslight and oil-light the lights which have the greatest yellow-green zones in the flame give the most powerful illumination. In fact, he notices that all the improvements of late years in gaslight and oil-light have been devoted, unconsciously

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as it were, to one object, to enlarging the yellow-green zone of the flame—that is, of course, the luminous zone. An instance is that of the Welsbach mantle, the most formidable rival of the electric incandescent lamp. He sees that the flat luminous zone of the batwing is by the aid of the mantle made to assume a cylindrical form, and at the same time is diluted faintly with blue, producing a bluish-white light, which to the eye is a more faithful imitation of moonlight than of sunlight, hence its candle-power is a doubtful factor, as candle light follows more after sunlight than moonlight. Again, the inventor notes in the case of many industrial oil-lights, notably the "Well's industrial light," that by the use of compressed air the luminous zone of the flame is considerably lengthened, and therefore the lighting power of the flame increased. So also the same principle occurs in the small oil-lamps, where by introducing circular discs in the flame, or making the wick assume a circular form, the light is much increased. From his studies of the production of artificial light so far, the inventor would naturally come to the conclusion that if the best artificial light has a maximum of yellow-green light or luminous rays, with a minimum of green, blue, and violet rays, then surely sunlight itself must be something similar. But according to the "Spectrum of the Sun" it is not so, and it is said it can be proved by the aid of the prism. But, asks the inventor, what proof is there that the prism *does faithfully analyse* the sunlight, and only the sunlight? In return he is shown the rays of the sunshine passing through the prism, and showing the various colours of the spectrum at the background. Granted, but the effect just produced is no answer to his question as above, so the inventor returns to the "Spectrum of the Sun," and notes that the natural colours of the atmosphere of the earth, and that of the composition of the prism and their necessarily diluting or colouring the rays of the sun with their colours, are never taken in account by Sir Norman Lockyer and other teachers of the spectrum of the sun, who appear to accept the prism as an infallible analiser of the sunlight. And it is at this point in the study of the production of artificial light and the study of sunlight that the inventor is compelled, after much thought and persistent observation in daily life, to practically reject the present-day teaching of the spectrum of the sun as being for the most part incompatible with the true facts of sunlight; and try how he will, he cannot make the so-called spectrum of the sun fit in with everyday facts in the phenomena of light and organic life. For his part the writer holds most emphatically to the idea that sunlight at its source on the surface of the sun is wholly luminous rays entirely devoid of heat, but that by the time it passes through the atmosphere of this earth and reaches the surface of the earth it is diluted with from 3 to 10 per cent. of green, blue, and violet rays; the colouring being greatest in the tropical region, where the living atmosphere is thickest and where the snow line is the highest, and at the polar regions, where living atmosphere is absent, the colouring is nothing or trifling. In proof of this we have the light of the glow-worms and fireflies, which is wholly luminous rays, and is similar to sunlight, for the simple reason that organic life (which is an individual combination of a spiritual form and a physical form) depends upon sunlight for its growth and development, and for its life upon this earth generally. In fact, it is only under luminous rays that vegetation can be made to grow, that chicks can be hatched, and that disease can be mastered. So much for the boasted scientific education of the present time, which I for one have found of very little use in the solution of the most pressing problem in the electrical industry.

Again, in reference to the X-rays which were accidentally discovered by Prof. Röntgen a few years ago, according to the evidence of our eyes, we see that the X-ray tube when in use gives a pale-green light, yet those in authority over us still persist in endeavouring to drum it into our heads that they are *ultra-violet* rays. Why, one asks, in the name of commonsense; yes, why this hopeless contradiction? Either they must be pale-green rays or else ultra-violet rays. I rather place belief in one's eyes that they are pale-green rays than in the imaginations of other people that they are ultra-violet rays. Again, what are ultra-violet rays? As one who has had to do a little in the mixing of paints, I have always been under the impression that when deep violet is darkened it becomes approximately black. The words "ultra-violet" is, to my mind, meaningless when used in connection with X-rays. So much, again, for the educational authorities in their unreliable teaching. Instead of all this talk and literature about so-called ions and atoms of gases colliding with each other in the X-ray tube, it would be well if we had an answer from those above us to the question, "Why is it that the pale-green rays of the X-ray tube implant an outline of the bone on the photographic plate and not that of the flesh also?" Yes, why? that is the question. A plain, simple answer to this question would be more welcome than tons of literature on the words "ultra-violet," ions and atoms of gases, which to my mind is wholly irrelevant to the subject at issue.

In conclusion, in connection with the educational system of to-day, the chief fault against it is the enormous use made of mathematics and guesswork. These two combined form the foundation of at least 60 per cent. taught in the name of science to-day. To my mind the use of mathematics has been greatly exaggerated out of all proportion to their utility, and the student and the inventor has it forced into their heads that mathematics are the alpha and omega of a good scientific education; and it is no wonder that many of the students of science are beginning to kick against their mathematical teachers. Mathematics may be all very well when used in their proper place and in moderation, but to have to purchase text-book after text-book, only to find the pages of them over-run with mathematics, is very annoying, and means the waste of money to many a student who can ill afford it. If scientific education is to proceed at all, it must be less trammelled with mathematics, guesswork, and wild deductions, and contain more hard fact and truth. Try how one might, it is impossible to obtain a reliable and accurate text-book on organic life, electricity (theoretical side), light, sound, and heat. At the present day all the teachers appear to be at loggerheads with each other on many of most of the vital facts in each department of science. Wild guesswork and the free use of mathematics about sums up the contents of most text-books, with the result that progress in inventive thought has, as you say, generally to rely upon the comparatively ignorant few whose minds are not narrowed and bigoted by the false science of the present day. I think it was Huxley who said that "Science is the classification of common-sense." I would that it were so; but unfortunately it is not so.—Yours, etc,

GEO. H. SMITH.

37, Daniel-street, Cardiff, April 25, 1901.

[N B—We admit that to a man with no knowledge of mathematics the most modern scientific books are unintelligible, but this is no excuse for our correspondent's want of knowledge respecting light. He should read Faraday's books on "Heat and Light," which will do much to remove his confusion.—ED. *E. E.*]

SMITH'S NEW X-RAY TUBES.

Mr. Smith writes as follows of the two new X-ray tubes which he has invented, and claims to have several important advantages over the Röntgen X-ray tube invented by Prof. Röntgen some few years ago:

No. 1 new X-ray tube renders the flesh invisible and the bone visible on the photographic plate, and the No. 2 tube renders both the flesh and bone invisible on the photographic plate, and thereby photographing only the foreign substance or material in the body. Each of the new tubes requires shorter exposures, and gives finer definitions than obtained with the present X-ray tubes. Moreover, both the new tubes have the additional advantage that they are practically non-poisonous or non-injurious in short or long exposures. Persons who have submitted their bodies to the influence of the X-ray tubes for long exposures know to their cost the injury set up by the rays, and consequently the last-mentioned advantages of the new X-ray tubes cannot fail to be of immense benefit to all who have to submit their bodies to the influence of the new rays.

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Mr. Smith thinks that with the new X-ray tubes, X-ray photography will become of secondary importance, and that by the curative action set up the rays of the new tubes will become of first and vital importance. For instance, the No. 1 tube can be used beneficially in all ailments in the flesh portion of the body. Severe scalds and burns can, by being put occasionally under the influence of the No. 1 tube, have the pain considerably modified and lessened and the skin grown on in a shorter time. Again, in case of severe operations and wounds, which is often a very critical period in the lives of many patients, the wounds can be made to unite and grow together within 48 hours by submitting them to the new rays every few hours. Again, typhoid fever, cholera, and other ailments which chiefly attack the intestines, can quickly be overcome by the occasional use of the new rays. In fact, almost any bodily ailment, such as paralysis, deafness, partial blindness, etc., which can be especially localised in the body, can be considerably benefited by occasional exposures to the No. 1 tube, even if not practically cured in every case.

As regards the No. 2 tube, this will be found of especial benefit in connection with the anatomical or bony portion of the body. For instance, broken bones, which at present take many weeks and months to successfully heal and unite together, can now be more quickly united and healed—in fact, in a matter of a few days. A broken arm, leg, collar-bone, etc., by being put alternately under the influence of the rays of the No. 1 tube and then under the No. 2 tube, can be successfully united in three to seven days.

Mr. Smith anticipates that with his two new X-ray tubes the art of healing will have received a great advance, and that the period of pain and soreness will be considerably curtailed.

LOCALISATION OF FACTORIES.

SIR,—I read with interest the letter of Mr. R V. Lynn relating to firms contemplating new works and the best part of the country most desirable to erect them. It may be of interest to state that the Dunstable Town Council, of which I am privileged to be a member, have decided to collect information for the use of such firms, and a letter to the courteous town clerk, C. C. S Benning, Esq., would not fail to receive attention. Dunstable is only 33 miles from London, and in close proximity to three central lines of railway. Land at a low price can also be obtained close to and beside the railway. The town is situated on a dry, chalky soil; it is also exceptionally healthy, and house rent is cheap, and the town has good educational advantages. The environments and conditions are such that it would prove beneficial to both employer and employed.—Yours, etc.,

JAMES FIELD

High-street North, Dunstable, May 7, 1901.

THE MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The report of the committee on the first year's working of the above section has just reached us, and we are very pleased to note that the section has been worked so satisfactorily. There have been seven ordinary general meetings at which papers have been read, several of which are of exceptionally high value to the profession at large, and they have evoked considerable discussion. The first of these was on "Some Phenomena of Electric Sparks," by Prof. Schuster, F.R.S., while at the last ordinary meeting Mr. Sidney H. Short delivered a most able paper on "Direct-Current Generators." The committee report that the average attendance at these meetings was nearly 100. In order to keep a complete record of these meetings, in view of the fact that all the papers will not be printed in the *Journal* of the parent Institution, the committee are arranging to bind in duplicate copies of all the papers, which will be added to the library of the section. The committee express their regret that they have not yet been able to make arrangements for a convenient place for the library. According to the report, the total roll of the section now comprises 75 members, 79 associate members, 136 associates, and 35 students. The committee were approached during the session by the Manchester Society of Junior Electrical Engineers with a view to its members joining the Institution of Electrical Engineers, and it is expected that this arrangement will very shortly be carried out. No accounts are issued, as all expenditure is provided for by the office in London. The committee express their great appreciation of the kindness of the council of the Owens College, and Dr. Schuster, professor of physics, in allowing the meetings of the section to be held in the new physical laboratory of the college. In conclusion, the committee consider that they may congratulate the members upon a successful session, and also upon the promise of the future, as they feel that the existence of the section has been shown to be fully justified by the interest shown in the proceedings, and they hope that members will contribute, as far as possible, to the success of the coming session by the offer of papers, by attending the meetings, and taking part in the proceedings.

At the annual general meeting of the section, Dr. E. Hopkinson being in the chair, a letter from the Home Office was read conveying the thanks of the King for the resolutions of condolence of the members of the council and local sections of the Institution on the occasion of the lamented death of her late Majesty Queen Victoria. The chairman then moved the adoption of the report above referred to, which was carried. Votes of thanks were accorded to the chairman and the hon. secretary, Mr. E W. Cowan, for their services during the past session; also to the council of the Owens College and to Dr. Schuster for the use of the physical laboratory for the meetings of the section. The following gentlemen were elected members of the committee for the ensuing year: chairman—Mr. C. H. Wordingham; vice-chairman—Mr. H. A. Earle; hon. secretary—Mr. E. W. Cowan; committee—Messrs. S V. Clirehugh, C. M. Dorman, W P. J. Fancus, A H Gibbings, A. S. Giles, J. S. Highfield, A B. Holmes, H. Lindley, G. F. Metzger, A. B Mountain, R. C. Quin, C D. Taite. Dr. Lees having described the Owens College physical laboratory in detail, the members were conducted over the building and shown some very interesting experiments, one of the most attractive being the production of liquid air.

ELECTRICAL ENGINEERS R.E. (VOLUNTEERS).

Regimental Orders.

1. A roll of non-commissioned officers for duty is posted at headquarters.

2. **March-Out.**—A march-out will take place on Saturday, May 11. Parade at headquarters 3 30 p.m. Dress: tunic, parade trousers, forage cap, leggings, rifle, bayonet, pouch in centre of back.

3. **Recruit Drills.**—Tuesday and Thursday, 6.30 p.m. and 7.30 p.m.

4. **Instruction in Engine-Driving.**—Non-commissioned officers and men for trainings June 8 to 15 and June 15 to 22 will parade for instruction in oil-engines at headquarters on Tuesdays and Thursdays, at 6.30 p.m. Non-commissioned officers and men for trainings July 6 to 13 and 13 to 20 on Mondays, at 6.30 p.m. Non-commissioned officers and men for trainings July 20 to 27 and Aug. 8 to 17 on Wednesdays at 6.30 p.m. Non-commissioned officers and men for training Aug. 17 to 24 on Fridays, at 6 30 p.m.

5. **Bugle Band.**—A bugle band is being formed; there are a few vacancies for lads from 15 to 17 years of age.

6 **Commission in Army.**—The undermentioned officer is granted the temporary rank of lieutenant in the Army whilst serving with a volunteer section in South Africa: Second-Lieut. T. Rich, the Electrical Engineers R E. (Volunteers), dated Feb. 23, 1901.

7. **Enrolments.**—The undermentioned having been enrolled are taken on the strength of the corps: Regimental Nos. 530 T. A. Barnes, 531 A. G. Chisnall, 532 T. H Dennis 533 F. E. Peel, 534 C H. Redgwell, 535 P. M. Robinson, 536 H. B. Shepheard, 537 G. W. C. Clack, 538 E. C. Price, 539 R. Porter.

(Signed) R. S. ERSKINE, Major,
O.C.E.E.R.E. (Vols.)
C. T. RUSE, Acting Sergt.-Major.

Lowestoft.—An enquiry is announced for next Wednesday into the Council's application for a loan for electric lighting extensions.

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THE TELEGRAPH AND TELEPHONE SERVICES.

According to the *Times*, a letter has been addressed by the Postmaster-General to the Associated Chambers of Commerce, stating that he has given his careful consideration to the memorial from that body on the subject of telegraphic and telephonic communication with the Continent. Lord Londonderry states that the question of providing direct wires between this country and important commercial centres on the Continent continues to engage his attention. Direct wires from London to Magdeburg, Lyons, Zürich, Budapest, and Genoa have been recently established, in addition to the direct wires already existing to Berlin, Hamburg, Bremen, Cologne, Frankfort, Paris, Bordeaux, Marseilles, Lille, Havre, Amsterdam, Rotterdam, Brussels, Antwerp, Vienna, and Rome, and the Postmaster-General is in negotiation with the Italian telegraph administration respecting a direct wire to Milan. The new telegraph cable to the Netherlands is now in full operation; the cable to Germany will probably be laid by the end of May, and the Postmaster-General is in communication with the Belgian telegraph administration on the question of an additional cable to Belgium. The amount of telegraphic traffic to Munich is not sufficient to justify the establishment of a direct wire to that town. The Postmaster-General points out that the provision of direct wires between Havre and the cotton manufacturing towns in the north and east of France would be of little benefit to traffic from this country for the district of France in question. The Postmaster-General hopes that it will be possible before long to bring the provincial towns of England and France into telephonic communication. The question of a decentralisation of the central telegraph office in London has been receiving his careful attention, and, although no definite decision has yet been arrived at in the matter, everything possible will be done to accelerate the foreign telegraph traffic passing through London. The question of the provision of direct wires from provincial centres in England to the Continent has also been carefully considered, but the Postmaster-General regrets that he does not see his way at present to arrange for the establishment of any additional wires of this description, with the possible exception of one between Liverpool and Paris, respecting which he is in communication with the French telegraph authorities.

The Postmaster-General, in reply to a communication addressed to him upon a resolution on the subject of underground telegraphs passed at the Paris meeting of the Associated Chambers of Commerce of the United Kingdom, has written to say that the question of the inconvenience caused by any dislocation of the telegraphic service has engaged the serious attention of the Government for many years. It was very unusual for departmental notices of delay to be in force for more than one or two days through storms, and it seldom happened that any town was completely cut off from telegraphic communication. In the North of England towns, for example, during the past six years the average number per year of notices of delay had been only six, and the average duration of the notice 1 hour 23 minutes. Last year seemed to have been singularly unfortunate. Much had already been done to provide against interruptions. The principal lines had been renewed with much stouter timber. A large number of reserve wires has been provided, and these had, as far as practicable, been taken by alternative routes. Respecting the provision of underground lines, the great costliness of guttapercha-covered wire and its electrical defects had until recently stood in the way of its being used except in limited extent. The introduction of the paper-insulated cable, both cheaper and better from an electrical point of view, had, however, enabled the Department to construct the important experimental underground line between London and Birmingham. The line had already proved of great advantage during last year's storms. It was subject to some drawbacks, but he felt justified in extending it further northward, and sanction for the necessary expenditure would be sought. He hoped also to lay an underground section from Preston northwards, and was not without hope that further extensions might be made.

THE ILFORD FIGHT.

One can usually judge of the success of an enterprise by the steps which are taken to oppose it by other undertakings with which it competes. Judged on these lines the municipal electric undertaking at Ilford is already an assured success, although the station has not even been formally opened. The number of lamps applied for by private consumers is high, and the Council have wisely adopted electric light for their street lamps in all those places where a private supply is being given. The Ilford Gas Company, so ably managed by Mr. J. H. Brown, has succeeded up to the present in maintaining a price of 3s. 10d. per 1,000 cubic feet for gas. Judging from the pamphlet which it has issued, the company is exceedingly fearful of competition with electricity supplied at 5d per unit. It has accordingly conducted experiments on original lines to prove how absurd it is for anyone to take electric light, and that the Council are absolutely throwing away large sums per annum by introducing incandescent electric lamps for street-lighting. The methods of making a comparison are so common that we need do no more than refer to the line of argument in the pamphlet. In the first place, the writer assumes that four watts per candle is a fair average for the best electric incandescent lamps. He then compares this average consumption with the maximum figures that can be obtained from incandescent gas light. The result is, of course, obviously that electricity is a most costly illuminant, and that gas is the light of the future. Now, if an electrical engineer had any need to do what the gas manager has done in the way of special pleading, he would point out that the average candle-power actually obtained from a Welsbach incandescent burner was more nearly 16 c.p. than 48, and that the cost of renewing mantles could not be neglected, as has been done in the Ilford's gas manager's figures. The more reasonable course, however, is to remark that if gas has such enormous economical advantages, how can the gas engineer explain the fact that the demand for electric light is still on the increase, even in those places where gas can be obtained at half the rates charged in Ilford, and where the electric light consumers know from experience how much they have to pay for the illuminant which they prefer? In the same way, while Mr. Brown quotes several extracts from newspapers to show the excessive cost of electric light and the unreliability of the same (we note that the dates of these extracts are omitted), we could, if it would serve any useful purpose, quote 10 times as many extracts showing just the opposite conclusion. We do not, however, know of a case in which an electrical undertaker has felt called upon to go the length that the Ilford Gas Company have done. Thus, finding the street-lighting taken out of their hands, they have started to light the streets free of cost, and have put two incandescent gas burners in each lantern, replacing one ordinary batswing burner. Surely the Urban District Council must be pleased with such a public-spirited policy, and will not grudge a vote of thanks if the gas lighting is maintained gratis for a year. There is one more point before we finish, and that is a statement that "the company are also prepared to supply and erect electricity generating plants complete (gas-engine and dynamo) for persons requiring more than 20 lights to produce electricity for under 2d. per unit. Where electricity is necessary this system of private installations, which is now very extensively adopted throughout the country, will be found cheaper than obtaining current from the Council. Managers of shops and public-houses intending to instal electric light would do well to consider this system, as in large installations a saving of over 50 per cent. can very often be made."

We can imagine the pleasure of a householder going into his cellar in the middle of the night to start a gas-engine before he can get light enough to look for a supposed burglar. Even his pleasure would, however, be a small matter compared with that arising out of the contemplation of the actual cost of keeping his plant going, as com-

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pared with what his light would have cost if he had only taken a direct supply of electricity from the municipal works.

NIBLETT'S IMPROVED TRACTION ACCUMULATORS.

Mr. J. T. Niblett, who for many years has been working on accumulator design, has sent us the following particulars of a new type of cell he has recently been working on. His aim has naturally been to get a cell of light weight and small bulk, which shall be durable and capable of standing high discharge rates. The cell in question deviates somewhat from the ordinary lines, and, as the result of some months' testing, the following particulars are given by the inventor: "The metallic conductor used is of small dimensions and light weight. It forms the backbone of a frame wherein the active material is contained, and is so arranged that all those parts immersed in the electrolyte, and not covered by the active material, are insulated. By this arrangement all the lead salts are brought under direct electrolytic action, and therefore uniformity of formation is ensured both in the initial processes and also in the charging and discharging operations, and greater efficiency is obtained. As indicated above, the material employed in both the positive and negative plates is not the usual lead oxides, but is a compound of lead salts produced electrolytically, and is of a conductive nature. When set and properly seasoned, the material is of a stone-like nature, while the necessary porosity is obtained. Cells made by the new process can be formed very rapidly, and the amount of energy consumed in the formation is only about one-half of that required by the ordinary grid or pasted type of cell. As previously stated, the active material is of an exceedingly hard character, and as the expansion on the positive and contraction on the negative plates during formation is greatly reduced, the elements do not tend to bend, buckle, or 'shed' their active material, either during the formation or in the subsequent charging and discharging. It has also been found that the charging operation can be performed with a lower E.M.F. than that usually required; thus from 2·2 to 2·3 volts per cell is found to be enough to effectually recharge. In large batteries this gain in energy will be much appreciated. Plates of any size, shape, or thickness, within reasonable limits, can be produced by adopting the new plan of construction. So far, plates varying from 0·1in. to 0·75in. thick have been tested, and give uniform and equally good results. The following are the particulars of a cell constructed for motorcar work: Number of positive plates, four; number of negative plates, five; gross weight of conductors in plates, 3lb. 10oz.; gross weight of positive active material, 8lb.; gross weight of negative active material, 6lb. 7oz.; gross weight of complete cell, including containing vessel and electrolyte, 24lb. 9oz.; normal discharge rates, 16 amperes; current density of positive surface at normal discharge, one ampere for seven square inches; capacity, 160 ampere-hours; capacity per pound of complete cell, 6·55 ampere-hours.

"The above results were obtained with a fall of potential down to 1·75 volts per cell, but under ordinary conditions the E.M.F. may be safely run down to 1·7 volts without injury to the elements or loss of efficiency. At half rates of discharge, the capacity per pound of cell was found to be 7·5 ampere-hours. It should be mentioned that the above cell was constructed for normal rates of charge and discharge, the current density being as stated, one ampere for seven square inches of exposed surface. In cells made with thinner plates, the current density on both charge and discharge may be very much increased; thus, in the case of the thinnest elements yet tried, rates of discharge of one ampere per square inch of positive surface have been obtained, the E.M.F. remaining practically constant. By working at this current density, cells can be constructed which can be fully discharged or charged in less than one hour without great loss of capacity or efficiency."

The above figures are good, but it will be more interesting to see after a lengthy trial what is the life of the plates. The general lines of the design seem to us to be such as should lead to success

FORTHCOMING EVENTS.

FRIDAY, MAY 10.

Royal Institution.—At 9 p.m., Prof. J. C. Bose on "The Response of Inorganic Matter to Mechanical and Electrical Stimulus."

Physical Society of London.—At 5 p.m., ordinary meeting. Papers: "Applications of Elastic Solids to Metrology," by Dr. C. Chree, F.R.S.; and "The Thermal Properties of Isopentane compared with those of Normal Pentane," by Prof. S Young, F.R.S., and Mr. J. Rose-Innes. Council meeting at 4 30 p.m.

Society of Arts.—At 8 p.m., Howard Lecture on "Polyphase Electric Working" by Mr. A. C. Eborall (Lecture III.).

MONDAY, MAY 13.

Society of Arts.—At 8 p.m., Dr. T. Kirke Rose on "Alloys" (Lecture IV.).

TUESDAY, MAY 14.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper to be read: "Rotatory Converter Problems," by Mr. F. Vigor.

WEDNESDAY, MAY 15.

Society of Arts.—At 8 p.m., Mr. G. Marconi on "Syntonic Wireless Telegraphy."

THURSDAY, MAY 16.

Conference.—Conference of delegates from the Metropolitan Borough Councils to confer with the Highways Committee of the London County Council upon the questions arising consequent upon the establishment of generating stations for the supply of electrical energy in bulk within the county of London.

FRIDAY, MAY 17.

Society of Arts.—At 8 p.m., Howard lecture on "Polyphase Electric Working," by Mr. A. C. Eborall.

North-East Coast Institution of Engineers and Shipbuilders.—Closing meeting at Newcastle-on-Tyne.

SATURDAY, MAY 18.

Institution of Electrical Engineers.—At 10 a.m., students visit to the works of Messrs. Elliott Bros., Lewisham.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Electrical Supplies, Rubber, and Ebonite Company, Limited (Sheffield).—Capital, £1,000 Object: to carry on the business of manufacturers of and dealers in electrical machinery, cables, and all accessories required for electric lighting, traction, and power, etc.

G. Fawley and Son, Limited.—Capital, £8,000 Object: to acquire certain lands and premises at Bell Hall Mount, Halifax, with the business carried on there and at King Cross, Halifax, as G Fawley and Son, and to carry on the business of plumbers, plumbers' merchants, ventilating, heating, sanitary, and electrical engineers, etc.

REDDITCH ELECTRICITY ACCOUNTS.

From the accounts of the Redditch Urban District Council electricity works, just received, it appears that the total capital expenditure on capital account to Dec. 31, 1900, amounts to £16,532. Abstracts of the revenue account and general balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£	s.	d.
Coal, coke, and carting, and town gas		905	14	11
Oil, waste, water, and engine-room stores		250	2	11
Wages at generating station		448	17	7
Repairs and maintenance of buildings, plant, etc.		105	14	10
	Distribution of Electricity.			
Wages		22	5	8
Repairs and maintenance, etc., of mains		7	16	9
Repairs, etc., of transformers, etc.		33	15	3
Repairs, etc., of apparatus at distributing stations		4	10	3
	Public Lamps.			
Attending and repairs		20	5	8
Renewals of lamps		59	1	11
Rates and taxes		45	18	9
	Management Expenses.			
Salaries—engineers' department		195	0	0
Stationery and printing		11	19	5
General establishment charges		43	3	7
Law charges—fees		0	19	0

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Special Charges.			
Insurances	13	15	0
National Electric Wiring Company, Limited	45	13	6
Allen and Richards	2	5	3
Meters	26	10	0
Wiring materials and labour	203	8	5
	£2,446	18	8

Cr.	£	s	d
Sale of current at 5½d., 5d., 3d., and 2d. per unit	1 134	14	1
Public lighting	629	9	2
Meter rents	45	18	8
Sale of meters	27	0	0
Redditch Urban District Council and sundry wiring accounts	237	11	1
Free wiring rents payable to the National Electric Wiring Company, Limited, and Allen and Richards	47	18	9
Repairs	5	5	4
Amount carried to net revenue account	319	1	7
	£2,466	18	8

Dr. GENERAL BALANCE SHEET.	£	s.	d
Capital account – amount received	18,911	0	0
Sundry creditors	945	5	9
Balance due to treasurer (revenue account)	1 567	8	2
Petty cash account (capital)	1	2	8
Old materials sold	6	8	3
	£21,431	4	10

Cr.	£	s	d.
Capital account—amount expended for works, less preliminary expenses	16 220	3	2
Stores on hand at Dec. 31, 1899	96	15	4
Sundry debtors, less bad debts	603	13	10
Public lamps	158	18	10
Cash with treasurer (capital)	3 417	16	5
Cash in hand (revenue)	2	16	3
Net revenue account—balance being deficiency	931	1	0
	£21,431	4	10

CATALOGUES RECEIVED.

Messrs. Mather and Platt, Limited, are issuing an engine catalogue, from which we gather that they are now making a series of standard engines for dynamo driving. The type adopted is the vertical compound marine, and the speeds for which the standard engines are designed are not abnormally high. For instance, the 400-kw. engine runs at 120 revolutions. We think this is a move in the right direction, as without doubt high speeds with large engines are being overdone in certain directions at the present time. Besides these larger engines the list gives information concerning a number of similar independent engines which can be used for various purposes. We also learn for the first time from this list that the firm are now making steam-driven feed pumps, although on another page we see that they are fully alive to the advantages of driving all auxiliary plant—such as feed, air, and circulating pumps—by means of electric motors.

From the Improved Electric Glow Lamp Company we have received their list of direct and alternating current desk, ceiling, and ventilating fans. These are stocked in a great variety of designs and appear to combine mechanical simplicity and strength with efficiency and finish. While type A direct-current fan, which is designed to operate at a very low current consumption, is suitable for desks, etc., type E is recommended where hard usage and little attention are inevitable, on account of its strong mechanical construction. The other types of bracket and ceiling fans illustrated also seem to embody all the qualities which go to make up a serviceable and highly efficient article.

The British Thomson-Houston Company have just issued their pamphlet No. 94, dealing with alternate-current transformers. We are pleased to see in this list really good illustrations showing the construction of the transformers. These details show most careful design, and when one remembers the great faults which have existed in transformers in past years through faults in small details, these designs will be all the more appreciated. In the large sizes we note that the transformers are surrounded by oil, and also that the oil is cooled by means of water circulating in a coil of pipes over the top of the transformer. The cooled oil then sinks to the bottom. The arrangement is such as to keep up a good circulation of oil. From the illustration we gather that the pipe used to convey the water is made without a joint inside the transformer, so as to avoid all possibility of water leaking through into the oil.

The British Westinghouse Electric Company send us their circular No. 1,046, illustrating the alternating-current fan motors as manufactured by them. We notice that at present these are only made for 50 and 100 volt circuits, but we presume that the company will soon have fan motors on the market for the 220-volt circuits. By means of a three-contact switch located in the base, the motor may be run at full speed or a moderate speed, the latter meeting the requirements of an ordinary desk fan. From the illustrations and description given in this circular the motors appear to us to be highly finished machines.

APPOINTMENTS VACANT.

Wireman, for telephones, bells, lighting, and plant, etc. Full particulars in our advertisement columns.

Engine Driver, Borough of Luton Electricity Works, 30s. per week, May 18. Apply to Town Clerk, Town Hall, Luton.

Wireman Jointer, Borough of Luton Electricity Works, 32s. per week, May 18. Apply to Town Clerk, Town Hall, Luton.

Tramways Foreman, Burnley Corporation, May 13. Applications, stating wages required, etc., must be sent to Mr. G. H. Pickles, A.M.I.C.E., borough surveyor, Town Hall, Burnley.

Assistant Electrical Engineers, Bedford Corporation Electricity Works £108 per annum, May 17; Battersea Borough Council Electric Supply Department, £175 per annum, May 17. Full particulars in our advertisement columns.

LEGAL INTELLIGENCE.

LOCAL AUTHORITIES AND THE NATIONAL TELEPHONE COMPANY.

The National Telephone Company, Limited, v. the Mayor, etc., of Tunbridge Wells; Same v. the Mayor, etc., of Huddersfield.

Last week, in the Court of Appeal, these two cases came before the Master of the Rolls and Lords Justices Vaughan Williams and Romer, on the appeals of the National Telephone Company from the judgments of the Divisional Court. The actions arose in this way: The National Telephone Company, as the licensees of the Postmaster-General, wished to disturb the streets in Tunbridge Wells and in Huddersfield for the purpose of putting down telephone wires. By agreements made by the Postmaster-General and the respective corporations the consent of the corporations to part of this work had been obtained, and the work so agreed to be permitted was scheduled in the agreements. The company desired in each case to extend its system, and applied to the corporations for leave to do so. But this had been refused. The company alleged that its statutory powers gave it a right in such a case to appeal to the county court. The corporations denied the company's alleged rights and raised before the county court judge the question of jurisdiction. The judge of the Tunbridge Wells County Court considered that he had jurisdiction, though he did not exercise it, and therefore stated a case to have the question argued and decided. The history of the matter showed that in 1878 the law, so far as it related to the Postmaster-General, was altered and modified thus: The Postmaster-General was empowered to exercise the powers given to the old companies, notwithstanding the refusal of the local authorities to consent to a disturbance of the roads, if on appeal to the county court judge or some other proper tribunal he could get a judgment to the effect that the necessary consent ought to be given. In 1892 power was given to the Postmaster-General to authorise any company to exercise the powers given to him by law, but that was subject to a provision, for the first time introduced into the statute, that, notwithstanding anything in the Act of 1878, the licensee should not exercise any power to break up the roadways except with the consent of the rating authority, and that proviso was not made subject to any right of appeal at all. Therefore, though wider powers had by this statute been given to the Postmaster-General, the licensees could exercise such powers as were conferred on them only if the local authority was willing to give consent, and in case of a refusal there was no appeal. The special case came before the Divisional Court, who, having expressed the opinion that the law was as stated above held that the county court judge had no jurisdiction to hear an appeal by the company against the refusal of a corporation to grant leave to disturb a roadway for the purpose of laying down wires, and made absolute a rule obtained by the Corporation that a writ of prohibition should go to prohibit the county court judge of Kent from proceeding with a plaint in the county court whereby the Telephone Company was the plaintiff and the Corporation the defendant. The company now appealed.

Mr. Cripps, K.C., Mr. Roskill, and Mr. Cassell were counsel in each case for the company; Mr. Joseph Walton, K.C., Mr. Macmorran, K.C., and Mr. Boxall for the Mayor of Tunbridge Wells, and Mr. Macmorran K.C., and Mr Alexander Glen appeared for the Mayor of Huddersfield.

Mr. Cripps said the question as to whether a stipendiary magistrate or a county court judge had, since the Telegraph Act of 1892, any jurisdiction to determine an appeal from a refusal of the highway authority to allow a telegraph company to open up streets for the purpose of laying wires or tubes, was one of particular importance.

The Master of the Rolls: I thought perhaps this case had something to do with electric cars.

Mr. Cripps: No, my Lord.

The Master of the Rolls: I was down at Kew Bridge the other

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day, and I never saw such a mess as things were in there from the electric cars, and if this had been an objection by a public body to the roads in its district being broken up for that purpose I should not have wondered at it being brought.

On the conclusion of counsel's argument, **Mr. Roskill** said the case of the National Telephone Company *v.* the Huddersfield Corporation differed from the one the Court was now considering mainly in that the agreement did not contain an arbitration clause.

Without calling upon counsel for the respondents,

The **Master of the Rolls** gave judgment dismissing both appeals. In his opinion, the view of the effect of the recent legislation taken by the Divisional Court was correct, but the appellants could not succeed in face of the wording of the agreements themselves. The work for which consent was given by the local authority was limited and specified to that set out in the schedules attached to the agreements themselves. The work now proposed to be done was outside of this, and therefore the company must first obtain the consent of the local authority, which consent it had in each case failed to get. Both appeals therefore failed, and must be dismissed. Judgment accordingly.

LEYTON ELECTRIC LIGHT WORKS.

The case of Hawkes *v.* the Leyton Urban District Council came before Lords Justices Collins and Stirling in the Court of Appeal on Wednesday, on the appeal of the defendant Council from the order of Mr. Justice Buckley, by which he directed a writ of sequestration to issue against the defendants on the ground that they had disobeyed an injunction granted against them in regard to their electric lighting undertaking.

Mr. H. Terrell, K.C., and Mr. Dibdin, K.C., appeared for the appellants; Mr. Astbury, K.C., and Mr. A Beckett Terrell were for the respondent.

The plaintiff claimed an injunction to restrain the defendant Council from carrying on their works in connection with electric lighting in such a way as to cause a nuisance to the plaintiff by noise and vibration. In February, 1900, Mr. Justice Buckley granted an injunction, but suspended it over April 9, 1900 on an undertaking given by the defendants, and on that day a further suspension was granted, a further undertaking being given. The defendants appealed, but the Court of Appeal affirmed Mr. Justice Buckley's judgment, with a variation—viz., by confining the injunction to noise and vibration arising from the use of gas engines. The plaintiff alleged that the defendants had broken their undertakings and also disobeyed the injunction, and he applied for a writ of sequestration against the defendants for their contempt of court. The judge held that the defendants had deliberately and wilfully disobeyed the injunction, and directed a writ of sequestration to issue against them. Hence this appeal of the defendants.

Lord Justice Collins, in the course of his judgment affirming the order, said there was abundant evidence to justify the learned judge in holding that there had been a nuisance, and therefore a breach of the injunction. There was indeed, an admission by the defendants' own engineer that he had deliberately chosen to disobey the injunction; and the defendants were responsible for his acts. The defendants then came to the Court asserting that what they had been doing was within their rights, and making no apology to the Court. That was not the attitude which should be taken up by defendants, who were under a peremptory mandate of the Court, and had deliberately violated it. Under such circumstances it was the right of the plantiff to have the only remedy which was available against the defendants—viz., a sequestration. An appeal was made for some indulgence; and it was said that the defendants were a public body, and that a writ of sequestration, being issued as a punishment for a contempt of court, should not be employed unless there was something in the nature of contumacy. His Lordship did not dissent from that He agreed there must be a deliberate violation of a known obligation. It was sufficient to show that the party charged had with a full knowledge of the facts elected not to obey the order of the Court. They were conducting their business with a desire to extend the supply of electricity to as many people as possible; and they took the risk of the Court's not visiting them with the consequences of their disobeying its order. In his Lordship's opinion the writ of sequestration ought to go. It had been suggested that the Court should modify the order so as to cause less inconvenience to the defendants. Mr. Justice Buckley gave them an opportunity of obtaining some modification, but the defendants had not taken any steps to meet his suggestions. The case was clearly one in which the plaintiff's only remedy was by sequestration, and no mitigation of the order should be made now. If any mitigation could be made, it should be dealt with by Mr. Justice Buckley. The writ would issue; but it might remain in the office for a week to give the defendants an opportunity of making a proper application to the learned judge.

Lord Justice Stirling concurred, and the appeal was dismissed

THE SMOKE NUISANCE.

In the Divisional Court, before the Lord Chief Justice and Mr. Justice Lawrance, the case of the South London Electric Supply Corporation *v.* Perrin was disposed of. It was the appeal of the plaintiff corporation against a conviction by a metropolitan police magistrate under the Public Health (London) Act, 1891, for sending out black smoke in such quantities, it was alleged, as to be a nuisance. The magistrate imposed the maximum penalty of £10 and £100 costs. It appeared that the chimney from which the smoke issued was 180ft. high, and the evidence given was to the effect that black smoke was seen to issue from the chimney at certain times, but no single witness stated that the smoke was a nuisance to him. The contention of the appellants was that the mere issuing of smoke from the chimney was not sufficient. It must be in such quantities as to create a nuisance, and that there must be evidence to show there had been annoyance caused, or some evidence of what would constitute a nuisance at common law.

Mr. Cripps, K.C., and Mr. Scott-Fox, K.C., appeared for the appellants; and Mr. Horace Avory, K.C., and Mr. Watson for the respondent.

Without calling upon counsel for the respondents, the **Lord Chief Justice** said he must not be thought to say that the magistrates must convict simply because black smoke had come out of a chimney. On the other hand, he was of opinion that it was not necessary to show that a particular individual or property had been subjected to a nuisance by reason of black smoke. In his opinion it was impossible to argue there ought not to have been a conviction, and the appeal failed.

Mr. Justice Lawrance concurred, and the appeal was dismissed with costs.

BRITISH MOTOR TRACTION COMPANY'S PATENTS.

On Wednesday, in the Chancery Division of the High Court, the case of the British Motor Traction Company, Limited, *v.* Sherrin was heard. The plaintiffs brought the action to restrain an alleged threefold infringement of their patents by the defendant. The infringement was admitted, and the only issue for trial was as to validity. The following were the patents in question: (*a*) No. 16,072, of 1893, granted to Wilhelm Maybach for an invention of "improvements in the method of producing the explosive mixture in hydro-carbon engines;" (*b*) No. 19,734, of 1895 granted to Count Albert De Dion and Charles Bonton for an invention of "improved means or apparatus for electrically igniting and governing petroleum and other like motors; and (*c*) No. 13 671 of 1899, granted to the British Motor Company and Charles Jarrott for an invention of "improvements in or relating to motor vehicles." The plaintiffs complained that the defendant had imported and sold in this country motorcars constructed in infringement of the above letters patent. The defendant alleged want of novelty, no good subject matter, anticipation, etc, of the patents.

Mr. Moulton, K.C., and Mr. A. J. Walter were for the plaintiffs; and Mr. Pitt Lewis, K.C., and Mr. R. M. Stephenson for the defendant.

In the event **His Lordship** granted an injunction in respect of all three patents, and also a certificate of validity in respect of them. Judgment accordingly.

BRITISH ELECTROZONE CORPORATION.

On the petition of Messrs. Ede and Allom for the compulsory winding-up of the British Electrozone Corporation, Limited, coming before Mr. Justice Wright in the Winding-up Court on Wednesday, counsel for the petitioners stated that an arrangement had been made with the petitioning creditors, and he therefore asked leave to withdraw the petition.

His Lordship agreed.

COMPANIES' MEETINGS AND REPORTS.

WEST COAST OF AMERICA TELEGRAPH.

The general meeting of the shareholders was held this week at Winchester House.

Mr. J. Denison-Pender, who presided, stated that the advance in the expenses, as well as to a certain extent in the receipts, was owing to the exchange, which in 1900 varied from 15¼d. to 17d., and in 1899 from 12¼d. to 16d. The Company had had six repairs to make in 1900. Last year there was a considerable increase, as the shareholders were aware, in the price of coal, and the repairs, which were more numerous than usual, cost more than they would have done in an ordinary year owing to the greater expense of working the ship. He thought, however, that on the whole the increase in the receipts, as compared with 1899, and especially with 1898, was satisfactory. With reference to the current year, there had been so far no interruption to the lines, and the traffic was maintained. Last year's accounts showed that cable was sent out to the value of £4,000, and therefore if any break occurred there was now an efficient stock of cable ready for any emergency. He moved the adoption of the report and accounts.

Sir A. J. L. Cappel seconded the motion, which was carried unanimously.

WESTERN AND BRAZILIAN TELEGRAPH.

The ordinary meeting of the shareholders was held on Wednesday at Winchester House.

Mr. W. S. Andrews presided, and, in moving the adoption of the report, congratulated the shareholders on the satisfactory financial position of the Company. After referring to the amelioration and advancement in the affairs of the United States of Brazil, he stated that the new cables last year enabled them to greatly improve the service, affording them the means of coping

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with what they hoped to find—a considerable increase in the traffic. In continuance of the policy of extending their operations and of providing more feeders to their system as far as was prudent, the Board had lately secured a financial interest in a telegraphic and telephonic line which was in course of construction between Buenos Ayres and Rosario. As to wireless telegraphy, he did not think there would be any difficulty with the Company's circuits. Wireless telegraphy was a most interesting invention, and, within certain limits, was calculated to do good service; but the Board did not fear that it would extend beyond those limits. They were rather inclined to look upon it as an ultimate feeder to the telegraphic system.

Mr. F. Youle having seconded the motion, it was carried.

CALCUTTA ELECTRIC SUPPLY.

The annual general meeting of the proprietors was held on Wednesday at the Cannon-street Hotel, E.C.

Colonel A. J. Filgate, R.E., the chairman, in moving the adoption of the report, referred to the license for the Alipore district, which was officially gazetted on Sept. 13, and a further license for additional areas in the vicinity of Sealdah and the Calcutta Docks had been gazetted on April 3. Part of the new additions to the scope of their operations could be worked from their existing station, and every endeavour would be made to push on with the Alipore station and have the current available in the whole of the added area by the hot weather of 1902. In their generating station in Emambagh-lane they had now two 60-h.p. steam dynamos, two 180 h.p. and two 360-h.p., and they had a third 360 h.p. dynamo which would shortly be shipped. They were now maturing plans for increasing the accommodation at this station, and had under order two 1 100-h.p. Crompton-Belliss sets, which would be erected therein. This would increase their power at this station to 3,760 h.p. Four Babcock and Wilcox boilers of 400 h.p. each had been erected, and further boiler power would be added before the large dynamos now under order were erected. They had obtained an excellent site for the new Alipore station on the banks of Tollys Nullah, and in this they proposed to erect two 60 h.p. and two 300-h.p steam dynamos in the first instance. These had already been ordered. They had already laid about 17 miles of overhead mains and nine miles of underground mains and they had authorised the laying of about six miles of overhead and one mile of underground mains in addition, a large portion of the materials for which had already been shipped. In order to meet the demand for electric fans they had sent out on their own account 1 100 fans and although the supply of fans was remunerative, they did not propose to establish the hiring of fans as a permanent branch of their business. At the end of 1899 they had on their system 115 houses, and the lamps and motors connected therewith were the equivalent of 9 463 8-c.p. lamps, while at the end of 1900 they had 409 houses, and the lamps and motors connected to the system to the equivalent of 28 748 8-c.p. lamps. Owing to a clerical error in the revenue account, the total number of units sold was entered at 199 829. This was the number of units sold for lighting purposes only; in addition to this they sold 213 121 units for power, chiefly for electrical fans; this made the total number of units sold during the year 412 950, which compared very favourably with the 54,897 units sold in the 8½ months they were working in 1899. The business suffered considerably from the abnormal rains which were experienced in Calcutta last September. This materially affected the underground mains, and entailed a lot of heavy work, besides adding considerably to the expenses. Their agents had not yet been able to get any definite proposals from the Calcutta Municipality for lighting the streets of the city. They had, however, practically concluded an agreement with the Port Commissioners for lighting the jetties and the Hooghley Bridge, and they hoped that as soon as the mains were laid in Harrison-road they might obtain the contract for lighting that road, which was now done by the Municipality. Meanwhile, however, the demand for private lighting steadily continued. The present position of the Corporation and its future prospects were in every respect satisfactory, and pointed to a prosperous future.

Mr. E. Boulnois, M.P., seconded the motion, which was carried unanimously.

The proceedings terminated with a vote of thanks to the chairman.

SUBMARINE CABLES TRUST.

The general meeting was held on Tuesday at the offices, Winchester House, Mr. J. Denison-Pender presiding.

The Chairman, in moving the adoption of the report and accounts, said that the trustees had disposed of the allotment of the Eastern Extension Company's new shares which came to the Trust in right of their holding of old shares in that company, but as the Trust had no money to invest, the allotment was sold, and this had resulted in a net profit of £2,623. This sum, with the amount transferred from the revenue account, had enabled the trustees to purchase 21 certificates, exclusive of the coupons of reversion, costing £2,511, and to draw for redemption at £120 per certificate a further 30 certificates, the numbers of which were set out in the report.

Sir A. J. L. Cappel seconded the motion, which was carried unanimously; and a resolution was afterwards passed confirming the trustees' resolution to dispose of the allotment of new shares in the Eastern Extension Company.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Buxton.—The Urban District Council will shortly advertise for additions to switchboard and for steam piping.

Burnley.—Tenders are invited for lighting works by electricity. Apply to the Burnley Ironworks Company, Limited, Burnley.

Colne.—The Corporation invite tenders for a boiler, mechanical stoker, economiser, overhead crane, transformer, etc. Tenders by May 20.

Bristol.—The Electrical Committee invite tenders for alternating-current transformers. Tenders by May 12. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the wiring of the new Council offices. Tenders by June 5. Details in our advertisement columns.

West Stanley (Durham).—Tenders for electric lighting are invited on inspection for new Catholic church, West Stanley. Apply to Rev. J. Thompson. Tenders by June 1

Rochdale.—The Corporation invite tenders for the supply and delivery at Rochdale, Lancs., of copper rail bonds. Tenders by 23rd inst. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and erection of two-phase motor-alternators and switch gear. Tenders by May 15. Details in our advertisement columns.

Motherwell.—The Electric Light Committee invite tenders for cast iron lamp columns, arc lamps, switches, fittings, etc. Tenders by May 18. Details in our advertisement columns.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the annual supply of stores and materials. Tenders by May 14. Details in our advertisement columns.

Lichfield.—The Corporation invite tenders for electrical communication to the members of the fire brigade from the police station. Tenders by May 17. Details in our advertisement columns.

Plymouth.—The Corporation invite tenders for overhead line construction, etc. Full particulars may be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by May 18

Cleckheaton (Yorks.).—The Urban District Council invite tenders for the erection of an electric light station and destructor works. Specifications, etc., may be obtained from the Surveyor. Tenders by May 14.

Hull.—The Electric Lighting Committee invite tenders for 12 direct-current street arc lamps, erected complete with cast-iron posts and spare parts and accessories. Tenders by May 23. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for the supply and erection of main switchboards, sub-station switchboards, transformers, arc lamps, and arc lamp pillars. Tenders by June 3. Details in our advertisement columns.

Newcastle-upon-Tyne.—The Corporation invite tenders for supply of 800 tons of tramway rails, fishplates, etc. Particulars may be obtained at the office of the City Engineer, Town Hall, Newcastle-upon-Tyne. Tenders by 19th inst.

Dundee.—The Gas Commissioners invite tenders for the supply and erection at the electrical power station, Dudhope-crescent-road, of one 700-h.p. triple-expansion steam engine and dynamo. Tenders by May 11. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of permanent-way construction over three miles of tramways. Specification, etc., can be obtained from Mr. Wm. L. Macindoe, town clerk, Kirkcaldy. Tenders by May 13.

Fulham.—The Council invite tenders for the supply of materials and goods required in connection with their electric light and dust destructor station at Townmead-road, Fulham, for the period ending March 31, 1902. Tenders by May 15. Details in our advertisement columns.

Rotherham.—The Corporation invite tenders for wiring the municipal buildings preparatory to a supply of electricity from the Corporation mains. Specifications, etc., may be obtained on application to the borough electrical engineer, Mr. E. Cross, Town Hall. Tenders by 17th inst.

Bermondsey.—The Borough Council invite tenders for the wiring, fittings, and other material required in connection with the installation at the Corporation's electricity supply station and stables, Neckinger, Bermondsey, S.E. Tenders by May 21. Details in our advertisement columns.

Long Eaton.—The Urban District Council invite tenders for the manufacture and delivery on seat of two steel Lancashire boilers, engines, dynamos, switchboard, and accessories. Tenders by May 20. Details in our advertisement columns.

Exeter.—The Council invite tenders for boiler-house equipment, pipes, etc., engine-room equipment, switchboards, connecting cables, coal bunkers and conveyors, and feed and condensing water tanks. Tenders by June 14. Details in our advertisement columns.

Burnley.—The Electricity Committee invite tenders for the supply and erection of (A) economisers, (B) mechanical stokers. Specifications, etc., may be obtained on application to Mr. Robt. Birkett, borough electrical engineer, Aqueduct-street, Burnley. Tenders by May 14.

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Manchester.—The Tramways Committee invite tenders for the supply of 5,000 tons of steel girder tramway rails and about 170 tons of steel fishplates, 110 tons of steel tie-bars for tramway rails and 35 tons of bolts and nuts for fishplates, and 5,000 steel tramway poles. Tenders by May 18. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works of two 412-kw. steam dynamos. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by 16th inst.

Madrid.—Tenders are invited by the Spanish Government for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by June 3.

Bradford.—The Corporation invite tenders for the construction and erection of a five-ton electric travelling crane for their new tram depôt, Leeds-road, Thornbury, to operate on a 500-volt direct-current circuit. Specifications, etc., may be obtained on application to Mr. C. J. Spencer, A.M.I.E.E., tramway manager, 5, Forster square, Bradford. Tende s by May 18.

Madrid.—Tenders are invited by the Spanish Postal and Telegraph Department for the supply of 30,000 zinc cylinders for the service of the Government telegraph stations. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by June 1.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, invite tenders for the supply of 6,250 tons of steel girder tramway rails and 190 tons of steel fishplates, and points, crossings, and filling pieces. Specification, etc., may be obtained from Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S.W. Tenders by May 13.

London, S.W.—Tenders are invited for the supply of 13,400 tons of steel rails and 958 tons of fishplates for the Queensland Railways. Tenders will be received at the Queensland Government Office 1, Victoria street, London, S.W., until 2 p.m. on June 11, endorsed "Tender for Steel Rails and Fishplates," and accompanied by a preliminary deposit of 1 per cent. on the tender. Specifications, drawings, etc., may be obtained at the office of the Agent-General for Queensland.

Kingstown.—The Urban District Council invite tenders for the construction, supply, and erection of boilers, pumps, steam and water pipes, tank, economiser, ironwork, etc., engines, generators, balancer and booster, switchboards and instruments, battery of accumulators and accessories, supply and laying of insulated electric cables, conduits, road frames and covers, street work, drawing-in boxes, feeder switch pillars, etc., fitting of electric light at the electricity supply station, George's-place, Kingstown, supply of electricity meters, demand indicators, and main fuses, supply and erection of arc and incandescent lamps and fittings. Tenders by 30th inst. Details in our advertisement columns.

Ludlow.—The Corporation invite tenders for the supply and erection of one water-tube boiler to be erected and fitted for connection with a refuse destructor, with electric motor, injector, etc.; one ditto, ditto, for a coal-fired boiler, and furnace connected therewith; two quick-revolution compound two-crank self-lubricating engines, coupled direct to compound-wound dynamos, equal to an output of 35 kw. each, with motor-transformers and accessories; steam, exhaust, and feed pipes; overhead travelling crane (six tons); switchboard and instruments; accumulators; electricity supply mains; and public arc lighting and glow lamps, the latter on existing pillars. Tenders by May 20. Details in our advertisement columns.

Tenbridge (Kent).—The Urban District Council invite tenders for the supply and erection of (Section A) boiler-house plant—two Lancashire boilers and accessories, steam pump, injector, and economiser; (B) engine-house plant—two 50 kw. steam dynamos, motor-transformer, and accessories; (C) condensing apparatus and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) electricity supply mains; (H) public arc lighting; (I) house meters; (K) public incandescent lighting, for the municipal electricity works. The whole bound up in one specification. Specifications, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders by May 30.

Battersea.—The Borough Council are prepared to consider schemes for the wiring of consumers' premises for electric lighting, free of all initial cost to the Council or the consumer. The wiring rules and the general conditions under which the work would have to be carried out can be obtained on application to Mr. W. Marcus Wilkins, town clerk, Lavender-hill, S.W., upon the deposit of £1. 1s., to be returned on the receipt of a bona fide tender. The conditions admit of payment to the contractors for the work carried out by them in one or more of the following ways: (*a*) by one cash payment by the consumer; (*b*) by the easy payment system; (*c*) by a fixed rental per annum; (*d*) by a small extra charge per unit supplied to the consumer, to be collected by the Council and paid by them to the contractors. Tenders by May 14.

RESULTS OF TENDERS.

Cardiff.—The Electric Lighting Committee have accepted the tender of Messrs. Melhuish, at £117, for alterations at the electric light works.

Rochford.—The tender of Mr. Coombes for a telephone at the workhouse to connect Connaught House with the infirmary, at a cost of £49. 10s., has been accepted.

Aberdeen.—The Gas and Electric Lighting Committee have accepted the tender of Babcock and Wilcox, Limited, for the supply of six boilers for the Ferryhill electricity station, at £10,175.

Bolton.—The Electricity Committee have accepted the tender of Messrs. Musgrave and Sons, Limited, conditionally upon the requisite additional borrowing powers being obtained from the Local Government Board, for the supply of engines.

Farnworth.—The Electricity Committee have accepted the tender of the British Insulated Wire Company for the lighting of their main streets by arc lamps, to the specification of the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar.

Buxton.—The Electricity Committee have accepted the tender of Messrs. Hornsby's, at £1,750, for the supply of three boilers, subject to the contract being entered into conditionally on the Local Government Board's sanction to the borrowing being obtained.

Warrington.—The Town Council have accepted the tender of J. A. Ewart, at £28,789, for the construction of the permanent way for the electric trams, and also the tender of R. W. Blackwell and Co., Limited, at £4,833. 10s., for overhead equipment, subject to the approval of the Board of Trade to the borrowing of the money.

Burnley.—The Corporation have accepted the following tenders: Oldham Boiler Works Company, two Lancashire boilers, £700; Chloride Electrical Storage Syndicate, booster for traction purposes, £1,068; Electric Construction Company, re-winding dynamos Nos. 2 and 3, £400; Tudor Accumulator Company, battery, £2,380, and maintenance of the same for a period of 10 years at £120 per annum.

Cardiff.—The Tramways Committee have accepted the following tenders for materials required in the overhead equipment: (Section 1) J. Williams and Co., Cardiff, poles, bases, and refuge pillars; (2) J. Preece, Bristol, brackets; (3) Thornton and Co., telephone boxes; Bergtheil and Young, feeder and section pillars; (4) Back and Mansen, trolley wires; F. Smith, span wires and guard wires; (5) R. W. Blackwell and Co., insulators and line suspensions.

West Ham.—The Town Council have accepted the following tenders: Hands, Limited, Garlick-hill, E.C., Veritys, Limited, 31, King-street, W.C., Geipel and Lange, Victoria-street, S.W., for house wire and wiring accessories; British Thomson-Houston Company, 83, Cannon-street, E.C., meters; Reason Manufacturing Company, Lewes-road, Brighton, double-pole house cut-out boxes; S. Z. de Ferranti, Limited, Hollinwood, Manchester, transformers; British Insulated Wire Company, Prescot, cable; Middleton Bros., 10, St. George-street, E., engine-room stores.

London.—The Metropolitan Asylums Board have received the following tenders for electric generating plant and boiler plant for heating, etc., at the Tooting Bec Asylum:

Lancashire Dynamo and Motor Company, Limited, Trafford Park, Manchester (accepted)	£6 399
Geipel and Lange, Parliament-mansions, Westminster	6 450
Crompton and Co., Limited, Mansion House-buildings, E.C.	6,650
Morley Electrical Engineering Company, Limited, Troy Works, Morley, Leeds	6 760
Cox-Walkers, Darlington	6,990
British Schuckert Electric Company, Limited, Olun House, Surrey-street, W.C.	7,048
Brush Electrical Engineering Company, Limited, 49, Queen Victoria-street, E.C.	7,060
Veritys, Limited, 31, King-street, Covent Garden, W.C.	7,110
G. H. Woods and Co., Blackburn	7,424
Bergtheil and Young, 12, Camomile-street, E.C.	7,597
Bilbie, Hobson, and Co., 80, Queen Victoria-street, E.C.	7,650
F. Suter and Co., Limited, 66, Berners-street, W.	7,757
Marshall and Woods, 2, Gray's-inn-road, W.C.	7,880
R. Dawson and Co., Limited, Hartley Works, Stalybridge	7,929
Rosling, Appleby, and Fynn, Limited, Trafalgar Works, Bradford	8 125
T. S. Anderson, Royal Insurance-buildings, Sheffield	8,200
Calvert and Taylor, 30, Green-street, Belfast	8,984
Nalder Bros. and Thompson, Limited, 34, Queen-street, E.C. (informal)	—

Consulting engineer's revised estimate, £7,292.

Mornsey.—The following tenders have been recommended by the Electricity Committee to the Urban District Council for acceptance: Fraser and Fraser, boiler-house plant, £4,856; Mather and Platt, Limited, engine-house plant, £6 601; Cole, Marchent, and Morley, Limited, condensing apparatus, £1,296; Couper, Schwarz, and Co., water-cooling apparatus, £385; Cowans, Limited, switchboard and instruments, £1,585. 10s.; Electrical Power Storage Company, Limited, accumulators, £2,888. 10s.; Carrick and Ritchie, overhead travelling crane, £292; Siemens Bros. and Co., Limited, electricity supply mains,

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£25,986. 5s.; General Electric Company, Limited, 12 arc lamp-pillars and brackets (with incandescents in each post), £3,166. 16s. 3d., with right reserved to vary the number of lamps by 50 per cent.; British Thomson-Houston Company, Limited, meters, £1,470. 15s.; Easterbrook, Allcard, and Co., Limited, tools, etc., for workshop equipment, £324. 1s. 2d.

BUSINESS NOTES.

TRACTION.

Hull.—The tramways manager's salary has been increased by £50.

Salford.—The Corporation have now taken possession of the tramways in the borough.

Eccles.—The Corporation are about to place an order for a motorcar for the fire brigade.

Wakefield.—The local tradesmen' association has unanimously agreed to the Corporation tramways scheme.

Nelson.—The Town Council have received the sanction of the Board of Trade to the borrowing of £3,404 for the purchase of the existing tramways in the borough.

Lincoln.—It is proposed to raise £2,100 and £1 679. 18s. 8d., required for the electricity works and the cost of the Lincoln Corporation (Tramways, etc.) Act respectively.

Personal.—We are informed that Mr. J. S. Raworth has been appointed a managing director of the British Electric Traction Company, with the title of "technical director."

Cheltenham.—At the Town Council meeting on Monday it was stated that the Corporation would be quite ready to supply electric current immediately it was required for the tramways.

Central London Railway.—Definite announcement, we note, has now been made that the Central London Railway is about to experiment with the "multiple-unit" system of electric traction.

Bolton.—The subject of the tramway management was discussed at the last meeting of the Town Council. An amendment to secure the discontinuance of the system of having fixed stopping places was negatived.

Blackpool.—The returns of the Tramways Committee for the year ended March 31 show that the amount to be devoted to the relief of the rates will be about £7,600, which is £2,400 less than the estimate.

Worthing.—The consideration of the question of applying for a provisional order authorising the construction of electric tramways in the borough and adjoining parishes by the Corporation has been postponed.

Dukinfield.—The Town Council have decided that the question of the site to be chosen for the generating station in connection with the joint tramway scheme shall be referred to a competent authority to be appointed.

Glasgow.—The Tramways Committee are considering the question of issuing season tickets on the Corporation tramways. The Town Council have decided to increase the maximum weekly wage of the motormen from 28s. to 30s.

London County Council Tramways.—The Tramways and Street Widenings Bill of the London County Council is now being enquired into before the Select Committee of the House of Commons presided over by Mr. Seale-Hayne.

Uxbridge.—The Urban District Council have decided to enter formal objection to the application of the London United Tramways Company to extend till May 9, 1903, the period for the completion of the light railways in Middlesex.

Paisley.—The enquiry under the Private Legislation Procedure (Scotland) Act into the rival Corporation and private tramway schemes for Paisley is proceeding before the Parliamentary Commission, the Earl of Camperdown presiding.

Batley.—The Town Council's application to borrow £52,451 for the purposes of the Batley tramways order has been sanctioned, and the engineers are preparing specifications with a view to the invitation of tenders in connection with the scheme.

Wrexham.—The difficulties which had arisen with the British Electric Tramways Company in regard to doing the repairs upon the Ruabon-road line of tramways have now been overcome, and the work of constructing the section will be commenced forthwith.

Dudley.—It was stated at the last meeting of the Town Council that with regard to Woodside and Netherton no alteration could be made at present in the tramway traffic, but that in the course of a few months the company would no doubt bring passengers into the centre of the town.

Worcester.—On the Worcester Tramways Bill being called on for hearing before the Committee of the House of Lords presided over by Lord Ribblesdale, it was announced that all opposition had been withdrawn, and the Bill was referred back to Lord Morley's Committee on Unopposed Bills.

Birkenhead.—The Town Council have adopted the recommendation to construct double tracks on certain of the tramway routes at an estimated total cost of £21,693. It is proposed to purchase 15 more cars than were originally ordered, also additional generating plant, the cost of which is put at £7,500.

Middleton.—Colonel C. H. Luard, R.E., has held an enquiry into an application of the Corporation for sanction to borrow £12 442 to meet the expenditure necessary for additional plant for traction purposes. Messrs. Lacey, Clirehugh, and Sillar, the consulting engineers, explained details of the scheme.

Littlehampton.—A company having approached the Urban District Council regarding a proposal for running an electric tramway from Worthing to Arundel, with a branch line from Patching to the corner of East-street and High-street, Littlehampton, the Council have resolved not to oppose the scheme.

Manchester.—The electricity department have given notice that in the course of a few days it would be ready to supply current for the working of the cars. It is probable that in the course of three or four weeks the Cheetham Hill, the Higher Broughton, and the Harpurhey cars will be run by electric traction.

Portsmouth.—Sir Frederick Bramwell's award for the purchase of the tramway undertaking by the Corporation from the Provincial Company is £185,600, which brings the total cost of the purchase and conversion of the lines to electric traction to something over £600,000. The sum originally asked by the company was £280,569.

Sweden.—A proposal is reported to be under consideration for the introduction of electric traction on the railways of the west coast of Sweden. A selection of the various large watercourses in the district, many of which, it is said, are capable of producing 2,000 h.p. to 3,000 h.p., would be made for the development of the electrical energy.

Private Bills.—In the House of Commons the West Cumberland Electric Tramways Bill was read a second time and the Gateshead and District Tramways Bill a third time, and on Wednesday the King's Norton and Northfield Urban District Tramways Bill, received from the Lords, was read a second time. In the House of Lords the City and South London Railway Bill has been read a third time.

Affairs in Spain.—A message from Madrid states that while the tramway service there is again in full operation, a new staff of men having been engaged, the situation at Barcelona resulting from the tramway strike has assumed a grave aspect. Disturbances have taken place in the streets, necessitating the calling out of the civic guard and the cavalry. Considerable alarm is felt at the attitude of the strikers.

Leeds.—Progress is being made with the electric installation on the Burley and Cardigan road tramway routes, and the new system of traction will probably come into use by the end of June. The hope is entertained that the present year will see every tram route in the city equipped with electricity. The City Council have rejected the proposal to reduce the fare to Roundhay, a distance of five miles, from 3d. to 2d.

West Hartlepool.—At the meeting of the Town Council on Tuesday, a letter was received from the tramway company stating that the improvement and development of the service was dependent upon the decision of the Council with reference to granting the company an extended tenure, and it was decided to reply stating that the Corporation were not prepared to lease to the company the tramways after the expiration of their order.

Colne.—The Town Council have passed a resolution that the strongest possible representation be made to the promoters of the Colne and Trawden light railway order "upon the unparalleled delay in obtaining the order, and also upon the serious pecuniary loss of the Corporation, as well as the public inconvenience, consequent on such delay, and that the promoters be informed that the Corporation are also forwarding a resolution to the Board of Trade on the subject."

Durham.—At the quarterly meeting of the County Council the surveyor reported on the Houghton-le-Spring and District tramways scheme, showing the method of constructing the permanent way proposed to be adopted by the United Kingdom Tramways Company. He recommended the Council to direct that granite setts should be laid extending the full width of the road, on the main roads and the county bridge roads and approaches The report was agreed to.

Speed of Motorcars.—At the annual general meeting of the County Councils' Association next Wednesday a memorandum on the subject of the speed of motorcars will be presented, containing the opinions expressed by 38 county councils in various parts of the country upon certain suggestions made by the East Suffolk County Council in regard to the regulation of light locomotive traffic. One of these suggestions was for the reduction of the maximum speed from 12 to 10 miles an hour.

Hammersmith.—The Borough Council have sealed the draft agreement with the London United Tramways Company. The Parliamentary Committee report that they have received the approval of the Home Secretary to the Council's opposition to the following Bills: Charing Cross, Hammersmith, and District Electric Railway, Central London Railway, London County Council (Tramways and Street Widenings), London United Tramways, and London and North-Western Railway Bills.

Bexley (Kent).—The Select Committee of the House of Commons presided over by Mr. Seale-Hayne, after a three days' hearing, have found the preamble proved of a Bill promoted by the Bexley Urban District Council seeking powers to construct electric tramways on the overhead trolley system, commencing on the far side of their district and connecting with the Woolwich and Greenwich tramways of the South-Eastern Tramways Company. This would form a continuous line to London.

Sheffield.—A somewhat serious condition of affairs has arisen in connection with the city tramways in consequence of the dismissal of Mr. G. E. Francis, who is depôt foreman at the Tinsley and

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Queen's-road car-sheds on the allegation of discourtesy towards the general manager, Mr. Fell. A general strike of the tramway employés was threatened, and in the case of a few of the disaffected ones the threat was carried out. They have now returned to their work, however, and for the present hostilities are suspended.

Ilford.—We understand the Urban District Council have passed the tramways scheme prepared by their consulting electrical engineer, Mr. W. C. C. Hawtayne, M.I.E.E., which provides for the construction and electrical equipment on the overhead trolley system of some 4½ miles of double track besides several miles of single track. When the lines are in operation they should provide a nice little day load for the Council's electricity works shortly to be opened. The enterprise of Ilford is certainly to be commended.

Folkestone.—Major Pringle, in recommending the Board of Trade to grant the provisional order of the Corporation for tramways Nos. 1 and 2, omitting tramway No. 3, says: "My opinion is that there are no engineering difficulties to bar the proposal of the Corporation to construct tramways in Folkestone on the conduit electrical system on a gauge of 3ft. 6in., and, further, that apart from the position of the light railway company, there is now no serious opposition in the borough itself to the construction of the tramways."

Workington.—The Parliamentary Committee of the Town Council have come to terms with the promoters of the West Cumberland Electric Tramways Bill, which will enable them to withdraw their opposition. The promoters have agreed to insert clauses reserving the right to the Corporation to lay down tramways, with running powers over the company's lines within the borough, to take electrical energy from the Corporation, and not to erect a generating station within three miles of the borough, to widen certain streets, and to run cheap trams for workmen at suitable hours.

Birmingham.—The Select Committee of the House of Lords presided over by Lord Ribblesdale, had before them the Tramways Bill of the Birmingham Corporation on Monday. The object of the measure is to authorise the construction of some short extensions of the tramways, and for certain other purposes in connection with the system. The Committee decided that the preamble of the Bill was proved, subject to certain amendments agreed upon between the parties. The official inspection of the new electric tramway along the Bristol-road is announced to take place to-day.

Tyneside.—The Tyneside Tramways Bill, which provides for an extension of tramways and tramroads from Gosforth and Walker through Wallsend and Willington to Tynemouth, has come before the Select Committee of the House of Lords presided over by Lord Ribblesdale. The committee eventually decided that the preamble of the Bill was proved subject to the promoters coming next year to Parliament for powers to do whatever the Newcastle Corporation had agreed to do in Walker, the committee being considerably impressed with the arguments in favour of additional tramways in that district.

Wigan.—At a meeting of the Electric Light and Tramways Committee last week, the electrical engineer was instructed to prepare specifications for new cars and to advertise for tenders for 12 cars. The borough engineer was instructed to prepare plans for a tramway along Poolstock-lane to the boundary of the borough. The Tramway Sub-Committee were authorised to enter into negotiations with the local authorities interested as to the extensions of the tramways to Coppull and Crooke. The borough engineer was further instructed to obtain quotations for the materials for the extensions within the borough.

Halifax.—The Tramways Committee have obtained powers to lay double lines in King Cross-lane between Park-road and King-street. They were preparing to lay a double line on the length from Park-road to the end of Lord-street, but have been threatened with an injunction, and have desisted. The committee have decided to send Mr. Lord, the borough engineer, on a visit to America. An order for £15,000 worth of fishplates and rails was recently placed by the Corporation with an American firm, and he is to see that the metal used is of the stipulated quality. Mr. Lord will also inspect and report upon the tram lifts, etc., in use in that country.

Belgium.—King Leopold is reported to have decided to assist in the elaboration of a scheme for the construction of a network of long-distance electric railways, which are estimated to involve a capital expenditure of £40,000,000. The scheme provides, among other lines, for the building of electric railways so as to place Brussels in connection with Ostend, Antwerp, and Paris, and the journey from the former city to the French capital would only occupy two hours. It is further stated that the King has personally conducted the negotiations with the French Government on the subject. The Paris house of Messrs. Rothschilds is understood to be interested in the scheme.

Tramways in South London.—Next month, it is stated, the London County Council will be able to give notice to the South London Tramways Company of its intention to purchase one-third of the company's system. These tramways are about 4½ miles in length, situated in Lavender-hill, Wandsworth-road, York-road, North-street, St. John's-hill, Falcon-road, Queen's-road, and Victoria-road. Other parts of the company's system will become purchasable next year and the year following. In August of this year the Council will also be in a position to give notice to the Woolwich and South-East London Tramways Company to purchase the whole of its lines, about five miles in length.

Burnley.—At the monthly meeting of the Town Council it was reported that the Light Railway Commissioners had settled the order authorising the construction of the Blackburn, Whalley, and Padiham light railway, and that it had been submitted to the Board of Trade for confirmation, and the Town Council was instructed to communicate with the solicitors to the promoters of the railway with a view to a conference for the purpose of securing uniformity in details of construction of track and rolling-stock, so as to facilitate interchange of traffic. The borough surveyor was authorised to order the necessary spare parts in connection with the tramcars and trucks, and the equipment, at a cost not exceeding in the aggregate £1,000.

Gateshead.—In view of the fact that the laying of double lines of tramways has made the West-street gradient dangerous, a portion of the footway, not exceeding 3ft. in width, is to be added to the roadway from the Mechanics' Institute downwards; also from the entrance to Tucker's Brewery downwards on the east side of the street, the roadway is to be widened, to leave not less than 9ft. 6in. between the pathway and the nearest tramline. The Gateshead and district electric tramways and power station were opened on Wednesday. The cars were run over the different routes, which within the borough measure 14 miles, and are eventually to be extended to Whickham, Dunston, and probably connected with similar enterprises in other portions of Durham.

Warrington.—At the monthly meeting of the Town Council on Tuesday, Messrs. Preece and Cardew submitted a report of the committee on the construction, cost, and system of traction of the proposed tramways from Sankey Bridge to Knutsford-road Swing-bridge, their estimate being: permanent way, £27,000; poles, trolley wires, etc., £6,000; tramcars, £6,340—total, £39,340. In addition, a traction switchboard would be required at the generating station, and a pair of cables from that to a point in Bridge-street, the cost of which should be covered by £350. It was decided to place contracts with Mr. J. A. Ewart for the construction of the permanent way for £28,789, and with Messrs. R. W. Blackwell and Co., Limited, for overhead equipment at £4,833. 10s., subject to the approval of the Board of Trade to the borrowing of the money.

Rochdale.—At the Town Council meeting last week, on the motion for the acceptance of the tender of Messrs. P. and W. McLellan and Co., Limited, Glasgow, for steel girder rails for straight and curved track, and for fishplates to be supplied from the Angleur Works, near Liege, Belgium, a councillor asked the chairman of the Tramway Committee if he could give some tangible reason why this contract was going out of the country. The Chairman said the committee had no tangible reason for placing the order for rails and fishplates out of the country except on the ground of cheapness. There could be no question about it, in his mind, that English steel was preferable to Belgian steel. Many corporations, in advertising for tenders, stipulated that the rails must be of English or American steel. The recommendation was eventually referred back to the committee.

Liverpool.—At the fortnightly meeting of the Tramways Committee the report of the general manager (Mr. C. R. Bellamy) showed a great increase of passengers carried on the electric trams during the past fortnight. The receipts for the fortnight were £17,790. 7s. 5d. as against £15 789. 5s. 1d. in the same period of last year, an increase of £2 001. 2s. 4d. The mileage run was 394,452, compared with 332,049 miles in the corresponding two weeks of last year, showing an increase of 62,403. The passengers carried numbered 3,344 281, as against 2,953,863 in the same fortnight of last year, an increase of 890,418. The vehicles working were seven horse cars and 290 electric cars, as against 189 and 107 respectively last year. At their last meeting the Tramways Committee desired to recommend the Council to apply to the Board of Trade for sanction to borrow the sum of £319,000 for the purpose of carrying out the works authorised by the Liverpool Corporation tramways extension orders, 1898 and 1900.

Tynemouth Tramways.—The tramway line from North Shields to Whitley is now giving a regular service, the frequency of which will be increased as soon as the British Electric Traction Company can get delivery of the additional cars required. The chief fault which is to be found with this line as at present worked is in connection with the fares, which are distinctly high. Mr. C. Turnbull has prepared for the benefit of the police a list of instructions which are to be followed in the event of an accident to the trolley wire on the above route. The general effect of his instructions are as follows: The trolley wire after fracture, or another wire hanging across the trolley wire reaching to the ground, must not be handled unless indiarubber gloves are used. It is also desirable, as pointed out, that when helping anyone who has become entangled in the wire some insulating material should be used on the hand, such as indiarubber gloves or dry cloth. Mr. Turnbull also points out that in the event of a shock the treatment to restore life should be similar to that used in the case of drowning, full instructions of which will be found in all the police stations or the free library.

Dundee.—At last week's meeting of the Town Council a letter was read from the Railway Department of the Board of Trade with reference to a proposal to place underground a number of the overhead telephone wires crossing the electric tramways. The letter intimated that the Board of Trade regulations in the present form required the provision of guard wires on the tramways, but the question of amending the regulations so as to dispense with guard wires where the crossing wires were insulated was now under consideration, and pending a decision on this point the Board asked an undertaking that if the regulations should not be altered they would erect guard wires even where crossing wires were insulated. This was agreed to. Some members of the Tramways Visiting Committee made an inspection of the new electric station and car

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shed on Monday. Among the new equipments which have recently been put in are an ingenious route indicator and an arrangement for timing the entrance and departure of the workmen. The foundry which formerly existed at Lochee in connection with the steam-car works there has now been removed to and fitted up in the new car shed, and forms a very complete little engineering shop, motive power being derived from electricity.

Wolverhampton.—On Monday the Town Council resumed the consideration of the proposals of the Tramways Committee as to the construction of an experimental line of tramways on the Brown underground surface-contact system, an offer to lay down the line having been made by the Lorain Steel Company. It was stated that the Board of Trade had virtually agreed to the Corporation giving the system a trial. With regard to the expense of the proposed line, it will amount to £24,500 more than the overhead system, and the extra cost per year with regard to repayment will be £1,155. It was ultimately agreed to construct the experimental line as proposed. The system with which it is intended to experiment consists of hermetically sealed-up studs communicating with an electric cable which runs beneath the tram route. The studs are contained in a box, the outer casing being a hollow composite granite trough. The lower portion of the trough contains the electric contact with the under cable and the stud, by means of which the current is taken up from the cable for the use of the car is fixed in a steel plate. Contact with the upper portion of the studs is obtained by means of a skate and magnets affixed to the bottom of the car. The magnets in the car draw up the lower stud, and thus establish electrical contact; but directly the car has passed, the lower stud drops back, and all risk of live electricity being left on the tramway is obviated. The stud cases are so closely sealed that the leakage of the current is considered impossible. The system is being worked in America by the Lorain Steel Company.

London Underground Railways.—The joint committee of the Lords and Commons appointed to enquire into the various Bills now before Parliament relating to underground electric railways in London, held their first sitting on Tuesday. Lord Windsor having been elected to the chair, Mr. Littler, K.C., stated the case for the Brompton and Piccadilly-circus Railway. The line had been authorised from Brompton-road by Hyde Park corner to Piccadilly-circus. It was now proposed to extend the railway from Piccadilly to Museum street, where it would join with the Central London Railway, and thus get a route to the Bank and North and East London. Sir James Szlumper, C.E., engineer to the company, examined by Mr. Coward, K.C., said the extension would give connection, not only from Brompton into the City, but would also give a means of communication from Earl's Court, where there was a physical junction in the open with the District Railway to all places served by the District Railway, such as Wimbledon, Putney, Ealing, and the western suburbs of London. He considered this scheme and that of the Piccadilly and City Railway incompatible. Mr. Balfour Browne, K.C., for the Piccadilly and City Railway, contended that the Bill in question was not a *bonâ fide* attempt to give facilities to the public but simply a blocking line. The town clerk of Holborn was called in opposition to the Brompton and Piccadilly scheme. The Holborn Corporation, he stated, considered the proposed extension was on an undesirable route, and were firm in that view since the proposed extension to Islington had been given up. The Chairman stated that the committee were of opinion that if a route, having in view possible extensions, was a suitable one for relieving the traffic they would give it their favourable consideration. The committee postponed the further consideration of the schemes till they should hear the views of the County Council and the City Corporation. Afterwards they opened the consideration of the Charing Cross, Hammersmith, and District Railway Bill.

The Manchester-Liverpool Monorail.—The revised Bill promoted by the Manchester and Liverpool Electric Express Company for powers to connect Manchester and Liverpool by a monorail line has been before the Select Committee of the House of Lords presided over by Viscount Falkland this week. It was stated that every local authority along the route, with the single exception of the borough of Salford had approved the scheme, the only other opposition coming from the railway companies on the ground of competition. Mr. Behr, the inventor of the system, stated that the result of his experiments had satisfied him that it would be possible to run at the rate of 110, or even 130, miles an hour without risk of derailment. If a train should break down, a signal would be given to the succeeding train at a point many miles from the scene of the accident. There would be no more difficulty in pulling up at the terminus than in the case of an ordinary rail way. The estimated amount to be expended on construction was £1,218,306, and on land £563,508 including £30,000 for stations at Manchester and Liverpool. Dealing with the petition of the Salford Corporation, he said the construction of such a tunnel as was suggested by the borough engineer would involve an expenditure of £400,000, and an annual cost of from £10,000 to £13 000 for pumping. With regard to the opposition of the Cheshire Lines Committee, Mr. Behr disclaimed any intention to construct a rival scheme. Among the other witnesses examined on behalf of the promoters were Major Cardew, Mr. R. E. Cooper, C.E., Mr. J. M. Dobbon, and Mr. Shelford, C.E. The first named engineer said he saw no reason whatever why a train of 50 tons, the weight of Mr. Behr's carriage, should not be driven on the proposed line so as to cover the distance between Liverpool and Manchester in 20 minutes, and there was no reason to suppose that the train would not be under proper control. He did not think this line would involve any exceptional risk. Sir William Preece also gave evidence in support of the Bill, more particularly with reference to the electrical portion of the scheme. He approved of the proposal to establish a central generating station at Warrington, and stated that within a limit of 50,000 h.p. the larger the station the cheaper the cost of production. He was satisfied that there would be no difficulty in carrying passengers in safety and comfort at a speed of 110 miles an hour. Sir Frederick Bramwell expressed the opinion that the proposed system of construction was well adapted for attaining high speed with safety and comfort. The monorail had the same advantage over the two-rail system that the bicycle had over the tricycle. On the question of brakes, he believed a train running at 110 miles an hour could be pulled up in 25 seconds within a distance of 750 yards without any injurious shock to the passengers. As compared with the ordinary railway, the necessity for brake power on the proposed line was less in a remarkable degree. He did not think the suggestion of a tunnel, put forward by Salford, wise or practicable. It would be destructive of the scheme, and would be of no advantage to Salford. Speaking from a knowledge of Salford, he said that if ever a boon was offered to a place it was the proposal of the promoters in the present case. The committee adjourned.

LIGHTING AND GENERAL.

Bolton-on-Dearne.—The Urban District Council are supporting the Yorkshire Electric Powers Bill.

Bacup.—The Town Council are still conferring with the Lancashire Electric Power Company.

Shipley.—Mr. S. D. Schofield has been appointed electrical engineer to the Urban District Council.

Penge.—The Urban District Council have sealed an agreement with the Lewisham and District Electric Supply Company.

Sutton Coldfield.—Free connections are to be made to the premises of all applicants for the electric light on or before 31st inst.

Erdington.—The District Council have entered into an agreement with the National Telephone Company for the erection of 31 poles.

Leeds.—Messrs. Pease and Partners, Limited, are making arrangements for lighting the Waterhouses and Esh district with electricity.

Ludlow.—The Town Council have advertised for tenders for carrying out the electric light works and refuse destructor in the Smithfield.

Eccles.—Direct telephonic communication is to be provided between the Eccles and Salford fire stations by the National Telephone Company.

Matlock.—A scheme for suggested electrical supply and for lighting was discussed in private at last week's meeting of the Urban District Council.

Brechin.—The District Committee have allowed Mr. M'Nab, Keithock, to carry electric light wires over the road at Newton Mill instead of underground.

Belfast.—The question of providing telephonic communication with No. 1 lighthouse has been referred to the Navigation Committee of the Harbour Board.

Kearsley.—The Urban District Council have authorised Messrs. Lacey, Clirehugh, and Sillar to prepare specifications for the complete equipment of the tramways.

Walthamstow.—Application is to be made for sanction to borrow £945 in connection with the installation of the electric light at the Council's public buildings.

Darlaston.—Mr. F. H. Tulloch has held an enquiry into the District Council's application for sanction to borrow £200 for wiring and electrically equipping the town hall.

East Dereham.—The Urban District Council have carried a resolution to the effect that an approved telephone company receive permission to work a telephone system in the town.

Derbyshire and Nottinghamshire Electric Power Bill.—This Bill has passed Sir William Houldsworth's Select Committee of the House of Commons, and will be reported for the third reading.

West Hartlepool.—At the meeting of the Town Council on Tuesday, the Electric Lighting Committee recommended the extension of supply mains to Seaton Carew at an estimated cost of £3,500.

Anglo Irish Cable.—The shore end of a cable just laid for the Commercial Cable Company between England and Ireland has been successfully landed at Weston super-Mare from the steamer "Silvertown."

Share Market.—During the week electric shares kept firm. Metropolitans, Westminster, and St. James's were in demand. British Electric Tractions and British Insulated Wire debentures were fairly active

Hexham.—The Council have instructed Messrs. Lacey, Clirehugg, and Sillar to prepare a report on a combined scheme for lighting and traction, dealing with the advisability of the utilisation of water for motive power.

Southwick.—In response to an application from the town clerk of Brighton for permission to fix overhead telephone wires in the district, the Urban District Council are forwarding a reply expressing strong objection to the overhead system

Ilkeston.—Arrangements have been made whereby the Council can purchase electrical energy from the Derbyshire and Notts Electric Power Company, it is stated, at a more reasonable price than that at which they could produce it themselves.

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Goole.—The Goole Chamber of Commerce have passed a resolution in favour of the Yorkshire Electric Power Syndicate's Bill, and have authorised the chairman of the chamber to give evidence in support of the measure before the Parliamentary Committee.

Bury.—At a recent meeting of the Electric Lighting Committee a report was presented showing an increase of 22½ per cent. in the current sold and 20 per cent. in the revenue for the quarter ending March 31, as compared with the corresponding period of last year.

Leith.—Regarding leakage of electric energy, the Electrical Engineer reported at Tuesday's meeting of the Town Council that there was absolutely no leakage on the system in Leith, and that the units unaccounted for compared favourably with other towns.

Agency.—We are informed that Mr. H. Bath Spencer, M.I.Mech.E., has been appointed agent in London for Messrs. George Fletcher and Co., at 21, Mincing-lane, E.C., particularly in connection with condensing plant installations for power stations.

Alloa.—The British Electric Plant Company, Limited, who have secured the contract for the electric installation for the burgh, have for some time been busy in erecting their works They expect to be able to supply current by October or November at the latest.

Wrexham.—The Council have obtained from the Alliance Insurance Company the sum of £5,000, being the fourth equal instalment and residue of the electric lighting loan of £20 000 authorised to be borrowed with the sanction of the Local Government Board, dated Nov. 13, 1899.

Hammersmith.—The last report of the Electricity and Lighting Committee states that seven additional consumers have been connected, representing a maximum of 260 8 c.p. lamps; these added to the number previously reported, show a total of 862 consumers taking current from the mains.

Treorky.—The *Western Mail* says there are in Treorky and Cwmpark (which is within the postal area of Treorky) somewhere about 15,000 inhabitants, principally colliers, but, strange to say, there is no telephone exchange there, either belonging to the Post Office or the National Telephone Company.

Boiler Blocks and Flue Covers.—Mr. William Stokes boiler setter, builder, etc., 7, Queen's-road, Reading, has issued a new catalogue descriptive of the well known boiler seating blocks, straight flue covers, boiler flue covers, copings, etc., which he manufactures, and of which he is the patentee.

Montrose.—At a meeting of the Town Council on Tuesday a letter was read from the Board of Trade enclosing copy of the approval the Board proposed to issue for the connections to be formed by Edmundsons' Electric Lighting Company which are to be made at certain parts of their electrical works.

The Cester Question.—The town clerk of Shoreditch is dealing in a practical way with this question. Commodious new stalls have been erected by the Borough Council Each is fitted with two powerful incandescent electric lights. The rent asked is 7s. 6d. per week, which includes removal of refuse.

Greenock.—At the meeting of the Police Board on the 7th inst. the receipt was signed for £30,000 to be borrowed from the Public Works Loan Board, notwithstanding a little opposition on account of no statement having been submitted of the previous expenditure of £50,000 by the Board on electricity works.

Burnley.—The Council have agreed to rescind a previous resolution to borrow £10,400, and intend instead to apply for sanction to the borrowing of the following sums; for expenditure on electric lighting account in excess of borrowing powers, £3,787. 10s. 9d.; and for proposed extensions to the electricity supply works, £7,760.

Maidenhead.—The Town Council have granted an application from Mr. H. Rose for permission to lay an underground cable from his house in Ray Mead to the river for the purpose of launch charging, informing him at the same time that after the Corporation have established their installation he will be unable to supply electricity to any person.

New Issue.—An issue is being made at 97½ per cent. of £400,000 of 4 per cent. first debentures in the Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited. The company has been formed with a share capital of £1,200,000 to acquire the undertaking, property, and assets of La Compania Primitiva de Gas de Buenos Ayres, which was formed in 1855.

Sleaford.—The Electric Lighting Committee reported the acceptance of several tenders at the last meeting of the Urban District Council. The offer of the gas company to sell the whole of the street lamps for £350 was declined, and a tender for new electric light pillars accepted. A loan for £7,000 at 3¾ per cent. has been arranged with the Prudential Assurance Company.

Airdrie.—The Town Council are opposing the Bills of the Caledonian Electric Power Company and the Clyde Valley Electric Power Company with the view of securing clauses protecting the burgh's rights as to the roads, etc. They have also asked the Scottish House-to-House Electricity Company, Limited, for the insertion of clauses into their Bills protecting the interests of the Town Council.

Sheffield.—Mr. S. E. Fedden, engineer and manager of the Sheffield Corporation electric supply department, on the 3rd inst. presided at a dinner at the Carlton Restaurant, to celebrate the doings of the football club during the past season. The club, which only started to play during the second half of the season, has a good record—10 matches played, five won, two drawn, with a goal average of 39 against 16.

King's Lynn.—The Corporation have decided to make a reduction in their charges for current for lighting purposes, and instead of a general charge of 5d. per unit, a scale has been adopted as follows: for all current consumed during the months of May, June, July, and August 3d., and for the remaining eight months 5d. per unit; for each winter quarter, after 10 units per 8-c.p. lamp have been used, 3d. per unit.

Blaydon.—The District Council are considering offers to supply electrical power to the district from the Newcastle-on-Tyne District Electric Lighting Company and from the Durham and District Company. The latter company will not only consider the lighting, but also the bringing of trams into the district. The matter stands adjourned until June, so that in the meantime the newly-elected members might consider the question.

London Gazette.—Mr. H. W. Freshwater, Brighton-chambers, St. Stephen's-avenue, Bristol chartered accountant, has been appointed trustee in the estate of G. T. Lloyd (trading as G. T. Lloyd and Co.), lately residing at 109, Chesterfield-road, Bristol.—A receiving order has been made out *re* G. F. Cook (trading as G. F. Cook and Co.), lately residing at Lightcliffe, Yorkshire, and carrying on business at Charles-street, Bradford, on debtor's petition.

Edinburgh.—Owing to a short-circuit of the mains, caused by the breaking of a feeder, the supply of current was interrupted for a short time on May 1. The Cleaning and Lighting Committee of the Town Council have decided to recommend certain lighting improvements in the city, including the introduction of the electric light in Albert-street, from Leith walk to Easter-road, and in that portion of the Portobello road from Abbeyhill to Jock's Lodge police station.

Cleveland and Durham Electric Power Bill.—The amendments inserted into this Bill include a clause for the protection of Stockton Bridge. A proviso added to Clause 43 authorises the company to furnish energy to authorised distributors. A proviso has also been inserted that the terms to such distributors should be as favourable as those granted to any other person. With these amendments the Bill passed through committee of the House of Commons on Tuesday.

Yorkshire (West Riding).—At the meeting of the County Council on Wednesday, the Law and Parliamentary Committee reported that the only action taken upon the Electric Power (Yorkshire) and the South Yorkshire Electric Power Bills had been to seek clauses for the protection of the main roads and county bridges within the respective areas of supply. Both promoters applied for the support of the County Council, but the committee decided to remain neutral.

Alfreton.—At the recent Board of Trade enquiry much opposition was raised to the Urban District Council's electricity proposal on account of the expense involved and the inopportune time to introduce the light. The Board of Trade in consequence decided not to proceed with the application The Council are thus placed in a peculiar position. They have incurred a large sum of money in preliminary expenses, while they have decided to oppose the Derbyshire and Notts Electric Power Bill.

Heckmondwike.—The Council's petition against the South Yorkshire Bill has been withdrawn, and the chairmen of the Council and of the Electric Lighting Committee will give evidence before the Select Committee in favour of the Bill. Amongst the Finance Committee's recommendations for the next year we find that they have provided for the electric light installation a sum of £393. This was not estimated for at the beginning of the year, and they have not obtained sanction to borrow the money.

Lanark.—At a meeting of the Lower Ward Committee of the County Council on Tuesday some discussion took place on the question of a charge for underground wayleaves for the Corporation telephone wires. Mr. D. M'Lardy, with a view of inducing the Corporation to lay their wires underground, proposed that, where underground wayleaves were adopted, no charge should be made. It was ultimately decided, however, that the rate of 1s. per mile, which was agreed upon at a former meeting, be adhered to.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Edison and Swan United Electric Light Company, Limited, £100,000 5 per cent. second debenture stock, in lieu of the provisional certificates now quoted. Application has been made to the Exchange Committee to allow the Central London Railway (£2 062,970 ordinary stock, £393,515 4 per cent. preferred stock and £393,515 preferred stock in lieu of the shares now quoted) to be quoted in the official list.

Compensation.—The action brought by Mr. Edward H. Robinson, of Collins street, Blackheath, against the Blackheath and Greenwich District Electric Light Company for damages under Lord Campbell's Act in consequence of the death of his son Arthur, who was killed in October last while at work on the switchboard at the company's premises at Blackwall Point, has been settled, the company having paid to Mr. Robinson the sum of £200, including costs. Mr. C. E. S. Mason, of Blackheath, was solicitor for the plaintiff.—*Kentish Mercury.*

Epsom.—The Lighting Committee propose to engage a clerk of works to superintend the construction and laying of the mains, fixing the plant, boilers, etc The Urban District Council have decided to advertise the tenders for meters and cut-outs for consumers' premises, and at the same time to give notice that except where exceptional conditions prevailed, the Council would take into consideration the advisability of making connections free of

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charge to the meters of those applying for electric light during the laying of the mains in the compulsory area.

Malvern.—At a meeting of the District Council on Tuesday it was decided to adopt a scheme prepared by the surveyor for erecting a refuse destructor in conjunction with an electric lighting installation, at a total cost of £17,000. The Council having refused to allow overhead telegraph wires through a portion of their district, the Postmaster-General wrote stating that if the refusal was persisted in the extension of the telegraph to the outside district must be abandoned, as the expected business would not justify an underground cable. The matter was referred to the Streets Committee.

Watford.—The Electric Lighting Committee of the Urban District Council reported at the last meeting of the latter that Messrs. Preece and Cardew's observations, practically approving of Mr. Colebrook's report, were considered, and the committee recommended the acceptance of Messrs. Ferranti's estimates for switch gear amounting to £733, and for 12 junction boxes amounting to £210, the remainder of the extension works to stand over until after the Local Government enquiry. The committee recommended that application be made to the Local Government Board for sanction to borrow a sum not exceeding £31,000 in order to carry out the works suggested by Mr. Colebrook and approved by Messrs. Preece and Cardew. The reports were agreed to.

Cardiff.—The engineer has presented a return showing that during the last month the works cost of generating current was 1·04d. per unit. That, however, does not include management costs. He hopes in time to reduce the cost to ·75d. per unit. Mr. Ellis has further submitted a statement showing an estimated excess over the estimate for one year ending March 31, 1901. This showed that the estimated expenditure was £6,733. 6s. 6d., and the total expenditure £7,684. 1s., or total excess expenditure over the estimate of £950. 11s. 6d. This excess is attributed partly to the increase in stores, which totalled £1.166, or about £300 more than last year. The lighting account for the year ending March 31 shows a total revenue of £1,641. 17s. 3d., and an expenditure for public lighting of £1,528. 10s. 4d., leaving a balance on the right side of £113. 6s. 11d.

Dundee Telephones.—At a recent meeting of the Town Council a discussion arose upon the proposal to give underground wayleaves to the National Telephone Company without any charge. It was pointed out that if the Council at any time desired to municipalise the telephones and to open a municipal exchange, the wayleaves granted prior to that time would have become the perpetual property of the company. It is reported that it was decided that in the agreement with the company it should be declared that if at any future period the Town Council applied for and obtained a license, then the Telephone Company should not be entitled to ask that the wayleaves already granted to them should be made permanent. This would be an easy way out of the difficulty if it were feasible, but no contract over-riding the Government regulation would be tenable at law.

Manchester.—An enquiry was held on Tuesday into the application of the Corporation for power to borrow sums of £310,110 and £500,000 for the purpose of supplying electricity and several smaller amounts. The Town Clerk said the Corporation had agreed to supply other districts outside their own area with the electric light, and had also entered into agreements, in connection with the tramways scheme to go beyond their own area into part of Salford, part of Stockport, Middleton, Droylsden, Audenshaw, Denton, Gorton, Heaton Norris Levenshulme, and Failsworth. When all those lines were completed, the Corporation would have 150 miles of single track. The amount authorised to be borrowed by the electricity department up to the end of last March was £894,011, and the total amount expended on capital account to the same date was £867,322. There was no opposition to the present proposals.

Worthing.—The laying of the casings and the erection of the arc lamp columns is being proceeded with, and the cables in connection with the arc lamps on the Parade will be laid by Whitsuntide. The Council have decided to adopt as a general rule a recommendation that requisitions for extensions of distributing mains be acceded to, on an undertaking being given guaranteeing, as a minimum charge, a return of 10 per cent. on the actual outlay incurred until the revenue from such extended main from private consumers equals that percentage (the Corporation allowing in the meantime, as a set off against the percentage so payable, such sums as may be received for current supplied to premises connected with such extensions), and leaving it open to the committee, should they think fit, to recommend any variation in excess of that percentage so far as regards any particular street or streets in respect of which a requisition is made.

Newcastle Telephones.—A deputation from Newcastle this week had an interview with Lord Londonderry with reference to the city telephones. The members of the deputation were introduced to the Postmaster-General by Mr. Renwick, M.P., and stated their case at some length. Newcastle was said to possess a larger number of subscribers to the Post Office telephone than any other city in the kingdom, there being 600 or 700 on the list. Preferring the Government service to any rival concern, they are anxious to secure an extension of its lines as well as other facilities. Unless the Post Office authorities exert themselves, however, there is a fear that the National Telephone Company may secure the entire control, and thus establish a monopoly which, they thought, ought not to be allowed. His Lordship received the deputation very courteously, listened with close attention to the various points brought under his notice, and promised to carefully consider the remedies that had been suggested.

Bankruptcy.—The first meeting of creditors was held on Monday under the failure of A. W. B. Pearson, electrical contractor, etc., of 81, Palmerston-buildings, E.C. The debtor has carried on business since 1898, and has held contracts for the London County Council and other public bodies. He is also interested in various patents and secret processes, among the number being eborine, a vulcanite substitute, a rotary engine pump, a patent switch, an artificial indiarubber, a method of treating waste cork, etc., for the manufacture of paving and flooring, and a dry cell. His present position is apparently due to the failure of Mr. Herbert Alexander, of Leeds; Messrs. Schmolze, Rischmann, and Co., foreign bankers; and others, to meet their acceptances. The Chairman said that the debtor was unable to attend the meeting, but had sent in a draft statement of affairs showing liabilities £10,216, and assets expected to produce £13,814. Mr. J. R Woodley, chartered accountant, was appointed trustee.—*Daily Telegraph.*

Kingston (Surrey).—Sanction has been obtained to the borrowing by the Corporation of a further sum of £17,800. The Local Government Board have informed the Council that they were advised that the proposed underground main flues should be strengthened, and some means taken to prevent heavy weights coming directly upon them. The borough electrical engineer is about to prepare a section of new flues. Tenders for a loan of £6,000 are being invited. An enquiry having been made as to the price at which the Corporation would be prepared to supply continuous current for a lift at the workhouse, a reply has been sent that the current supplied by the Corporation was alternating current, which was equally applicable for the purpose, and which could be supplied at the reduced price of 3d. per unit. Subject to the approval of the Council, and to the Works Sub-Committee being satisfied as to details, additional machinery is to be ordered, in accordance with the details prepared by the borough electrical engineer, at a cost of £4,800.

Battersea.—Application is to be made to the Local Government Board for sanction to the borrowing of the sum of £318 to defray the cost of electrically wiring the central library building, and, upon receipt thereof, to the London County Council for the advance of the sum in question. A mortgage deed has been sealed in respect of a further loan for £10,600 on account of the general electric lighting scheme. The Lighting Committee of the Borough Council have been in communication with the Electrical Trades Union and Callender's Cable and Construction Company, Limited, with reference to the wages paid by the company to cable jointers and jointers' mates in connection with their contract for laying electric mains, etc., throughout the borough, and in their last report state that they have had no reason given to them to interfere with the arrangements made by that company for carrying out the contract in question. The committee have also revised the wiring rules, etc., and the charges relative to the supply of electricity to premises within the borough.

Islington.—The Borough Council have decided to borrow £5,300 for necessary distributing mains, and £3,100 for extension of mains, besides £2,212 for meters, indicators, terminal boxes, etc. The Lighting Committee has reported having had under consideration a report from the electrical engineer stating that he has made exhaustive enquiries upon the subject of mechanical stoking and recommending a trial of two new types of stoker with a view of economising the consumption of coal and reducing the quantity of dust passing into the flues and stack. The makers of these appliances were prepared to fix them complete to the Council's boilers on trial for two months on condition that if found satisfactory the Council should purchase outright, and under these circumstances the committee were of opinion that a trial should be made. The estimated cost of the two stokers was £500, and the committee recommended that the estimate be approved, and that they be authorised to proceed with the trial and to purchase the stokers if such trial was in their opinion satisfactory. The report has been adopted.

Dalkeith.—The lighting provisional order for the burgh of Dalkeith issued to Messrs. Crompton and Co., Limited, states that the streets to be included in the area in which mains are to be laid are High-street, Eskbank-road from corner of Newbattle-road, Buccleuch street, South-street, and Lothian-street. It is expected the arrangements for the supply will take about two years. Where the consumer is charged electricity for lighting for his own use he will pay 10s. for any amount up to 20 units, and for each additional unit over 20 6d. He can also have the option to pay for any amount not exceeding the equivalent of 91 hours of supply at the maximum power which has been demanded by him at the rate of 7d. per unit, or for any further supply exceeding the equivalent of 91 hours of supply at such maximum power at the rate of 4d. per unit. When the consumer is charged by the electrical quantity contained in the supply given to him he shall be entitled to pay according to scale, the amount of energy supplied him being taken to be the product of that electrical quantity and the declared pressure at the consumer's terminals as may be declared by the Messrs. Cromptons' officials under the Board of Trade regulations.

Earl's Court.—The Military Exhibition at Earl's Court, which was opened by H.R.H. the Duke of Cambridge on Saturday last, bids well to become a very attractive place when it is a little more forward. It is but fair to say that the "Military" Exhibition part proper is quite ready, and there electric searchlights may be seen cheek-by-jowl with mediæval casks, to which they bear a very marked resemblance. The side shows, however, are lingering. The electrophone is still to the fore, motor launches are on the programme, also a miniature railway, an accumulator train in the shape of a ferocious dragon, and the Reno inclined elevator,

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which is American for moving stairway. Amongst the entertainments already in full swing, the greatest attraction, bar the highly spectacular "China," in which about 1,500 persons occupy the stage for a considerable stretch of time, and shout and shoot at each other to their hearts' content, there is the stereorama from the Paris exhibition, a great mechanical contrivance, producing a beautiful effect; also Holz's military tableaux, a trip down the Canton river by means of a millrace, a trestle bridge erected by the Royal Engineers, and a pontoon bridge on the lake. The gigantic wheel, which is still all there, has been most wonderfully besmeared by the advertising fiend.

Darlington.—The number of consumers connected during the last month was six, making a total of 70. The number of 8-c.p. lamps connected during the month was 537, making a total of 6 047. There had been applications from 21 intending consumers who will require 1,208 8-c.p. lamps. The number of units generated during the month was 10,373, and 30½ tons of coal had been consumed, the cost of coal per unit being 61d. From the annual estimates for the electric lighting department we note that the Finance Committee is to be asked to provide £500 for the purpose of meeting the expenses of this department for the year ending March 31, 1902. The Council are opposing the Cleveland and Durham Electric Power Bill. Dr. A. B. W. Kennedy is to give evidence. The electrical engineer has reported that in order to provide for the probable requirement of the near future it will be necessary to extend the works, and he has been instructed to prepare the necessary plans and specifications for such extensions without delay. Messrs. Kennedy and Jenkin are to be communicated with as to their professional charges for acting as consulting engineers in the extensions. The borough electrical engineer is about to prepare and submit another report as to the probable cost of extending mains in order to supply any of the works in the town where a supply for power purposes may be required.

Warrington.—It is proposed that application be made for sanction to the borrowing of a further sum of £15,000 for extensions, in accordance with the following report by Mr. Preece: "The present full-load capacity of the works is about 350 kw., allowing one of the 250-kw. engines and dynamos as spare plant. It is desirable to arrange without delay for the addition of a new boiler, engine and dynamo to enable the output of the works to be at least 600 kw. The necessity for this has already been explained to the committee, and a resolution has been passed to enable estimates to be prepared for this extension. The following is my estimate of the expenditure necessary within the next 12 months: new boiler, superheater, brickwork, and pipes, £1,520; one 500 kw. engine and dynamo, £5 000; additions to switchboard for new dynamo and feeders, £200—total for works, £6,720. As regards the extensions of the mains, a plan is submitted showing the work that is necessary to enable the Corporation to supply pending consumers. They involve extensions along Liverpool road Bewsey street, Howley lane, and Church street, with three new feeding points. It will be necessary to provide for some 4 000 yards of conduit, 4,000 yards of feeder, 2 600 yards of distributors. The cost will be £6,500. Hence the total cost is estimated at: generating plant, £6 720; mains, £6,500; engineering and contingencies, £780—total, £14,000. No provision has been made for any extension of the public lighting, though this may be considered advisable wherever mains are laid in new streets."

Barnsley.—The Town Council have written to the Local Government Board in reference to the proposal of the Guardians to borrow money for an installation of the electric light at the workhouse, submitting the following statement: "Under the powers of the Electric Lighting Provisional Order, 1890, the Corporation had expended nearly £30 000 and were about expending another £20,000, for the supply of electricity within the borough. The workhouse was within the borough, and the Corporation were able and willing to supply electrical energy to the workhouse. On Feb. 20, 1900, the Lighting Committee received a deputation from the Board of Guardians as to the terms upon which the Corporation would supply electrical energy to the workhouse. On the 26th a letter was addressed to the clerk to the Guardians, on behalf of the Lighting Committee, stating the terms which they were prepared to recommend the Council to offer for a supply of electrical energy, but from that time until now no reply had been received from the Board of Guardians. The Lighting Committee now learnt that it was the intention of the Board of Guardians to expend upwards of £4,000 in providing a system of their own for generating electrical energy at the workhouse. The Corporation could supply energy at much less cost than the Guardians could possibly supply themselves, and believed the proposal of the Guardians, if carried into effect, would be an extravagant waste of funds obtained from the public rates and the Lighting Committee therefore trusted the Local Government Board would refuse to sanction that application."

"The Glasgow Herald."—The *Glasgow Herald* is being printed at the Glasgow Exhibition by a Hoe machine capable of being worked in two sections, each of which produce an eight-page paper at the rate of 48,000 an hour. Papers, varying in size from 24 to 32 pages, can be produced at a speed yielding 12,000 an hour by a change of coupling. The machine is fitted with a very complete electric motor driving equipment on the "reducer" (Spence's patent) system of the British Electric Plant Company, Limited, of Alloa. The apparatus comprises a motor of 50 b.h.p., capable of developing a turning effort at starting equivalent to 100 h.p., which drives the machine direct through a flexible coupling. When going at full speed the motor runs about 400 revolutions per minute, while for preparation of the printing rolls and for leading in the paper a speed not exceeding $\frac{1}{25}$th of this, or 16 revolutions, is demanded. This requirement of a dead-slow speed, which must be constantly maintained without variation, is met by the employment of a motor generator transformer, the reducer, whose function is to reduce the pressure of supply from 500 volts in this case to a lower pressure corresponding to that of the slow speed. The transformer has a capacity of about 13 h.p., and at the slow speed named this enables the press motor to turn with an effort equivalent to 100 h.p. at its normal full speed. The controller is of special design, and by the continuous motion of a handwheel all the necessary motions for starting, regulating, and stopping the machine are performed, the arrangement being such that each follows in its proper sequence. Another feature is the provision of a reversing switch for enabling the motor to turn the machine backwards when wanted. Owing to the high velocity and to the great mass of machinery in motion, the inertia at full speed is very large, and considerable loss of time would occur were the motor merely switched off and allowed to slow down gradually. To prevent this an electromagnetic brake is provided, which comes into action automatically whenever the current fails or is switched off, and to further complete the effectiveness of control a number of push buttons are fixed at different positions on the machine, pressure on any one of which opens the cut-out and applies the brake. Thus any attendant noticing a breakage in the paper can promptly stop the machine and prevent waste.

Colchester.—The supply at the Corporation's electricity works was started in December, 1898, for private lighting only. A low-pressure continuous (three-wire) system was adopted. The pressure of supply is stated at 105 volts. Loans to the amount of £21,400 have been sanctioned, £20 763 was borrowed, of which £712, 10s. 7d. has been repaid. We have received the following analysis of accounts for the year ending March 31, 1901, the second year of working: Capital expenditure to Dec. 31, £21,948. 16s. 6d.; revenue from electricity supply, £3 033 8s. 1d.; revenue from meter rents and other sources, £111. 12s. 8d.; total revenue, £3 145. 0s. 9d.; total costs, £1,813. 8s. 2d.; gross profit before providing for interest, charges, and sinking fund. £1,331. 12s. 7d.; percentage of gross profit to capital (outlay during year being averaged), 6·57; interest on loans, less interest receivable, £469. 12s. 9d.; sinking fund, £497 17s. 5d.; percentage of sinking fund to capital (outlay during year being averaged) 2·27; financial result, after payment of all charges (surplus), £364; capacity of dynamos March 31, 400 kw; maximum load reached, 162 kw.; load factor, 10 76; number of 8 c.p. lamps connected March 31, 10,540; units sold, 111 400; units sold per 8-c.p. lamp connected (connections during year being averaged), 13 34; statutory maximum price per unit 8d.; rent charged, private lighting, 8d. to 5d.; power and heating, 4d.; average price obtained, 6½d. The analysis of cost is as follows: (A) Generation and Distribution Costs.—(1) Coal and other fuel, including cartage, 1900-1, £780 or 1 68d. per unit (1899-1900 £211 or ·83d. per unit)—increase, ·85d.; (2) oil, waste, and stores, £101 or ·23d. (£39 or 15d.)—increase, ·08d.; (3) wages, £270 or ·58d. (£189 or ·74d.)—decrease, ·16d.; (4) repairs maintenance, etc., £113 or ·24d. (£130 or ·51d.)—decrease, ·27d. Total works costs £1,264 or 2·73d. (£569 or 2 23d.)—increase, ·5d (B) General Costs.—(5) Rent, rates, and taxes, £76 or ·16d. (£50 or ·2d.)—decrease, ·04d; (6) management expenses, salaries, stationery, printing, insurance, and general establishment £418 or ·9d. (£275 or 1 07d.)—decrease, ·17d. Total costs, £1 758 or 3 79d. per unit (£894 or 3 5d. per unit)—increase, 29d. Thus the financial result for 1900-1901 give a gross profit on year's working of £1 331 (less interest on loans, less interest receivable, £469, and amount provided for sinking fund, £498), making the surplus for the year £364.

Hastings.—It is proposed to borrow £3 289 two-thirds of which amount is for stock to be purchased on the capital account from time to time. The rest is for the purpose of saving and guarding against waste. The borough electrical engineer in his last report on mains extensions says that he has made further enquiries re extending mains up London-road, Filsham road, etc., but has been unable to obtain sufficient applications to appear to justify this expenditure. He therefore advises that unless a number of definite applications are received from other quarters extensions be confined for the present year to the roads in which mains are already laid. They would probably require during the next winter about half-a-dozen additional 20-kw. transformers. With regard to complaints from consumers during the past winter, owing to the number of occasions upon which it had been necessary to disconnect their supply during the daytime to enable the men to work on the cables for the purpose of joining-on new consumers, etc., he recommends that disconnecting pillar boxes, about 4ft. 6in. high by 1ft 3in. square, be fixed at various points. The cost of these disconnecting pillar boxes, fitted complete with the necessary switches is estimated at about £15 each. A three-way wattmeter and two ammeters are to be fixed in each of the existing sub-stations. The object of the former would be to measure the monthly output of each of the sub-stations in order that this might be compared with the readings of consumers' meters. Details of the loan mentioned above are given as follows: 4,000 yards of $^{7}/_{16}$ cable for house services, laid and jointed complete, at 4s. 6d. per yard, £900; 150 joint-boxes at 24s. each, £180; 150 house fuses, including fixing, at 18s. each, £135; 150 meters at £6 each, £900; 10 disconnecting pillar boxes at £15 each, £150; 22 ammeters at £10 each, £220; 11 three-way wattmeters at £12 each, £132; 11 double-pole switches at £15 each, £165; two static voltmeters at £10. 10s. each, £21; six 20-kw. transformers at £62 each, £372; four low-tension four-way fuse boards at £6 each £24; two equalisers (for connecting two-wire system with three-

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wire system) at £45 each, £98—total, £3,289. The Council have declined to accept their Lighting Committee's recommendation that by way of experiment the terms of Mr. Andrews's (the borough electrical engineer) engagement be so modified as to admit of his practising privately as a consulting engineer for the period of one year, subject, however, to his obtaining the permission of the committee to act in that capacity previously to every occasion upon which he might desire to do so. We think that they might have done so, or at least have offered a higher salary by way of compensation, as the fast-growing department can well afford it.

Glasgow International Exhibition.—The electric lighting of the exhibition buildings has been divided into three distinct sections—viz, industrial hall, grand avenue, and machinery hall—and each section is still further sub-divided into several circuits, so that no serious inconvenience would be felt should any breakdown occur. The industrial hall is lit by means of 345 10-ampere Brockie-Pell arc lamps, and 404 16-c.p. Zürich incandescent lamps; the grand avenue by means of 105 10-ampere Brockie-Pell arc lamps, 120 16-c.p. and 20 200-c.p. Ediswan incandescent lamps; the machinery hall by 250 10-ampere Brockie-Pell arc lamps, 200 16-c.p. and 30 200-c.p. Ediswan incandescent lamps. The main cables for the lighting of these buildings have been given on hire by the British Insulated Wire Company, Limited, Prescot, and the arc light cables by Messrs Isidor Frankenburg, Limited, Salford, Manchester. The wiring installation for the industrial hall has been carried out by Messrs. Claud Hamilton, Limited, Glasgow, and the wiring for the grand avenue and machinery hall by Messrs. Lowdon Bros. and Co., Dundee. The main switchboard has been given on loan by Messrs. Kelvin and James White, Limited, Glasgow. Fine Art Galleries.—The lighting for this building has been carried out by the Glasgow Corporation electricity department, and about 4,000 incandescent lights have been installed and 100 h.p. for motors. Grand Concert Hall and No. 1 Restaurant.—The concert hall is entirely lit by means of 326 16-c.p. and 61 32-c.p. Ediswan incandescent lamps, and the restaurant by 49 10-ampere Brockie-Pell arc lamps, the wiring contractor being Claud Hamilton, Limited. Nos. 2, 3, 5, and 6 restaurants are fitted with 158 10-ampere Brockie-Pell arc lamps and 140 16-c.p. Zürich incandescent lamps, the wiring contractors being Lowdon Bros. and Co., Dundee. The power for the electric lighting is being supplied by the following firms: Messrs. Willans and Robinson, engine and Crompton dynamo and engine and Schuckert dynamo; Messrs. Robey and Co., engine and Mavor and Coulson dynamo engine and Scott and Mountain dynamos (two); Messrs. Ruston-Proctor, engine and dynamo; Messrs. Scott and Mountain, engine and dynamo; Messrs. Alley and Maclellan, engine and Mavor and Coulson dynamo; Messrs. Browett-Lindley, engine and Edison and Swan dynamo; Messrs. Belliss and Morcom, engine and Bruce Peebles dynamo; Messrs. Sisson and Co., engine and Clarke-Chapman dynamo; Messrs. Davey-Paxman, engine and Electric Construction Company dynamo; one balancer, capable of dealing with 100 amperes out of balance, by D. Bruce Peebles and Co. Steam-boilers are being supplied by the following firms: Messrs. Babcock and Wilcox, two water-tube boilers; Messrs. Davey-Paxman, Limited, one water-tube boiler; Messrs. Stirling Boiler Company, Limited, two water-tube boilers; Messrs. Babcock and Wilcox, one marine boiler; Messrs. Penman, four Lancashire boilers. The whole is under the supervision of Mr. Thomas Young, M.I.M.E., M.I.E.E., electrician and engineer to the exhibition.

London County Council.—The Council on March 26 sanctioned the borrowing by the Council of the metropolitan borough of Stepney of a sum of £5,163, repayable within 20 years, for the lighting by electricity of the streets within the borough, and the money will now be advanced. From the report of the Fire Brigade Committee, presented last Tuesday, we note that on being asked for an estimate of the annual charge for two fire-alarms, the Post Office intimated that if the wires were carried overhead the rent was estimated at £16, including a special charge of £5. 10s. for new poles, but that if the wires were laid underground, it was estimated that the rent would be £72, including a special charge of £62 for new pipes. Having regard to the policy adopted by the Council in respect of the use of overhead wires, the committee feel that they cannot press the local authorities (who in these cases either entirely decline or are extremely loth to consent to such use) to agree to wires being carried overhead, and, as the chief officer considers the provision of these two fire-alarms is necessary, they advise the Council to agree to pay the larger amount. This rent of £72 will, after 10 years' time, be reduced to £10. The expenditure is covered by the amount provided in the estimate for the current financial year for fire-alarms and telephones. A similar recommendation was made with regard to the provision by the Post Office of two other fire-alarms at an estimated annual cost of £62. 2s. 6d. Notices by various companies to lay mains were agreed to as follows: From the Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, to lay mains of high and low tension along Longridge-road and along Abingdon-villas. From the Charing Cross and Strand Electricity Supply Corporation to lay mains, under the St. Martin's District Order, 1889, from the company's proposed new station in St. Martin's-lane, along St. Martin's lane and place, Cranbourn-street, Whitcomb-street, James-street, the Haymarket, Pall-mall East, Trafalgar-square (east and west sides), Cockspur-street, Spring-gardens, Charing-cross, Whitehall-place, Northumberland-avenue, the Strand, and Adelaide-street, and under the Strand District Order, 1896, along Cranbourn-street, Leicester-square (north side), and New Coventry-street (the works above specified were disapproved by the Council on Feb. 26, 1901, owing to the meagreness of the details supplied by the company of the works proposed to be executed, and the supposed extensive interference with the public way in connection with the construction of a large underground chamber outside the company's new station in St. Martin's-lane. The Council have since ascertained that the company is already in possession of cellars, with an area of 45ft. by 8ft., under the footway and part of the carriageway in front of the station, and that the company proposes to do away with these cellars, and, in lieu thereof, to construct an underground chamber with an area of 11ft. 6in. by 10ft.). From the County of London and Brush Provincial Electric Lighting Company, under the St. Olave Order, 1895, to lay low-tension mains along Great Maze-pond, St. Thomas-street, Joiner-street, Tooley-street, Snowsfields, Shand-street, Queen Elizabeth-street, Shad Thames, Horselydown-lane, Tower Bridge-approach, Duke-street, Railway-approach, and Denman-street (Railway approach and Denman-street are on private property, and are not maintained by the road authority, and the Council has no power as regards the works in those thoroughfares). From the Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1899 and 1895, to lay mains across, and along a portion of, Lancaster-road (in substitution for the works referred to in a previous notice of the company); from the same company, under the same orders to lay mains along and across Lansdowne-road. From the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along portions of High street, Camden Town, and Crowndale-road. The Council also received a notice under an order granted to a local authority from the South London Electric Supply Corporation, under the Lambeth Order, 1892, of intention to lay mains along Ferndale-road, Torrens-street, Glendall-street, Bythorn street, Allardyce-street, Medwin street, Ducie-street, Tintern-street, Santley street, Sandmere-road, The Avenue, Raeburn street Ballater-road, Corrance road, Solon-road Plato-road and Kepler-road (the order was originally granted to the late Vestry of Lambeth, and subsequently transferred by agreement to the company, and contains no provision enabling the Council, as in the case of orders granted to companies direct, to approve or disapprove of works).

PROVISIONAL PATENTS, 1901.

APRIL 29.

8738. Improvements in electric and other fluid pressur motors and gears. Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

8744. Improvements in methods or means of insulating electric wires. Benjamin George Hodges, Imperial-chambers, Albert-street, Derby.

8803. Improvements in safety devices for electrical measuring instruments. Vittorio Alessandro Arcioni, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8806. Improvements in switches for the trolley lines of electric tramways. Charles Dalmas, 53, Chancery-lane, London.

APRIL 30.

8831. Improvements in party line system telephony. William Garner, 266, Penistone-road, Sheffield.

8833. Improvements in interrupters of induction coils. Dawson F. D. Turner, 37, George-square, Edinburgh.

8883. Improvements in or relating to electric signals. Jacques Netter and Henry Queyroul, 111, Hatton-garden, London.

8890. Improvements relating to printing electric telegraphs. Joseph Emanuel Heimerdinger, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8892. Improvements in electric clocks and time-pieces. Robert Mann Lowne, 23, Southampton-buildings, Chancery-lane, London.

8906. Improvements relating to the transmission of electric currents. Louis Maiche, 45, Southampton-buildings, Chancery-lane, London.

8920. Improvements in electric switches. James Ernest Spagnoletti, Palace-chambers, Westminster, London. (Complete specification.)

8922. Improvements in or relating to telephone systems. Oreste Angelini and Adolfo Jengo, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 20, 1900, being date of application in Italy.) (Complete specification.)

8932. Improvements in primary electric batteries. Frédéric Marie Chaplet, 47, Lincoln's-inn-fields, London.

8936. Improvements in electrically-driven centrifugal machines. James Bingham Alliott and John McLure Caldwell Paton, 46, Lincoln's-inn-fields London.

MAY 1.

8943. Improvements in apparatus for measuring the magnetic properties of materials. Francis Gibson Baily, 11, Ramsay-garden, Edinburgh.

8963. Improvements in main switches specially applicable for high-tension circuits. Joseph Hamer, Commercial-street, Halifax.

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8956. Improvements in the construction of dynamo-electric machines and electro-motors. Edmund Scott Gustave Rees, Wolverhampton.

8957. An improved shade carrier for electric light fittings. James Alexander Morton, 115, St. Vincent-street, Glasgow.

8962. Improvements in switch apparatus for use in a surface-contact system of electric traction, and in operating switches used in such system. Thomas Hugh Parker, Prince's-chambers, Wolverhampton. (Complete specification.)

8964. Improved means for use in operating from a car or train switches employed with a surface-contact system of electric traction. Thomas Hugh Parker, Prince's-chambers, Wolverhampton. (Complete specification.)

8965. Improvements in, or in and relating to, skates or contact makers carried by cars for use in a surface-contact system of electric traction. Thomas Hugh Parker, Prince's-chambers, Wolverhampton. (Complete specification.)

8966. Improvements in switches. Carl Schinzer and Nathasius Joseph Goldfarb, 100, Wellington-street, Glasgow. (Complete specification.)

8967. Improvements in the method of forming armature coils for dynamos and electric motors and in apparatus for use therein. Thomas Hugh Parker, Prince's-chambers, Wolverhampton. (Complete specification.)

8985. An improved thermo-electric battery. Léon Bénier, 78 Fleet-street, London. (Complete specification.)

8997. Improvements in apparatus for governing electric currents. Alfred Warwick Gattie, 6, Bream's-buildings, Chancery-lane, London.

9005. Improvements relating to X-ray tubes. Alfred Charles Cossor and William Underhill Hilliar, 6, Bream's-buildings, Chancery-lane, London.

9002. Improved high-tension switch. William Phillips Thompson, 322, High Holborn, London. (The firm of Voigt und Haeffner Actiengesellschaft, Germany.)

9011. Improvements in the electro-deposition of metals for the manufacture of compound wire bars and the like and in apparatus therefor. Richard David Sanders, 4, South-street, Finsbury, London.

9019. Improvements in electric gear for controlling lifts or hoists. Jörgen Björnstad, 47, Lincoln's-inn-fields, London.

9023. Improved means for testing secondary batteries. Lars Bristol, 70, Chancery-lane, London.

MAY 2.

9033. Improvements in life-guards for electric tramcars or similar vehicles. Frank Lamb, 8, Lombard-chambers, Bixteth-street, Liverpool.

9056. Improvements in apparatus for treating telegraph or telephone cotton-covered cables or wires. Ernest Alexander Claremont and Charles James Beaver, 4, St. Anne's-square, Manchester. (Complete specification.)

9076. Improvements in or relating to mercury or mechanical interrupter for induction coils in connection with X-ray work. Harry William Charles Cox, 10, Cursitor-street, Chancery-lane, London.

9079. An improved method for the protection of overhead systems of transmission of electric currents. Cecil John Reginald le Mesurier, 19, Perrymead-street, Fulham, London.

9088. Improvement in the controlling of the working of railway signals and points by electricity. Illius Augustus Timmis, 2, Great George-street, Westminster, London.

9122. Improvements in or relating to means for utilising magnetic force for motive power, also applicable for insulating purposes generally. James Chandler, 8, Quality-court, Chancery-lane, London.

9127. Improvements in switches for use with alternating-current dynamos. The Electric Construction Company, Limited, 47, Lincoln's-inn-fields, London. (John Roberts, South Africa.)

MAY 3.

9147. A life-guard for electric cars, railway locomotive engines, motorcars, and all steam machines on the public road. George Kirby, 33, Averton-valley, Kirkdale, Liverpool. (Complete specification.)

9154. Improvements in or relating to telegraph, telephone, overhead tramway, and like wires. George Edward Heyl-Dia, 55, Market-street, Manchester.

9187. Improvements in electrical accumulators. Chaimsonovitz Prosper Elieson and Vladimir de Bobinsky, 4, South-street, Finsbury, London.

9188. Improvements relating to induction coils. Sir Charles Stewart Forbes, Bart., 45, Southampton-buildings, Chancery-lane, London.

9193. Improvements in gear for actuating the electric switches of cranes, capstans, and the like. Sir W. G. Armstrong, Whitworth, and Co., Limited, and Joseph Honner, 24, Southampton-buildings, Chancery-lane, London.

9206. Improvements in and connected with current-collecting devices for electric railways, tramways, and the like. Walter Behrens and Jean Pierre Tihon, 6, Lord-street, Liverpool.

9211. Improvements relating to the insulation of electrical conductors and the like and to compounds therefor. Henry Harris Lake, 45, Southampton-buildings, Chancery lane, London. (Oliver T. Hungerford, United States.) (Complete specification.)

9212. Improvements in the method for protecting underground electric mains and for like purposes. Fearnside Irvine, 18, Southampton-buildings, Chancery-lane, London.

9213. A new or improved galvanic cell. Gerhard Bodo Puchmuller, 70, Chancery-lane, London.

9217. Improvements in electrical fuses or cut-outs. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The D. and W. Fuse Company, United States.) (Complete specification.)

MAY 4.

9265. Electric arc lamp. Tapley W. Young, 7, Staple-inn, London. (Complete specification.)

9273. Improvements in electric time-checking and time-recording apparatus. Charles Miles, Glenview, Withleigh-road, Upper Knowle, Bristol.

9275. Improvements in and connected with means of supplying current to electrically-propelled vehicles from an overhead conductor. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, Stamford-hill, London.

9276. An improved electric heating body. Ignaz Timar, 55, Chancery-lane, London. (Complete specification.)

9279. Improvements in and connected with the trolley poles of electric cars and the like. Phelam McCullough, Thomas Blaney, and Robert Baron, 6, Lord-street, Liverpool.

9284. Improvements in electrical instruments for signalling on railways. Edward Tyer, Frederick Thomas Holline, and Frederick William Leake, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

9295. Improvements in means for preventing the oscillation of alternators connected in parallel. Reginald Haddan, 18, Buckingham-street, Strand, London. (Otto Titus Bláthy, Hungary.) (Complete specification.)

9302. Improvements in electrical transformers. Arthur Francis Berry and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

9303. Improvements in electrical transformers. George Berry, 46, Lincoln's-inn fields, London.

9307. Improvements in circuit arrangements for inter-communication telephone or telegraph systems and other electric signals, and switches for same. Alfred Charles Brown and John Henry Hawksworth, 7, Queen's-square, Finsbury-avenue, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on May 25.

1900.

8179. Electric switch apparatus. Jones.

8274. Manufacture of electrical fuses for blasting and mining purposes. Haddan. (Fabrik Electrischer Zünder, G.M.B.H.)

9944. Incandescent electric lamps. Drake and Nernst Electric Light, Limited.

9988. Electric signalling device for preventing railway collisions. Del Monaco.

10214. Electrical ignition devices applicable to internal-combustion and like engines. McMullen.

11217. Method of and material for covering electric cables, conductors, or wires with insulating material. Heyl-Dia.

11260. Electric accumulators and electrodes therefor. Tribelhorn.

11720. Electrical ignition apparatus for exploding the charges in internal-combustion motors and for other similar purposes. Dawson and Dawson.

12179. Electrical tramways or railways. Hirst.

13311. Contact boxes for electric railways and tramways. Hillischer.

14063. Combined switches and fuses. Pillinger and Vandam.

21533. Electrolytical apparatus. Matthews and Davies.

23361. Electrical fuse carriers for distribution boards and the like. Sperryn and Wood.

1901.

3491. Arc lamps. Rignon, Carbone, and Moreno.

3526. Electrically-lit watch or clock case. Manger.

5121. Insulating strips or cores for rheostats, electric heaters, and similar devices. Justice. (Erie Exploration Company.)

5411. Electric measuring apparatus. Ziegenberg.

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5560. Electrical switches. Dorman and Smith.

5788. Telephonic apparatus comprising conversation counters or meters. Eichwede.

6271. Telegraphic or telautographic apparatus. Boult. (Gruhn.)

7136. Telephone metering system. Bliss and Holland.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	May 4	650	596	+ 54	—	—
Birmingham Trams.	,, 4	4 469	4 312	+ 157	73 712	—
Blackburn Corp'rat'n	,, 4	490	423	+ 67	7,781	7,002*b*
Blackpool Corporatn.	,, 2	346	280	+ 66	2.259	1,905
Blackpool-Fleetwood	,, 4	360	333	− 27	3 950	4 252
Bolton Corporation..	,, 5	1,398	1 083	+ 315	24 255	15,918
Bradford City Trams	—	—	—	—	—	—
Bristol Tramways Co.	,, 3	4.494	2 851	+1,613	—	—
Carlisle Tr'mw'ys Co	,, 4	164	—	—	2,345	—
Central London Ry.	,, 4	6,428	—	—	111 023	—
City & South London	,, 5	1,855	1,283	+ 572	35,716	22,246
Cork E. T. and L. Co.	,, 2	530	409	+ 121	6,520	5 775
Dover Tramways ...	,, 4	199	189	+ 10	3 070	2,842
Dublin & Lucan E.R.	,, 4	114	93	+ 21	1,490	1,368
Dublin U.T., elec. cars	,, 3	3.645	3,421	+ 224	—	—
Dublin S.D. Electric	,, 3	854	804	+ 50	—	—
Dundee Tram Co. ...	,, 1	602	387	+ 215	—	—
Glasgow Corporation	,, 4 1	1,756	9,194	+2,562	—	—
Halifax Corporation	—	—	—	—	—	—
Huddersfield Corp'n.	,, 4	784	617	+ 167	3,122*b*	3,521
Hull Corporat'n E.S.	,, 4	1.585	1,085	+ 500	8 020	8,258
Liverpool Corporat'n	Apl 27	9 224	7,354	+1 870	137.278	117.816
Liverpool Overhead	May 5	1.632	1,433	+ 199	27,551	25,336
Portsmouth Corpn...	,, 4	558	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 6	3,537	—	—	—	—
Southampton Trams	,, 2	713	441	+ 272	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—

b Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine (to April 8), £657 decrease.

Barcelona, £40 increase.

Barcelona Ensanche y Gracia, £71 decrease.

Brisbane (to March 20), £182 increase.

Buenos Ayres and Belgrano Electric (to April 7), £419 increase.

Calcutta, £233 increase.

Cape Town (month of February), receipts, £13,594; expenditure, £5,712.

Mexico Electric (month of April), receipts, £17,500; expenditure, £10,000.

Perth Electric, £357 increase.

Port Elizabeth (month of February), receipts, £3,043; expenditure, £1,203.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-½
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	11/16-13/16
British Electric Works, Ordinary, 50,001-95,000	1 —	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 —	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 —	85-90
British Insulated Wire, Ord., 1-70,000	5 —	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6½
—— 5 per cent. Mortgage Debentures	100 —	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 —	4½-5
Brush Electrical Engineering, Ordinary	2 —	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2 —	2-2½
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 —	101-103
Callender's Cable, Debentures	100 —	109-113
—— Ordinary	5 —	14½-15½
—— 5 per cent. Pref.	5 —	5½-6
Crompton and Co.	2 —	3½-4
—— 5 per cent. Debentures	— —	101-104
Edison and Swan United, Ordinary	2 —	1½-1¾
—— 5 per cent. Debentures	5 —	3-4
—— 4 per cent. Deb. Stock, Red.	100 —	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	— —	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2 —	1½-2½
—— 7 per cent. Cumulative Pref.	2 —	2½-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	101-104
Gitre Electro-Chemical and Power, Ord., 20,001-180,000	1 —	0-¼
W. T. Henley's Telegraph Works, Ordinary	5 —	15½-16½
—— 4½ per cent. Preference	5 —	5½-6
—— 4½ per cent. Debentures	100 —	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 —	20-21½
—— 4 per cent. Debentures	100 —	101-104
Telegraph Construction and Maintenance	12 —	36-40
—— 5 per cent. Bonds	100 —	101-104
Telegraph Manufacturing, Ordinary	5 —	10½-11½
—— 5 per cent. Cum. Pref.	5 —	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 —	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 —	6½-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 —	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 —	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75 —	70-75
Bournemouth and Poole, Ordinary	10 —	11½-12½
—— 4½ per cent. Cum. Pref.	10 —	10-11
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 —	7½-8½
—— 7 per cent. Preference	5 —	8½-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5 —	7½-7¾
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 —	5-5½
Chelsea Electricity Supply	5 —	5½-6½
—— 4½ per cent. Debentures	100 —	109-112
City of London, Ordinary	10 ..	8½-9½
—— 6 per cent. Cumulative Pref.	10 —	12-13
—— 5 per cent. Debenture Stock	100 —	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	— —	101-103
County of London and Brush Provincial, Ordinary	10 —	8-9
—— 6 per cent. Cum. Pref.	10 —	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 —	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 —	5-5½
—— 6 per cent. Cum. Pref.	5 —	5½ 6 xd
—— 4½ per cent. First Mort. Deb.	100 —	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p c. Cm. Pf., 1-20,000	5 ..	4½-5½
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5-5½
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 —	11-12
—— 4 per cent. Debenture Stock, Red.	100 —	102-105
Kensington and Knightsbridge and Notting Hill	100 —	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9½-10½
London Electric, Ordinary	2 —	1½-1¾
—— 6 per cent. Pref.	5 —	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	98-101
Metropolitan, Ordinary	10 —	12-13
—— ,, 85,001-98,769	5 —	11½-12½
—— 4½ per cent. First Mortgage Debenture Stock	100 —	110-113
—— 3½ per cent. Mortgage Debenture, Red	100 —	96-99
Notting Hill Electric Lighting	10 —	15½-16½
Oriental, 1879	1 —	1½-1¾
—— £5 Shares	5 —	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 —	5½-6½
River Plate Electric Light and Traction, Deb.	100 —	65-75
Royal Electrical Company of Montreal	$100 —	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100 —	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 —	2-2½
—— 4 per cent. Debenture Stock	100 —	80-90
South London, Ordinary	5 —	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5 —	14-15
—— 7 per cent. Pref.	5 —	8½-9½
—— 3½ per cent. Deb.	100 —	98-101
Westminster, Ordinary	5 —	12½-13½
Electric Railways.—		
Central London, Ordinary	10 —	9½-9¾
—— Pref. Half-Shares	5 ..	4¾-5¼
—— ,, deferred	5 ..	4¼-5
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 —	52-54
—— Ordinary	10 —	5-5½
—— 4 per cent. Debenture Stock	100 —	113-118
—— 5 per cent. Pref. Stock '91	100 —	122-127
—— ,, ,, ,, '96	100 —	122-127
Liverpool Overhead, 5 per cent. Pref.	— —	12-12½
—— Ordinary, 1-50,000	— —	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	103-104
Waterloo and City, Ordinary	100 —	94-97
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3¾-4½ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 —	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-3½
—— 5 per cent. Cum Pref., Nos. 1-75,000	5 ..	4½-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs all pd.	100 ..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 —	6¾-7½
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-10½
—— 4½ per cent 1st Mt. Debs., Nos. 1-5,250 of £40 each	40 ..	99-101
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 —	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 —	119-122
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1½-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5½-6¾ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	5-5½ xd
—— 5 per cent. Deb. Stock, Red.	100 —	104-107
—— Prov. Cert., all paid	100 —	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1 —	1½-1¾
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 —	3½-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 —	3½-3¾
—— 6 per cent. Cum. Pref.	10 —	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 —	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 —	10-11
—— 4½ per cent. Debenture Stock	100 ..	107-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent Preference	6s. ..	¼
—— £50,000 ,, ,,	1 —	1
—— £500,000 4½ per cent. Debenture Stock	1½ ..	1½
Telephones.—		
National Telephone, Ordinary	5 —	3½-3¾
—— 6 per cent. Cum. First Pref.	10 —	10-12
—— 6 per cent. Cum. Second Pref.	10 —	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 —	4-4½
—— 4 per cent. Deb. Stock, Red.	100 —	95-98
—— 3½ per cent. Deb. Stock, Red.	100 —	87-90
Oriental Telephone and Electric Company	1 —	15/16-1 1/16

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THE CONSUMERS' DEPARTMENT OF A CENTRAL STATION.

(Continued from page 512.)

When circumstances arise such as those previously described, and it is quite obvious that the contractor or his representative is ignorant of the job he has taken in hand, it is by far the best policy for the inspector to help him out of the difficulty, although the author is sadly afraid that this is rarely done. For reasons best known to themselves, a number of central-station engineers and their assistants show very little courtesy towards contractors for wiring installations, and very often appear to take a sort of fiendish delight in finding fault with their work. Do not let it be thought for a moment, however, that much sympathy should be shown for the contractor who connects a motor up in the manner shown, for such people should not be allowed to do electrical work. The worst of the matter is, however, that if any trouble is experienced in getting the supply connected, the party who suffers most is the one to whom no blame whatever is attached—viz., the consumer. If when the inspector makes the first visit to an installation he finds a few trivial faults and refuses to connect the supply until these are remedied, the consumer is generally annoyed about not being able to get his light on. If on the second visit all the points have not been attended to and the connection to the mains is still refused, the consumer will probably give vent to his feeling in a manner better imagined than described, but you can depend upon it that remarks will fly about not flattering to corporations and their officials. The author has always made a practice of connecting installations conditionally, if the faults were only trivial and could be easily done after the current was on. Of course, this is a point upon which the inspector must use his own discretion.

Before leaving the subject of motors, it would be as well to suggest that a practice be made of measuring the starting current of the motor, or, rather, the current which can flow through the armature when it is at rest and all the starting resistance in series with it. This should be kept within reasonable limits, which limits should be decided according to the conditions of the supply, and whether the motors are connected across the outers of a three-wire system or between one outer and the middle wire. Unless the starting resistance is constructed in such a manner that it is physically impossible to cut out the resistance quickly, some sort of electrical cut-out should be insisted upon which will open the circuit if too much current is allowed to pass, owing to the motor not being started properly. After the consumer has had his motor for a little time, he will soon learn the necessity of allowing the machine to come up to speed on each contact of the resistance before cutting another one out. A number of very good starting resistances are upon the market now, provided with both maximum and minimum cut-outs, which are so arranged that in the event of either acting, the starting resistance will automatically come into circuit with the armature.

If the system of supply is a multiple-wire one, such as three or five wire, great attention should be paid to the balancing of the consuming devices across the distributors. The importance of this will depend to a large extent upon the system which is employed for feeding the network from the generating station. If two-wire feeders are employed, it is very essential that the load on either side of the middle wire be kept as equal as possible, as, if this is not attended to, a large current will flow in the middle conductor, and if the balancing sub-stations are not sufficient in number, or are not properly spaced out, an unequal pressure will be the result; and if a consumer has circuits on his premises supplied from both sides of the system, the difference will be particularly noticeable. It is not sufficient that the network as a whole should be well balanced, for it might happen that the total balancing was practically perfect, and yet the balancing in a particular street might be very bad, which would mean that the light on one side of the system in that particular street would also be bad. Each street, therefore, should be balanced in itself, and if the installations are of any magnitude, they should also be balanced in themselves. The work of balancing installations and the making of arrangements with the contractors for grouping circuits in the proper manner, will come under the head of the consumers' department. When arranging the balancing of a large installation, the installation inspector should not only take into consideration the total number of lamps and other consuming devices, but should be guided by what will be the average working load. If, for instance, a large installation has to be connected, and it consists of both basement lighting (or long-hour lamps) and also of lamps which will only be used during ordinary lighting hours, then each system of lamps should be balanced in themselves. Take a case of a warehouse installation of 190 lamps, 100 of which are short-hour lamps and the remaining 90 long-hour lamps, the system of supply was a three-wire one, and the contractor had divided the installation into four circuits. Let us suppose that the circuits were divided as follows: 50 lamps, 60 lamps, 30 lamps, and 50 lamps, and that the two circuits of 50 lamps each were the short-hour lamps and the other two the long-hour ones. The proper way to arrange this would be:

	50	50
	60	30
Total	110	80

If, however, they were arranged in the following manner,

	50	60
	50	30
Total	100	90

the total balancing when all lamps were lighted would certainly be better than in the previous case, but this would only happen one or two hours per day during the winter months, whereas during the summer time it would probably never occur, and the whole of the basement lighting would be supplied from one side of the system.

When an installation has been connected, the balancing should always be verified by putting on all switches in the place and, after taking out one of the outer fuses, going round the installation and making a note of the number and candle-power of the lamps which light up. The same must then be done on the other side, by replacing the first fuse and taking the one out on the other outer. The mains engineer should be kept posted up with the balancing of the installations, in order that he can tell at once to which side of the system a new consumer must be connected, if it is an installation which only requires a two-wire service. The polarity of the mains should also be tested by the installation inspector or his representative, as it will serve as a check and ensure that the mains engineer's instructions have been properly carried out by the jointer. All apparatus on the consumer's premises belonging to the undertakers should be carefully sealed, so that it can at once be seen if it has been tampered with. It is advisable to obtain a signature from the consumer or his representative when the connection is first made, as if there is any fixed charge involved in the method of charging it is essential that one should have proof that the current was put on upon a certain date.

After an installation has once been connected it is very often left to look after itself, and probably no visit will be made to it until a compaint arrives from the consumer to say that the light has gone out. This, however, should not be the case, and periodical inspections and tests should be carried out in a systematic manner. I am not only referring to the installation itself, but also to the undertaker's apparatus which is fixed in connection therewith, such as fuses, meters, etc., as these are certain to get dirty after a time, and contacts are almost bound to work loose. On the occasions of these inspections, which, by the way, can be made by youths of about 18 years of age, all main fuses should be taken out and lugs taken off the cut-outs, the whole being thoroughly cleaned before being put back again. The meter connections should also be examined and tightened up if necessary. It is also a good practice to test the meter for starting at each

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of these visits, a small candle-power lamp being carried by the assistant for this purpose; and if the meter is found to be faulty, and cannot be put right on the spot, the matter should be at once be reported to the head of the department, who will see to it being changed without delay. The number and candle-power of the lamp should also be taken, and if the installation is supplied from more than two wires, the balancing should be checked; an insulation test of the installation and meter should be made, and a record kept of all particulars. If these periodical inspections are properly carried out, the installation will be kept in better condition, and the chances of the light failing will be reduced. The continuity of supply is the main thing to aim for, and the expense of these inspections should not be grudged if they assist towards this end.

(To be continued.)

BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Polyphase Equipment of Factories.

BY W. WYLD, ASSOCIATE MEMBER.

Before proceeding to the subject which we are to discuss this evening, I wish to express my thanks to the chairman and members of the committee for the honour they have done me in asking me to read the first paper after our chairman's inaugural address to this local section of the Institution. I had a great amount of diffidence in accepting the invitation, for I felt that this honour should have been for some older member of the profession who had been longer associated with this locality, for I am a comparative stranger here. It was urged, however, that the work upon which I have recently been engaged was a subject which would bring forth a good discussion, and it is therefore rather a subject for discussion which I wish to bring before you than a paper in the ordinary meaning.

Considering the number of the large power schemes which are now about to be started throughout this country, and seeing that one is to be right in our midst in this district, it is a very opportune time, I think, for a discussion to be held on the system upon which most of these schemes are to be worked, with particular reference to its applicability to the driving of factories, as I think it is from this source that the promoters of these schemes hope to derive a great proportion of their revenue, and, on the other hand, by which the public is supposed to be benefited. Most of these large power schemes are to be on the polyphase system for the generation and transmission of the electrical energy, but whether it is to be distributed from the sub-stations as continuous or alternating current I am not at all sure; but I expect that this matter will very much depend upon the nature of the demand—*i.e.*, whether the consumers will have an alternating-current supply or not; but if the current can be distributed as polyphase alternating current, the cost of converting it into continuous current will be saved and the cost of distribution thus diminished, and the consumer supplied at a cheaper rate per unit.

We are all fully aware of the inefficiencies of the old—the present, in too many instances—methods of driving factory machinery, whereby at least 40 to 50 per cent. of the power is lost in transmission, and probably 10 to 15 times more fuel consumed than necessary. We also all fully recognise the many and great advantages of electric driving, so that there is no necessity to here eulogise them. There are, however, great differences of opinion as to the best methods of obtaining the best results of electric driving in factories. I do not mean to enter into the *pros.* and *cons* of the different systems of applying motors, etc.—*i.e.*, by either single-motor driving or group driving—but I refer to the differences of opinion which exist upon the system of current to be used—viz., continuous or alternating. The continuous-current system has been the most commonly used until recently, particularly in this country, and is therefore the better known. For this reason I will not take up your time by describing it, as it is familiar to all of us; but as the alternating-current system may not be so familiar, and as it is probable that it will be much more used in the near future, I purpose giving a closer description of it. The alternating-current system may be divided into single-phase and polyphase systems. The single-phase system, however, is not particularly adapted for motor driving, although it is perfectly practicable; the difficulty with single-phase motors being to get them to start on a load. There are, however, in this country about 80 towns supplied with single-phase alternating current, and in most of these towns there is some motor load.

Polyphase System.—Any arrangement of conductors carrying two or more single-phase alternating currents definitely related to one another in point of time may becalled a polyphase system. Although this system has really only come into use to any extent in this country within the last year or two, it is by no means new. It dates as far back as the year 1879, when Walter Baily showed, in a paper read before the Physical Society of London, how Arago's rotation could be produced by a number of fixed electromagnets acting upon a copper disc. This paper is published in the *Philosophical Magazine* of October, 1879, which gives diagrams illustrating this principle of the invention and arrangement of apparatus. The latter consisted of a copper disc suspended in the centre on a needle point, so as to be able to revolve. Under the disc four electromagnets were placed, with their vertical axes equidistant from the centre and their poles close to the under surface of the disc. It is interesting to note that these magnets had laminated cores. The exciting currents were supplied by two batteries, and a commutator was placed to alternatively reverse the polarity of the field magnets. Baily says: "The experiment with four electromagnets may be readily performed by means of a commutator which will reverse the current several times per second, so he evidently recognised that reversals rapidly succeeding each other would give an increased effect." We have here all the important features of the modern two-phase motor embodied in an apparatus invented 22 years ago.

The next important step in the development of the induction motor was made by Prof. Galileo Ferraris, who constructed several two-phase motors in 1885, which were on view at the headquarters of the American Institution of Electrical Engineers at the Chicago Exhibition. The description of these motors was only published in March, 1888, but before then two other patents for motors of this kind were taken out, one by the Helios Company, of Cologne, in May, 1887, and the other by Borel and Paccaud in February, 1888. Then, three months later, we have Tesla's very complete specification for power transmission by two-phase alternating currents, and after that come many others. The production of a rotary field in the motor was explained by Tesla to be produced by employing two alternating currents of equal frequency, but having a phase difference of 90deg. If we build a Ferraris motor with three instead of two pairs of magnets, and energise them by three alternating currents with 120deg. phase difference between any two, we shall obtain a rotary field, and so on for any larger number of phases. There is, however, no advantage in employing more than three phases, whilst the multiplication of circuits constitutes an undesirable complication, so that for practical work the choice is limited to either two or three phases. In the two-phase system the two E.M.F.'s and currents are 90deg., or one-fourth of a cycle, apart, hence the relations of the currents to each other are such that the maximum of one occurs when the value of the other is zero. The windings of a polyphase machine may be connected in a number of ways, each affecting the relation of the E.M.F.'s of the outside conductors. The winding of most commercial two-phase machines are interlinked. The current in one phase is 90deg. apart from or in quadrature with the other. With a two-phase system either four or three wires may be used. A four-wire system consists of two separate circuits, deriving their currents from two independent armature windings in quadrature with each other, or from a continuous armature winding tapped at four equi-distant points. These two single circuits must be balanced as nearly as possible, and for this purpose the four line wires must be carried throughout the system. By joining two of the four conductors in the four-wire system, a common return is made for the two circuits. This arrangement is known as the two-phase three-wire system. It may here be remarked that a two-phase system with four wires is on a par with a single-phase two-line system; while with a three-wire two-phase system it is more, so far as the economy of copper is concerned. In the three-phase system the three E.M.F.'s and currents are 120deg. apart, and the impulses follow each other at 60deg. Each one of the conductors successively serves as a return for the other two, the algebraic sum of the currents in the system being zero. The windings of three-phase generators are usually connected up in one or two ways—either "star" or "mesh." In the former the coils of the armature are joined to a common junction, from which they branch starwise each to its own line. The pressure between the ends of any two of the generator coils in a three-phase "star" system is $\sqrt{3}$ (= 1·732) times that between the common junction and the terminals of the coils. In the "mesh" connection the coils are connected in series, and the line wires joined to points between the coils, forming a closed triangle without any common centre. An advantage for factory distribution, when transformers are not required, is to be found in the "star" winding, as by its adoption a higher voltage can be used for the motors and a lower one for the lighting, which is a great advantage where incandescent lamps are used. For instance, at the

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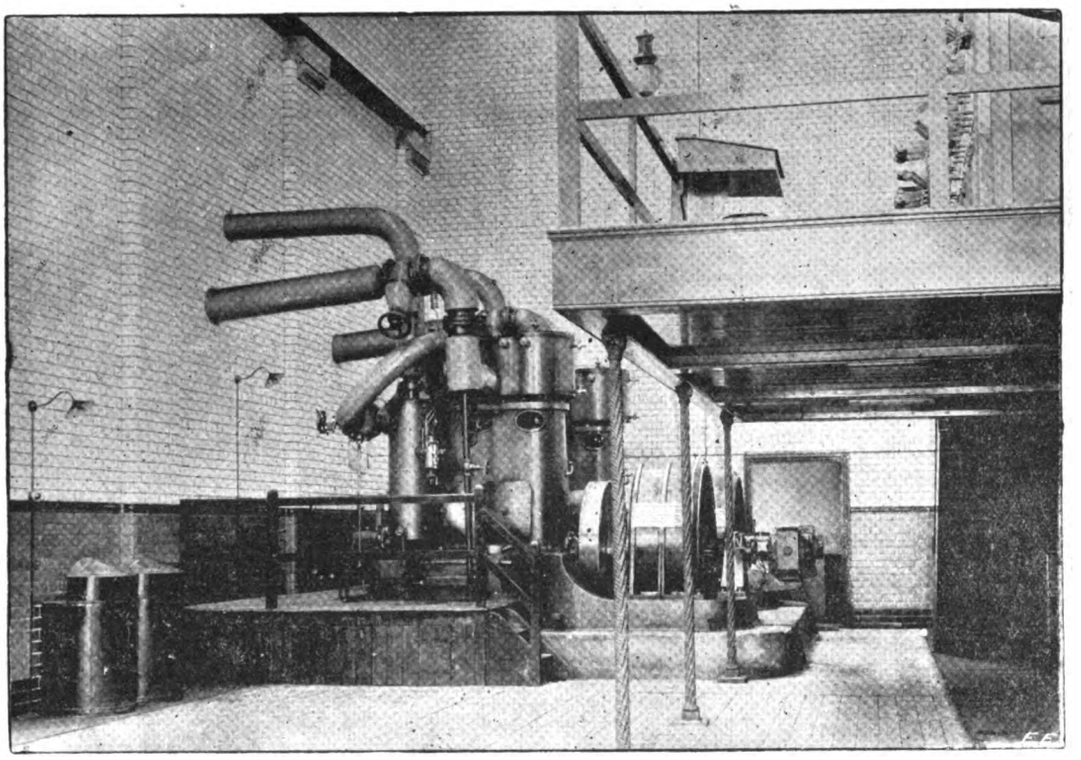
Patent Shaft and Axletree Company's power plant, the generators are "star" connected, the voltage between the three phases which is used for the motors being 350, whilst that from the star connection or common junction is 200, which is quite practicable for lighting circuits. With the three-phase system, as with the two-phase, three or four conductors may be used, but in this case the fourth or neutral wire, which is used when the generators are "star" connected, is only used for carrying the out-of-balance current, and need not be larger than about half the size of the other conductors; and when the generators are connected up in mesh fashion, three line wires are used and then the amount of copper used is about three-quarters that required for a single-phase two-wire distribution. In addition to the economy of copper in distribution, there are other advantages possessed by the three-phase system which will be considered in the next paragraph on motors.

Polyphase motors are of two types—the synchronous and the asynchronous. The synchronous motor is very similar to a generator in its construction. It is not adapted for use where a large starting torque or frequent starting on the load is necessary. It does not admit of independent speed regulation, and it has also the disadvantage of requiring certain station appliances, as with a generator, including some source of exciting current, which is usually obtained from some source other than the motor. From these reasons, then, it will be seen that the synchronous motor is not adapted for factory driving.



View of the Three-Phase Generating Plant at the Patent Shaft and Axletree Company at Wednesbury.

Asynchronous motors, on the other hand, are well adapted for factory driving. Their simple and substantial construction is one of their chief advantages, resulting in a minimum of cost of maintenance and attendance. An asynchronous motor consists essentially of two parts, the stationary and the revolving part. In most modern motors the stationary part, or "stator," contains the coils through which the high-pressure current passes from the line. The polyphase currents flowing through these coils produce a rotating magnetic field. This field acts upon the revolving part, or "rotor," and induces in it currents which magnetise it, so that the rotor takes the part of magnet, but is only excited by the induced currents from the surrounding stator, hence these motors are often called "induction" motors. The principles of operation of the induction motor are thus seen to combine both those of a motor and of a transformer, the "stator" being considered as the primary and the "rotor" the secondary. When running without load the speed of the rotor is very nearly that of the rotating field produced in the stator, or nearly synchronous, and then there is a very small current induced in the secondary. The magnetic pull of this current on the field produces a feeble torque, and then the current taken from the line into the stator is only the magnetising current required to overcome the mechanical and magnetic friction of the motor. When running under load, the speed of the rotor falls by a small percentage, and the E.M.F. and the induced currents in the rotor increase with the difference in speeds, and a powerful torque is produced by the pull of this increased current in the rotor. The difference of the speed of the rotor and that of the revolving field in the stator is known as the "slip," and this is proportional to a certain extent to the resistance of the rotor. To insure high efficiency and good regulation the windings of the rotor or secondary of the induction motor should have a low resistance. It will be seen, then, that the greater the load put on an induction motor (up to a certain extent) the greater the slip will be, in order that, at constant voltage of supply, the motor will have a correspondingly greater turning effort. Absolute synchronous speed is never obtained in an induction motor, for, as has already been shown, there is, even on no load, a certain amount of "slip" required to furnish the current necessary to overcome the light load losses. The fall of speed, from that at light load to that at normal rated load, will vary from 1·5 per cent. in motors of 100 h.p. to 3 or 4 per cent. in smaller motors.

It is sometimes said against the induction motor that it is inflexible in respect to the regulation of speed, but there are several methods of obtaining a variation of speed in an induction motor. The three most usually adopted methods are: (1) the inserting of a resistance in the rotor circuit which may be varied by short successive steps; (2) by changing the impressed voltage of the stator; (3) by changing the number of poles of the stator. The first one is the most commonly used in factory driving, particularly in Europe, on such motors as are used on cranes or printing machinery, etc. The range of speed demanded of such motors does not allow of the usual small starting resistances being used, which in some makes of motors, particularly American, is placed within the spider of the rotor. An external rheostat is therefore required of sufficient size to carry the comparatively large though low-pressure current of the rotor. This external resistance or controller necessitates the use of three collecting rings for electrically connecting it with the rotor. It has already been mentioned that the current taken by the stator, as well as the torque of an induction motor, depend upon the ratio of the "slip" of the rotor to its resistance. Therefore, by altering the rotor resistance, the speed of the motor may be altered, and the torque and the stator current kept the same. The second or potential variation method is effected by introducing an external resistance and impedance between the supply terminals and the stator. By having a sufficient number of tappings on the impedance coils, a graduated variation of the impressed voltage is obtained and a corresponding variation in speed. It is found, however, in practice that the motor thus controlled has a lower efficiency at full speed than a motor built for rheostatic control. A motor with rheostatic control has the same power factor at all speeds, whilst one with potential control has a lower power factor and efficiency at all but full speed. The third method, changing the number of poles, is effected by winding the stator so that by the movement of a switch the number of poles is changed. Where, however,

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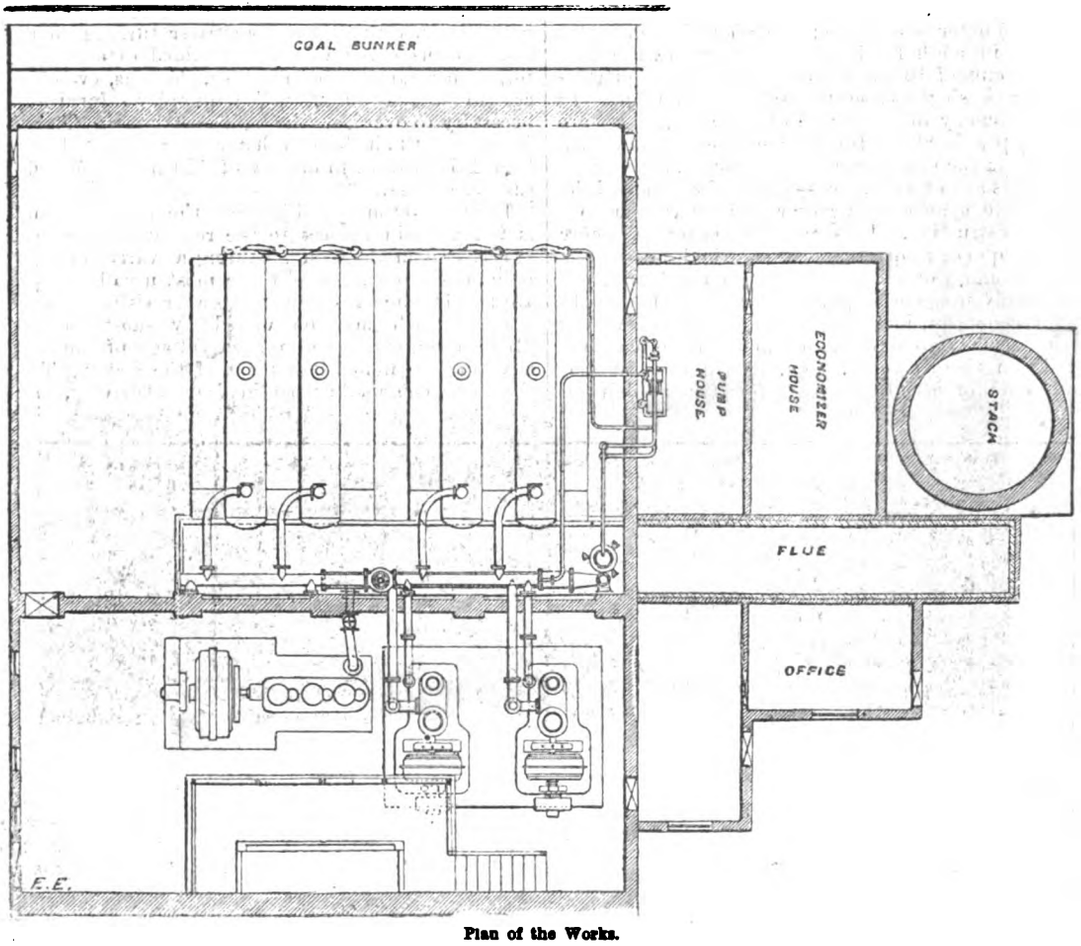
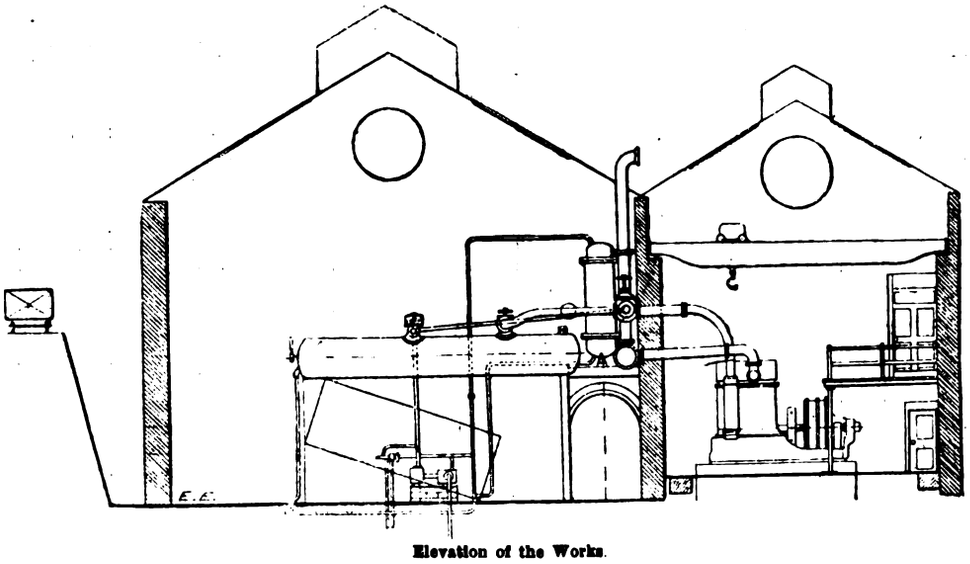
a great variety of speeds is required, this method is complicated. It also has the disadvantage of the motor only being able to run at full, one-half, and one-quarter speed. This class of variable-speed motor is the most efficient at half and quarter speeds. Of these three methods of controlling the speed the potential one is inferior to the rheostatic one, inasmuch as it is not so efficient, and the changing of number of poles is limited in its range. The worst feature of the best one, the rheostatic method, is that it necessitates collecting rings on the motor; but it must be borne in mind that these collecting rings carry a very low-potential current, and my experience of them has been that they give no trouble whatever, and I have now to the continuous-current motor, we see the main difference is that the current supplied to a polyphase motor at the full pressure of the mains simply passes through the "stator" windings, which are quite enclosed, and without having to traverse any exposed parts, such as commutators or brushes, and as these windings are stationary there is no danger of mechanical injury, and the insulation can be made very secure, and so enabled to stand a higher pressure than would be permissible with a continuous-current motor. This is the most important point in favour of the induction motor. The revolving part, or "rotor," of the polyphase motor is always of low voltage, requiring very little insulation, and can thus be very much more strongly and mechanically built than a continuous-current motor with its revolving armature, through which has to pass the full pressure current, and if this is of high voltage the winding of the armature has to be of fine wire and expensively insulated, and which is thus much more liable to burn out than the rotor of a polyphase motor. The continuous-current motor requires a commutator to commute the continuous current into an



Plan of the Works.



Elevation of the Works.

several running on cranes of from five to twenty tons, some of which are run under very severe and trying conditions.

Let us now consider the relative advantages of the polyphase motor over its rivals. The single-phase motor, though an induction motor, has the disadvantage of being unable to start on a load, as well as being invariable with respect to speed. In other respects it is similar to the polyphase motor. Coming

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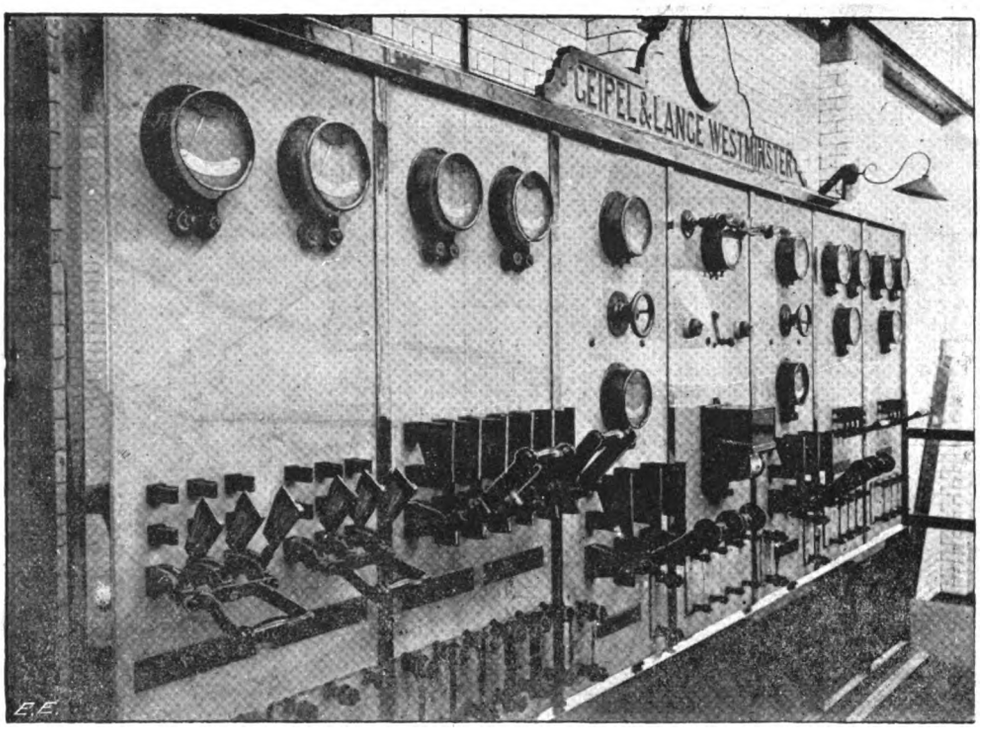
alternating one as it enters the armature; this necessitates the use of brushes for a rubbing contact, and these require a good deal of attention from time to time for trimming and readjustment, and the commutators occasionally require turning up, and this pretty frequently if there is any sparking, which is often, if not always, the case, particularly when run in dirty and dusty places. Now, the polyphase motor does not require any commutator at all, and is thus freed from a very expensive and, at the best, a very undesirable part which is essential to the continuous-current motor. Owing to the frailty of the continuous-current motor and the frequent sparking at the commutators, of late they have been made entirely enclosed; but this is undesirable, as it requires the motors to be larger and heavier for the same output, for the ventilation is not nearly so good as when open to the atmosphere, and, in addition, the various parts are not accessible. With polyphase motors, and especially those with squirrel-cage motors, there is absolutely no chance of the occurrence of a spark except at the starting switch, which may be placed at a distance from the motor. This is an important point when the motors are used in factories containing highly inflammable materials, or in fiery coalmines. The sizes of three-phase motors are less and the weights lighter for the same power and efficiency than those of continuous-current motors, and as there are no exposed parts such as brushes, etc., carrying the full voltage current and no adjustment required, the polyphase motor is simpler and consequently much more suitable to be left in the charge of an unskilled workman. Seeing these many and great advantages of the polyphase system, it is not surprising that so many factories, both old and new, are now being equipped with this system of driving. It is not many weeks since I heard one of the leading continuous-current engineers in the Midlands (and I believe he is here to-night) remark that even yet, with all the talk there is about the absolutely non-sparking continuous-current motors, that he had great difficulty in getting a really satisfactory continuous-current motor, for he said, "Even those of the best and well-known makers, after he had had them running a few months or a year, showed their weak points and gave trouble." It is often remarked that the polyphase system, although best adapted for motor driving, is not adapted for lighting. I do not think that anyone would think of putting down a polyphase



The Three-Phase Switchboard at Wednesbury.

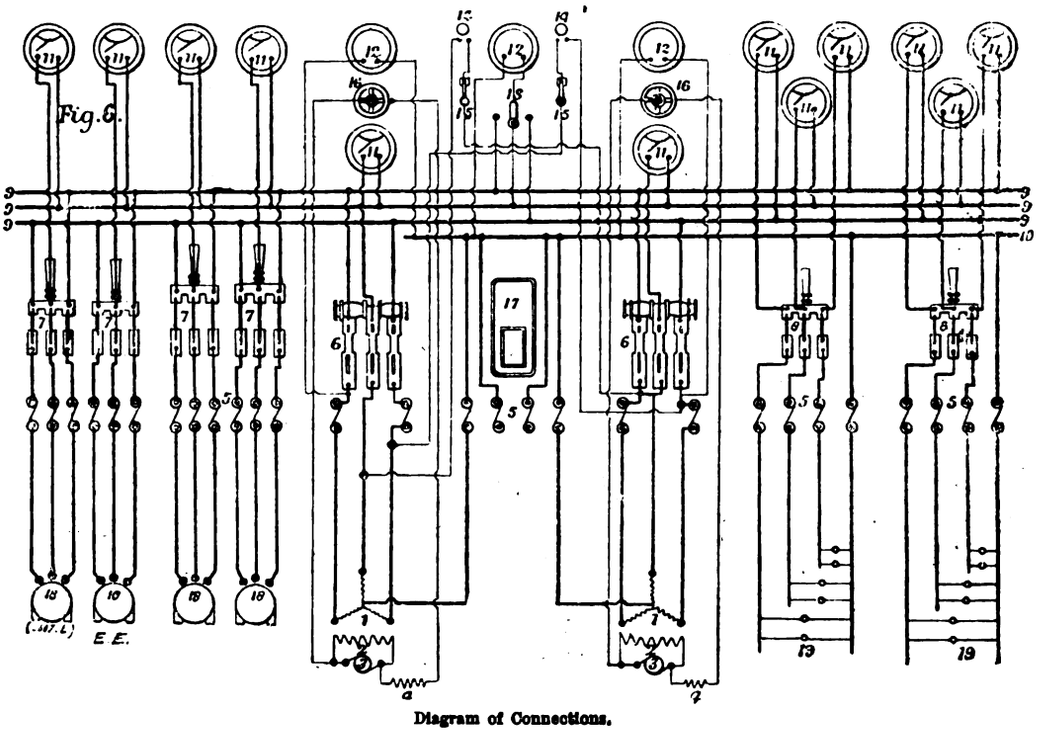


Diagram of Connections.

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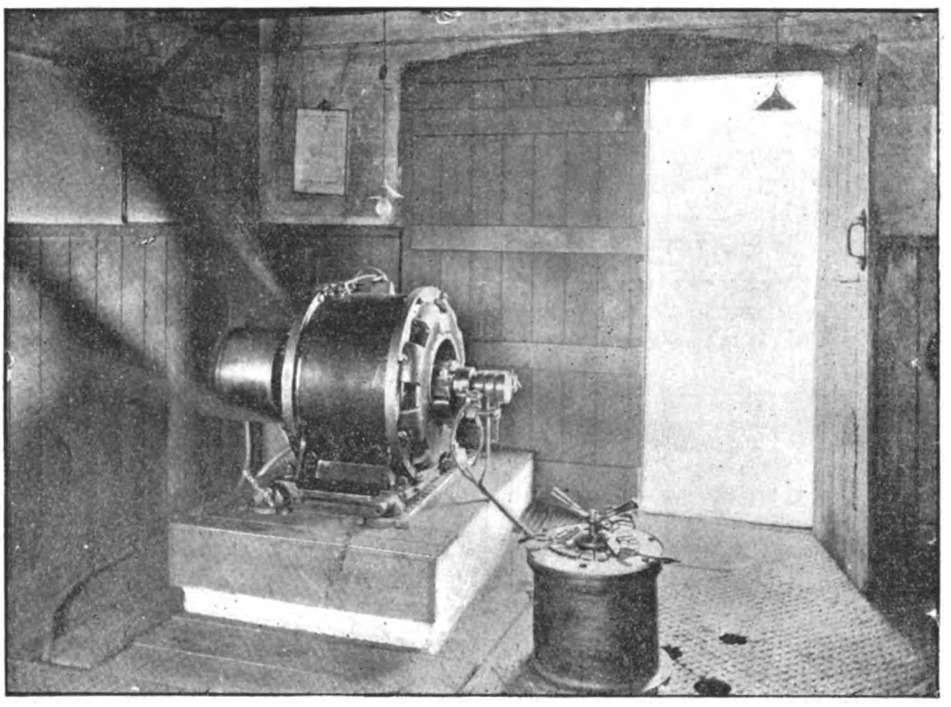
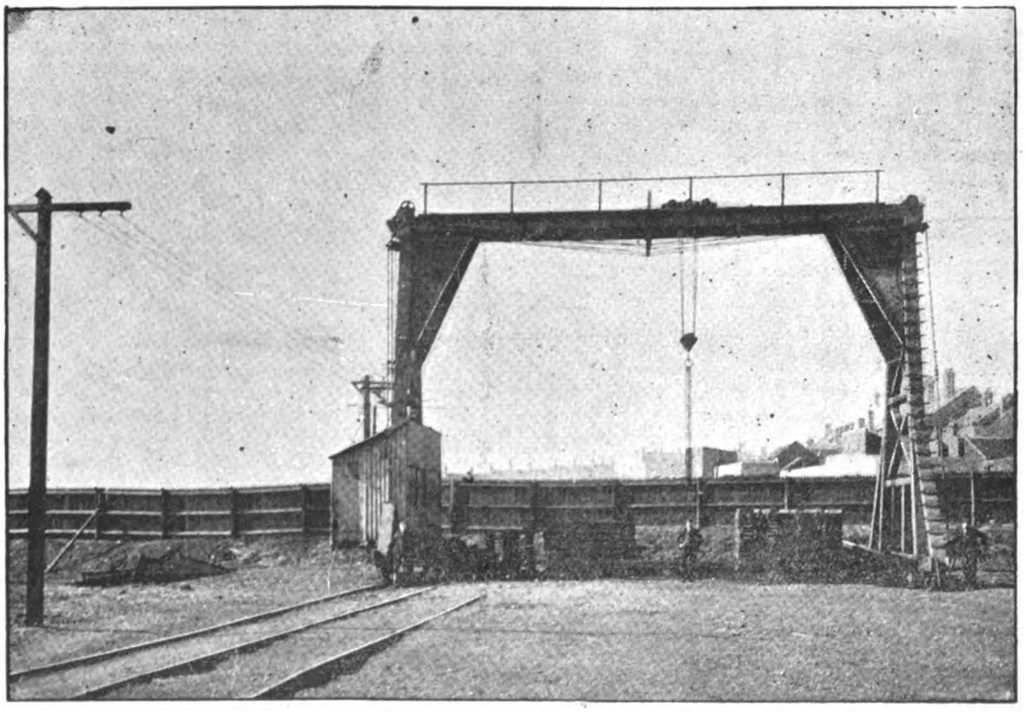
plant for lighting alone, but the advantages which it holds over other systems for motor driving are much greater than the objections raised against it for lighting, and warrant its adoption in such places as factories, and my experience is that by distributing the lighting evenly between the phases that no difficulty whatever is experienced.



Typical Arrangement of Motor and Starting Rheostat—the Motor taking up only a small fraction of the space previously occupied by the Steam Engine it replaces.

In America the induction motor has come more into general use than in this country, and I think it is very significant to note that such a firm as the Westinghouse Company, who make both polyphase and continuous-current machinery, have equipped their new works at Pittsburg with polyphase motors. Some 17 of the 60 induction motors replaced continuous-current motors which were originally put down to work the hoists. In addition to those given in the appended list there are numerous other factories being driven by polyphase motors supplied with current from such large stations as the Niagara plant and several large three-phase power-distributing companies on the Pacific coast. In Europe, too, there are many striking examples of polyphase factory plants, and those of us who attended the *réunion* in Switzerland two years ago will remember the Oerlikon Company's large engineering works at Zürich, where all kinds of electrical plant is built and where the whole works are driven by three-phase motors. Originally three generators of 200 h.p. each were installed, but since then other two units of about 600 h.p. each, coupled to Sulzer engines, have been added, thus bringing the capacity of the plant up to about 1,800 h.p. There are 94 motors throughout the works, including some 18 cranes with a total lifting capacity of 220 tons. All of these are equipped with three-phase motors. Messrs. Escher, Wyss, and Co.'s works, also at Zürich, it will be remembered, are driven throughout by about 100 three-phase motors. The fine shops of Messrs. Brown-Boveri Company at Baden, too, many of us will remember, are driven by about 100 three-phase motors. Also the Alioth Electrical Company's new works at Münchenstein, near Bale, which are driven throughout by three-phase motors. I remember asking the managing director of these works his opinion as to continuous-current and polyphase motors, and was informed by him that they had a few continuous-current motors connected to a generator, only used to show to clients who preferred continuous current, and I was



Goliath Crane, worked by Three-Phase Motors.

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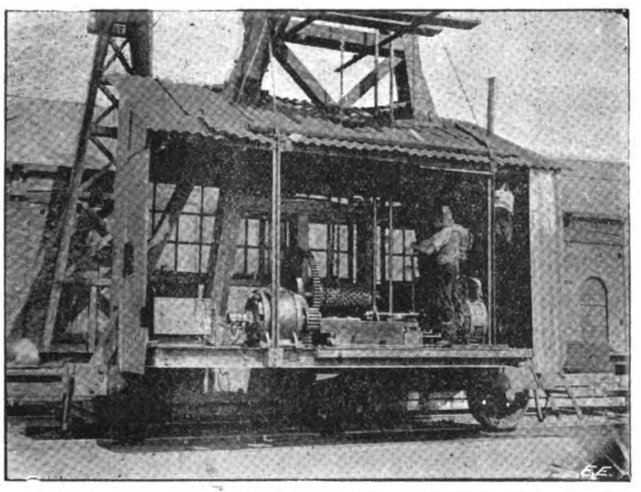
assured by him that they found the three-phase plant by far the more preferable.

The number of factories driven by polyphase plants is much too great for them to be described here, but I have made a list of some of them, thinking it might be of interest to some of the members. This list, I regret to say, is not complete, but it is large enough, I think, to show that polyphase factory driving, though somewhat uncommon in this country as yet, is by no means an experiment. In addition to those given in the list of European plants, there are several very large works in Germany, some of which many of us are looking forward to see at the next *réunion* on the Continent in the course of a few months, notably those of the Allgemeine Elektricitäts-Gesellschaft at Berlin, which cover an area of 125,000 square yards, and in which some 14,000 people are employed, and where the whole of the machinery is driven by three-phase motors, many of the tools being driven by separate motors. (They have about 700 motors in all.) The list of examples of polyphase factory plants of which I have been able to get a few details is much too long to read now, so I will only give a summary.

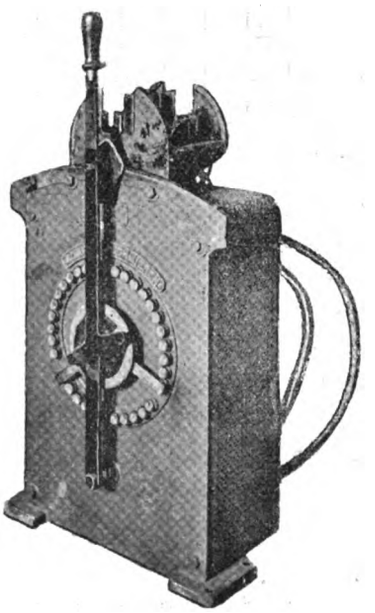
Summary of Examples.

United States of America	5	plants,	aggregating	7,130 h.p.
Sweden	2	,,	,,	4,105 ,,
Germany	15	,,	,,	7,685 ,,
Holland	1	,,	,,	450 ,,
Belgium	6	,,	,,	3,550 ,,
France	8	,,	,,	2,182 ,,
Spain	1	,,	,,	1,300 ,,
Switzerland	9	,,	,,	5,850 ,,
Austria	4	,,	,,	1,555 ,,
Italy	22	,,	,,	12,035 ,,
Russia	16	,,	,,	12,700 ,,
England	18	,,	,,	9,450 ,,
	107			68,192



View of Machinery for Goliath Crane.

A brief description of some of the English polyphase plants may be of interest. The first combined power and lighting plant was installed at Liverpool for the Grain Storage and Transit Company in the early part of 1897. It is a three-phase plant of 180 h.p. The lighting and power are both derived from the same circuits, and in spite of the antipathy to this practice, no difficulty has been experienced in the regulation. About this time (1897) a small three-phase plant of about 100 h.p. was installed in Glasgow, and another of about 130 h.p. in Edinburgh. In the same year Sir Thomas Richardson and Sons, of Hartlepool, laid down a large plant aggregating about 1,250 h.p. There are two large flywheel generators and a smaller machine of 100 kw. for night shifts. In the shops are installed some 25 motors, which vary in size from 65 h.p. to 10 h.p. In 1898 the General Electric Company, of Manchester, put in a three-phase plant at their factory in the Adelphi, Salford. The generator is of 200 h.p., and the motors, 30 in number, vary from 16 h.p. to ¼ h.p. The Bristol Carriage and Wagon Company about this time had their works remodelled, and a polyphase plant of 400 h.p. was installed. There are seven motor circuits, one to each shop, and the motors, 10 in number, vary from 65 h.p. to 2 h.p. each. There are 750 incandescent lamps and 32 arcs supplied from the same generator as the motors, and no difficulty has been experienced with the regulation. This plant has given such satisfactory results that another 400-h.p. generating set is being added. The Anglo-Swiss Condensed Milk Company's factory at Aylesbury is equipped with a three-phase plant; the eight motors installed vary in size from 10 h.p. to 1½ h.p. each. At the North-Eastern Steelworks, Middlesbrough, there is a two-phase plant, consisting of two generators of 350 h.p. each, and 11 motors—six of 40 h.p., five of 20 h.p. Messrs. D. Y. Stewart, of Glasgow, have a three-phase plant of 450 h.p., consisting of two generators of 250 h.p. and 200 h.p., and a large number of motors. Messrs. Beyer and Peacock, of Manchester, have a three-phase plant of 400 h.p., consisting of two generators of 200 h.p. each, and a large number of motors of 50 h.p., 30 h.p., and 20 h.p. each. Messrs. Hawthorn and Leslie, of Newcastle-on-Tyne, have a three-phase plant of 280 h.p. for driving the machines in their shipyard. Messrs. Dixon and Co., of Glasgow, have a three-phase plant of 660 h.p., consisting of three generators of 220 h.p. each, and a large number of motors for various purposes in their chemical works. The Kirkstall Forge Company, of Leeds, have a 150-h.p. three-phase plant in their works. Messrs. Brown, Marshall, and Co., of Birmingham, have a small three-phase plant of about 70 h.p. in their carriage and wagon building works for driving the machinery in one of their shops. Messrs. John Thompson, boilermakers, Wolverhampton, have recently installed a three-phase plant of 460 h.p., consisting of two direct-coupled steam alternators of 230 h.p. each, and a corresponding number of motors. Messrs. Jos. Rogers and Son have recently installed in their large cutlery works in Sheffield a two-phase plant of 320 h.p., consisting of two direct-coupled high-speed generators of 160 h.p. each. These alternators have only eight poles each, which give the low frequency of 21·3 cycles per second. There are seven motors of 25 h.p. to 7 h.p. each, used for working grinding wheels, hoists, fans, stamps, etc. Owing to the low frequency a motor-generator is used for arc lighting. Whilst at the Patent Shaft and Axletree Company's works at Wednesbury we have a plant of 420 h.p., consisting of two three-phase



Combined Starting and Reversing Switch for Crane Motors.

generators of 210 h.p. each, and some 30 motors, varying in size from 50 h.p. to 5 h.p., the small ones being in use on travelling cranes.

As I am connected with this last-named plant, perhaps I can give a few details of it which may be of interest. The power-house, which was built to the designs of the author, comprises boiler-house, engine-room, and the necessary offices, stores, and test-room, and is large enough to accommodate 2,000 h.p. In the boiler-house are four of Messrs. Babcock and Wilcox's water-tube boilers of 200 h.p. each; also a feed-water heater by the same firm. The boiler-house is so arranged that the coal is tipped direct from the railway siding into the bunker opposite the fronts of the boilers. These are fed by either a horizontal duplex Tangye's pump or a Gresham and Craven live-steam injector, which deliver either through the above-mentioned heater or direct into the boilers. The generating plant consists of two direct-coupled sets of 210 h.p. each, running at 375 revolutions per minute. The engines are of the compound two-crank single-acting enclosed type by Mirrlees, Watson, and Yaryan. The generators are of the well-known Brown, Boveri, and Co.'s three-phase type, having rotating fields and stationary armatures, the periodicity being 50, and the voltage across the phases 350. They are "star" connected with a neutral terminal, which, as already stated, serves for the lighting both arc and incandescent lamps at 200 volts. The exciters are direct-driven, their armatures being fixed on an extension of the generator shaft. The switchboard, which is fixed on a gallery commanding a view of the whole engine-room, consists of two generator

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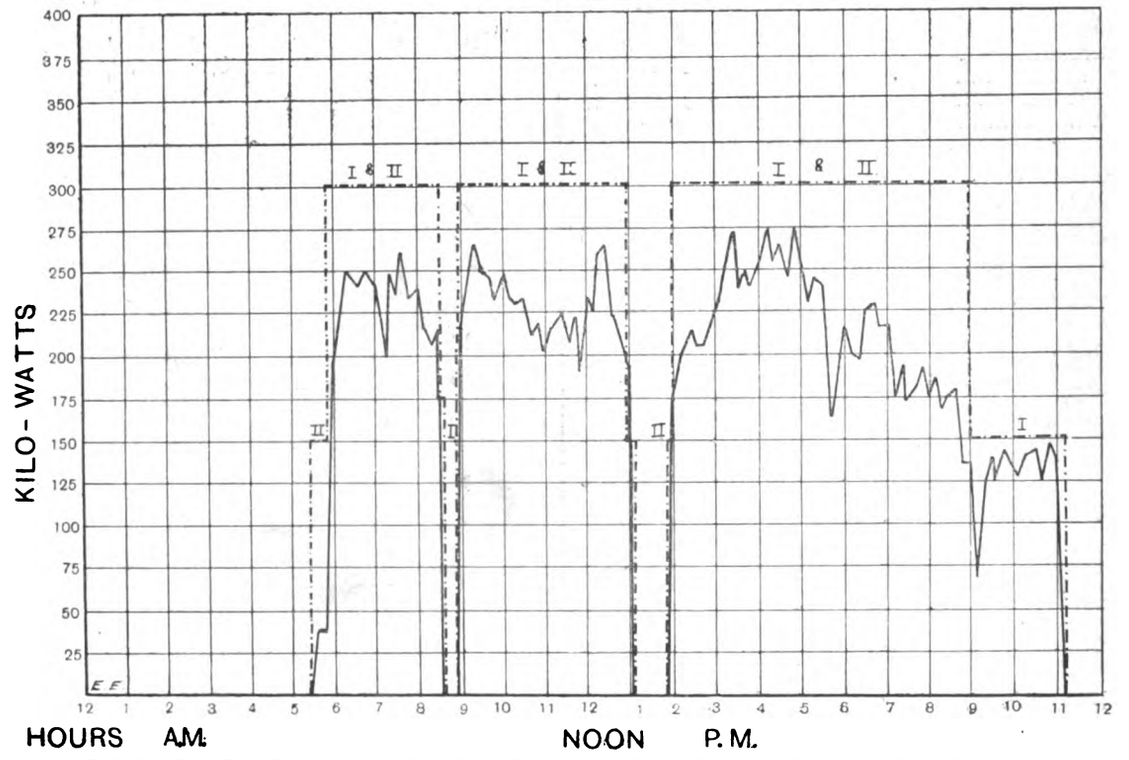
panels carrying main triple-pole switch and fuse, ammeter, voltmeter, and field rheostat, the latter being of the Ward Leonard make, one synchronising panel, having synchronising apparatus, main voltmeter with three-way switch for throwing the voltmeter across any of the three phases, a recording voltmeter and fuses for the neutrals of four generators, two feeder panels (each carrying two sets of triple-pole switches and fuses), and two ammeters, two lighting panels (each carrying one four-pole switch), and three ammeters, one being for each phase. The panels are of polished marble, supported on an iron framing placed 4ft. from the wall, while a glass roof and end doors keep out dust, etc., from the connections and terminals, and provide easy access to the back with a good light. The main cables or feeders are of the British Insulated Wire Company's make, and are drawn into Doulton conduits, the power mains having three twisted cores, while the lighting mains have four cores, the fourth being for the neutral return. The sizes of these cores vary from 37/12 to 19/15. These feeders run from the main switchboard to distributing switchboards fixed in sub-stations at various points in the works. These distributing switchboards carry six power and six lighting sub-circuits each, with triple-pole switches and fuses for the power, and single-pole switches and fuses for the lighting. There are separate bars for power and lighting which can in case of emergency be interconnected by means of plugs, thus providing for supplying the 'bus bars from either power or lighting feeders. A neutral bar is provided to which each lighting sub-circuit is connected, and in each sub-station the lighting circuits are balanced as nearly as possible. The sub-circuits consist of similar cables to the feeders, and are also drawn into Doulton conduits, triple-core for the motors and two-core for the lighting. The motors have been arranged to replace separate engines, and to drive on to the existing shafting in order that no disturbance might be made in converting to the new system. The lines of shafting in most cases have been split up so as to be driven in smaller groups for greater economy.

I may here remark that the whole of the transfer was effected without stopping any of the workshops. One of the Goliath cranes has been converted from steam to electricity; the motor replaced the boiler and engine which were previously used. The reducing gear consists of a raw-hide pinion fixed on the motor shaft of the crane, which operates the various motions. The motor controller is of the Brown-Boveri Company's type, and consists of a reversing switch connected in the stator circuit and controlling resistance in the rotor circuit. These switches are interlocked, and the whole controlled by one lever, so that the motor is started, the speed controlled, and the direction of rotation is reversed by the movement of this one lever. The motor derives its current from three trolley wires fixed on the usual overhead system. In the foundry are two new electric travelling cranes, each operated by three motors. One is for a maximum of 20 tons, and has two motors of 10 h.p. each and one of 5 h.p. The other is a five-ton crane, and has two motors of 7 h.p. and one of 3 h.p. The two larger motors are in each case for lifting and longitudinal motions, and are provided with controlling rheostats for reducing the speed. As a result of experience, 10 additional cranes are now being fitted with three-phase motors and controllers, and another generating set of 500 h.p. is being erected in the power-house. The lighting of the works is done by some 500 incandescent lamps and 60 arc lamps; the latter are run six in series on the 200-volt mains, and no difficulty has been experienced in the regulation, although the lighting is taken from the same generators as the motors. The whole of the wiring for the lighting is enclosed in "Simplex" steel conduits.

Since the plant was started, over a year ago, it has worked most successfully. The economy has been very marked, and will show still better results when all the cranes which are now being converted are electrically driven, and the new plant is in operation. During the recent enquiry of the Parliamentary Committee upon the Electric Power Bills there was a good deal said about the effect of a good load factor upon the cost of generation of electricity. As is to be expected, we get a very good all-day load on my station, and instead of getting a load factor of 11·05 per cent., which is the *average* of all the supply stations given in *Lightning's* table of costs, the load factor for the past year on our station was 42·01 per cent.; and with an output of 554,000 Board of Trade units per year the works cost of generation—viz., coal, water, wages, oil, and stores—work out to the remarkably low figure of ·552d. per unit, whilst the cost of distribution—*i.e.*, the motor attendants, crane men, and arc-lamp trimmers, etc.—works out at ·215d., so that the works cost of the energy delivered at the shafting or machines is ·552d. and ·215d. = ·767d. per Board of Trade unit. I do not mean that this low figure is necessarily due to the plant being polyphase, but I thought that this data would be interesting inasmuch that it bears out to such a marked degree the effect of the load factor on the costs.



Typical 24-Hour Load Curve from the Three-Phase Generating Station of the Patent Shaft and Axletree Company.

As a further sign of the growth of favour for polyphase plants in the country, I may mention that Messrs. Bolckow, Vaughan, and Co., the large ironmasters, are now erecting a power station at Eston, near Middlesbrough, for the driving of their works and the lighting of the town, and this is to be on the three-phase system. The size of the first generating sets, of which two or three are being installed, is 1,500 h.p. each.

It is seen, then, that since the introduction of polyphase factory equipment into this country in 1897 there have been no less than 18 installations started, amounting in the aggregate to about 10,000 h.p. I venture to think that the growth to this amount of a system in its first four years in this very conservative country of ours promises well for its success and development in the future.

[Through the courtesy of Mr. Wyld we have been able to take photographs of the works under his charge. These, with the diagrams and drawings supplied by him, give a good idea of the plant at the works of the Patent Shaft and Axletree Company.—Ed. *E. E.*]

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NOTES.

Society of Arts.—This society's conversazione is announced to take place this year at the Royal Botanic Gardens, Regent's Park, on Friday evening, June 28.

Civil Engineers' Conversazione.—The Institution of Civil Engineers are this year holding their conversazione in their own building in Great George-street, Westminster, on June 19 and 20.

Technological Examinations.—The programme of technological examinations for 1902 in connection with the City and Guilds of London Institute is now ready. Full information concerning the subjects of examination, etc., is published by Messrs. Whittaker and Co., of Paternoster-square, E.C.

"Electric Automobiles."—Messrs. Gaston Seucier and A. Delasalle are publishing a book on electric automobiles. This is, we believe, the first book devoted entirely to the subject of electrically-propelled self-contained vehicles. We gather from a note from one of the authors that it will consist of about 400 pages, with numerous illustrations. The book is to be obtained at 49, Quai des Grands-Augustins, Paris.

Train-Lighting in India.—Up to the present the application of electric light on railways in India has not made very great headway. A good sign of the development, however, which this branch of the industry is sure to enjoy sooner or later in that country, is the announcement that the Bombay E'ectric Company have entered into an agreement with the B. B. and C. I. R. for lighting the through carriages of the Rajputana-Malwa mail trains between Ahmedabad and Delhi.

Paris Electric Cab Service.—The French company which towards the end of 1899 placed a number of electric motor cabs on the streets of Paris, has gone the way of its *confrères* in England and America. The experiment has proved altogether unprofitable, and it is said that a sum of £180,000 has been sunk in the attempt to obtain the approval of the public to an electric cab service in Paris. The failure of the concern is attributed to various causes, among others, the high cost of maintaining the accumulators and the consequent excessive scale of charges which had to be enforced.

The Patent Law.—The present state of the patent law in this country was made the subject of a question to the First Lord of the Treasury in the House of Commons on Tuesday. Mr. H. Lewis wanted to know whether the Government proposed to introduce legislation to carry out the recommendations of the committee appointed by the Board of Trade to enquire into the working of the Patents Acts on certain specified questions. In his reply, Mr. Balfour stated that the report of the committee and the recommendations contained in it were of considerable importance, but had not yet been fully considered. There was no possibility of being able to give effect to them during the present session. It would be satisfactory, however, if time permitted, to deal with the point which formed the subject of international agreement, and also with the point relating to compulsory licenses, and with this object a Bill would be prepared.

Bicycle-Carrying on Tramways.—In this country tramway companies have not yet looked upon bicycle-carrying as a profitable branch of their traffic. In America, however, instead of being seriously injured by the use of bicyles, the tramways make them a valuable source of revenue. We have before us the case of the Market-street Railway in San Francisco. On this line special preparation is made both for bicycles and owners, many of the cars being equipped with bicycle carriers. Thus, the riders and their wheels are carried to and from the Golden Gate Park, where the riding is good, and also in other favoured directions. The resultant revenue to the company from the carriage of the bicycles alone in four years on this route has been nearly £1,000, to which must be added the fares of the riders, who would probably not have used the line had the bicycle carriers not been in use. This brings the total up to about £2,000, and when it is considered that the cost of putting on the carriers was only about £150, it will readily be admitted that this is a very satisfactory result.

Anglo-Irish Cable.—The laying of a new cable for the Commercial Cable Company between England and Ireland has just been successfully accomplished by the "Silvertown," one of the largest vessels engaged in cable-laying. The new cable is about 335 miles in length, and is carried from Weston-super-Mare to Waterville, co. Kerry, near Valentia Island. The present double-wire Transatlantic cable connected with Weston was scarcely sufficiently adequate to cope with its vast amount of work, and therefore the laying of the present one was necessitated. The new cable appreciably lessens the period of transmission, and will therefore play an important part in establishing an improved connection. Its total weight is 3,000 tons, giving an average weight of nine tons per mile, which is somewhat above the maximum standard. Extensive sets of apparatus have been landed from the "Silvertown" and installed at the company's offices in Richmond-street, Weston, and for a month hence testing operations will be carried on for a brief period each day. The cable will, however, be brought into immediate use for transmission purposes. It was manufactured and laid by the Silvertown India Rubber and Gutta Percha Telegraph Company, of London.

The London Telephone Service.—In the new telephone system which is being provided for Greater London the Post Office is adopting the right principle of refraining from connecting any subscribers until the work in the main exchanges is practically completed. We are told, however, that there is a chance of the new service being inaugurated in August or September next. The great question of the charges which are to be made for telephone connection with the Post Office exchanges is still to be announced. One of our daily contemporaries, however, has given a forecast of what these charges are to be, which we do not think can be quite correct. It does not even guess at what the lump sum subscription per annum is to be, but it states that for £2. 10s. per annum one can have a telephone fixed in an office or residence, and that in addition to this charge there would be a small charge per message, which would commence at a penny, and after a certain number of messages had been sent would be reduced to one halfpenny. This would involve automatic recorders, and also, we suppose, the payment of a deposit to cover calls. We notice that the Post Office are now drawing in cables into the conduits which have been laid in some of the chief streets, from which it is to be assumed that the connections in these streets will be available as soon as the exchanges are open.

Submarine Electric Railway Schemes.—Submarine electric railways are still things of the future. It seems likely, however, that such will not long be the case. In this country, for instance, we have the proposal to connect the Isle of Wight with the mainland by a railway under the Solent, on which the motive power would be electricity, and we notice that on the other side of the

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Atlantic a scheme has come before the Railroad Commissioners for the construction of a submarine electric railway under the waters of New York Harbour between Brooklyn and Port Richmond, Staten Island. The idea seems to be to form a connection with the rapid transit tunnel which is now being built in New York to allow of a through journey being made to Staten. We learn that the proposal has not received a very cordial welcome from a certain portion of the community of New York, and some doubt as to whether or not the scheme will receive the necessary sanction seems to be entertained. We should think, however, that exceedingly strong opposition would have to be forthcoming to waive aside the great advantages to be derived from such an electric train service as is proposed. In our own case, both from the point of view of commercial and social reasons, a direct railway communication between London and the Isle of Wight would be of immense benefit, and we should imagine it would want very strong reasons indeed to persuade the legislature of any country to defeat such enterprises which have the interests of the people at stake.

The Magnetic Properties of Alloys.—Dr. A. Schweitzer describes in the *Elektrotechnische Zeitschrift* the results of some investigations which he has made to determine the influence of aluminium on the magnetic qualities of cast iron when admixed in varying quantities. The ballistic method was used in making the observations. From a table of the results of the observations in relation to the curves of the induction which the writer gives, it is seen that the curves of the induction become flatter as the proportion of aluminium is increased, losing gradually the characteristic form of the induction curve of the iron. For field strengths down to H = 40 the decrease of the induction is almost parallel to the increased proportion of aluminium. From H = 11·6 to H = 3·6 the induction with 2·45 per cent. admixture of aluminium is greater than the corresponding values for an induction of 1·62 per cent. The curves of the permeability also lose their characteristic form with increased proportions of aluminium; their maximum becomes smaller, and the curves much flatter. The losses due to hysteresis increase with the larger proportions of aluminium, the curves of the losses as a function of the induction becoming increasingly pointed. For an induction B = 3,000 the hysteresis losses increase parallel to the increased proportions of aluminium, but for higher inductions they increase at a greater rate relative to the increase of aluminium. The results of the observations may be summed up briefly as follows: admixtures of aluminium with cast iron effect a decrease of the induction for equal field strengths and an increase of the hysteresis losses for equal inductions. The magnetic qualities of the iron, in fact, are lessened in value.

The Glasgow Tramway Telephones.—The organisation of a large department like that controlling the complete tramway system of Glasgow, with its extensions running in many directions beyond the boundaries of the city, is no light task. In order that any unexpected accident may not throw the whole system into disorder, it becomes of the utmost importance that there should be ready communication between various parts of the lines. That this may be done telephones are being made use of, and these are arranged on practically three distinct systems. The first of these, from the engineering point of view, is the connection between the main generating station, the electric engineer's office and home, the resident engineer's home, and the various sub-stations throughout the district. These connections enable prompt communication to be made in case any slight irregularity in the running of the plant in the sub-stations which supply the line with current. The next system, which is also under the control of the electrical engineer of the tramways, Mr. M. B. Field, connects up the various sectional feeder boxes with the main generating station and also with the electrical engineer's office. Here, again, there is a complete distinction between the people allowed to use these telephones and those who use the third system of connections, which is entirely in the hands of the traffic department. For this last purpose a number of independent pillars have been erected in various parts of the routes by which the inspectors—and, we believe, in some instances the conductors—are able to obtain connection with the head office, so that in the event of an accident causing a break in the schedule of cars, instructions can be sent out as to the best means of quickly getting the service working regularly again. It will be seen on looking into the matter that there is a great advantage in having this independence between the systems, although, of course, the heads of departments can be spoken to on all three.

The Chi-fu and Wei-hai-wei Cable.—The terms of the agreement made with the Eastern Extension Telegraph Company for the construction and working, on behalf of the British Government, of a submarine cable between Chi-fu and Wei-hai-wei, are embodied in a parliamentary paper just issued. The conditions which led up to the conclusion of this agreement are of interest. From a Treasury minute at the end of the paper we gather that the need for telegraphic communication with Wei-hai-wei became apparent soon after its occupation, and as it became still more urgent in view of the events of last year, the Government approached the Eastern Extension Company in order to ascertain the terms on which it was prepared to connect Wei-hai-wei with the rest of its Chinese system. In the course of the negotiations the company intimated that it had been asked by the local Chinese Telegraph Administration to extend its cables to Chi-fu and Ta-ku, and that, if this extension were made, communication with Wei-hai-wei could be effected by the laying of a comparatively short cable thence to Chi-fu. The company offered to lay this cable for the payment of £16,000, and to work it, on behalf of his Majesty's Government, for a subsidy of £4,000 per annum, and asked, in return, for the support of the Government in the negotiations which it was carrying on with the Chinese Telegraph Administration. The terms offered by the company were accepted by the Government, and embodied in the agreement referred to. The contract further stipulated for the employment of British staff at Chi-fu and Wei-hai-wei, and for the transmission of all traffic between these places, Shanghai, and Hong Kong, as far as possible by British staff. His Majesty's Government undertook to protect the company during the working of the cables, and to use its best endeavours to secure from the Chinese Administration the due fulfilment of its engagements with the company. The new line was opened for working on Sept. 5 last year.

The Northcott Prize Paper.—On the 3rd inst. Mr. Percival Marshall presided at the meeting of the Institution of Junior Engineers, when the Northcott prize paper on the question, "How may the Best Efforts of Employers and Employed be exerted for their Mutual Advantage and for the National Benefit?" which had been awarded to Mr. William Powrie, was read and discussed. The donor of the prize, which is of the value of £5. 5s., is Mr. W. H. Northcott, of London. The author, in commenting upon the relations existing between the employer and employed of the present day, expressed the fear that each class wrongly regarded the other as an antagonist, instead of recognising that their interests were identical. The modern factory

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system had tended to this condition, and the increase of limited liability companies (whose proprietors had only a financial interest in them) had also done much to discourage the formation of mutual friendship. Trade unions had not been an unmixed blessing, much bitterness of feeling having been caused by unreasonable interference between employer and employed. Referring to the attitude of the employer, it was unfortunately too common a practice for employers and managers to keep aloof from their men, and to treat them as if they were of an inferior race. Due consideration should be given to them, and means adopted in every possible way to show that the men's interest in their work was not disregarded. A common cause of increased cost of production was due to the objection of the workmen to run machines at the maximum speed, their stated reason being that more men would be required to do the same amount of work, but the actual result was that future orders were sent abroad, and work altogether lost to the operatives of this country. There would always be a difficulty in getting human beings, whether employers or employed, to do all they ought, but a more perfect education, the encouragement of higher ideas in both classes to assist in overcoming ignorance, indolence, and prejudice would do much to bring about a better understanding between them, to their mutual advantage and for the benefit of the nation at large.

The Automobile Industry.—The one improvement in an electromobile which would be welcomed more than another is an advance in the construction of the storage battery. Dealing with the question in an article in the *Electrical Review* of New York, Mr. W. H. Maxwell, jun., holds that the current year is one which will be filled with great things for the automobile. A battery which will give a greatly increased capacity for a much smaller weight should be the aim of inventors, and the author does not regard it as asking too much when he says we ought this year to be given a battery which will drive the ordinary carriage 50 or 60 miles on one charge, and have an active and efficient life of at least two years under ordinary conditions. In an editorial comment on the article it is pointed out that with a perfected design of battery the electric automobile will unquestionably supersede the horse for all forms of vehicular transport, especially in cities where the suppression of the horse, doing away at one stroke with all the dirt and 90 per cent. of the noise of the streets, would work a slow but genuine revolution in the condition of things. For sanitary reasons alone we should think the change would be directly beneficial to the people. Turning to the question of speed, it is not often that a demand is made for an automobile which will have a minimum speed of 70 miles an hour. Yet there is a report abroad in New York that a young gentleman who can afford it is on the look-out for such a machine. It is not stated for what purpose the automobile is wanted, but there is no doubt that a fairly general demand for exaggerated speeds would have a detrimental effect on the industry as a whole. It is not to be expected that the racing automobiles will ever prove so disastrous to their manufacturers as was the case with the racing bicycles, but the fact remains that the faster automobiles are made the less demand there will be for them, and the trade at large will receive a considerable set-back. The frailty of high-speed machines would be another drawback to their general use, and so long as we get a practical vehicle of moderate speed and lightness, with a maximum of comfort and safety, we may ignore such preposterous suggestions as a 70-mile-an-hour machine.

Train-Lighting by Electricity. — Prof. Geo. D. Shepardson recently read a paper on this subject before the St. Louis Railway Club. He first called attention to the various parts of the axle lighting systems, noting how different engineers have attacked the difficult problem. The author proceeded to review the different methods in vogue for securing the regulation of the voltage with varying speeds. One method of obtaining constant voltage, which, though old, has novel details, is that adopted by the Consolidated Railway Electric Lighting and Equipment Company. The arrangement consists of having a small motor connected with the adjustable arm of a resistance box and governed by a magnet in the main circuit; this motor automatically adjusts the resistance in series with the shunt field coil, so as to strengthen or weaken the magnetic field to compensate for any changes in speed above the critical speed of about 15 miles per hour. Experiments with this device showed that after the dynamo was connected with the lights, a sensitive Weston voltmeter indicated no perceptible variation of voltage between 15 miles and the highest speed attained—about 40 miles per hour. One of the earliest forms of this regulator was used experimentally on a Boston and Albany car about 1897. Another method of regulation is that formerly used by Moskowitz and now used by Vicarino in Europe—namely, a differential winding on the dynamo field magnet. This carries two sets of coils, one a shunt field, and in addition to this, a second coil of large wire through which the main current passes. As the car and dynamo run faster, the voltage tends to rise correspondingly, and consequently the current delivered to the lamps and batteries increases, but the current passing through the series coil weakens the magnetic field, and so tends to offset the higher speed. The author concluded with the statement that whatever may be said of some of the older systems which appeared from time to time, there are at present at least four systems in Europe and two in America which seem to have reached the practical and reliable stage, and it is now possible to obtain axle lighting equipments even on rental basis at no greater cost than gas, with strong guarantees of perfect service backed by ample capital.

The Kingsland Surface-Contact System.—On Friday last a short length of tramway equipped on the Kingsland system was on view at the works of the syndicate exploiting the system at Wolverhampton. The Kingsland system consists of placing a number of surface contacts in the middle of a track, which are connected to and disconnected from supply mains by mechanical means. A third rail is placed alongside one of the running rails, leaving a slot about ½in. In the shallow conduit thus formed star wheels are placed, which operate mechanically commutator switches at each contact block. On each car there are placed two strikers, which project down into the slot and engage with these star wheels. Each of the star wheels has six projecting teeth, and it is moved forward one-sixth of a revolution by each striker as it passes. The first striker then makes contact between the stud and the supply mains, while the one at the rear of the car again disconnects the stud. Mr. Kingsland has devoted considerable attention to the design of the apparatus in order to ensure that the star wheel and switch shall only rotate one-sixth of a revolution at each blow of the striker. In the track we saw the studs in the roadway were spaced 18ft. apart, the strikers were secured at the axles of the car, were 19ft. apart, and the collecting skate was 22ft. long. With these proportions the contact is always made by the stud in front before the stud behind the car is disconnected from the mains; in consequence the switch is not used to break a heavy current. The line worked well when we inspected it, and was

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free from certain objections which are found with electrically controlled surface-contact systems. The point in the Kingsland system, however, which one would expect to give trouble is the blow caused by the striker when it engages with the car wheel. This is to a certain extent reduced by the intervention of springs in the striker itself and also in the switch gear. In spite of these, however, the blow at reasonable speeds makes a noise which is objectionable to anyone standing by the track, and we should think it is likely to be destructive to the gear in course of time. Another point which needs attention is the design of the shallow conduit, which will collect a large amount of refuse from the streets. Provision will have to be made in the final designs for the removal of this from the conduits, or otherwise the star wheel will become choked.

The American Institute's Invitation.—It will be recollected that at the closing session of the Paris Electrical Congress the American Institute of Electrical Engineers extended an invitation to all the delegates present, as well as to all electrical engineering bodies in general, to visit America this year. The Pan-American Exposition at Buffalo is looked upon as an occasion offering unusual opportunities to European engineers and scientists for such a visit, and accordingly the American Institute has decided to hold its principal meeting this year at Buffalo during the month of August, when the exhibition will be in full swing. In the circular announcement which has been issued by the council of the institute the gratifying statement is made that the pleasure and the benefits derived by the American engineers who visited Europe during the summer of 1900, from contact with their colleagues of all countries, and from interchange of professional experience with them, convinced them of the desirability of continuing the pleasant social relations which were then established, and of further promoting an international feeling of good fellowship among technical men. With this object in view, and for the purpose of contributing to the social enjoyment, and of enhancing the professional interest of the foreign electricians who will visit America this summer, the institute has selected Buffalo for its principal meeting place, as stated above. A preliminary programme of meetings, visits, etc., has now been arranged. The formal welcome and reception of the European visitors will be held on Aug. 14 in New York City, and on the two following days technical visits will be made to important works and installations in the city and vicinity. On one of these evenings a banquet is arranged for. No special assignment is made for Saturday, Aug. 17, in order to enable visitors to make their own arrangements for sightseeing, etc., but the council committee has under consideration for Sunday, the 18th, a daylight trip up the Hudson (the American Rhine), thence by rail to Albany, where the party will stop overnight, leaving early on Monday, the 19th, for a visit to the works of the General Electric Company at Schenectady; from Schenectady the party will go by special train to Buffalo. On the following morning the general meeting will open at Buffalo, in the Temple of Music, with addresses by the exposition and municipal officials. On the three following days there will be sessions for the reading and discussion of papers in the forenoons, and perhaps on some of the afternoons. It is expected that the exposition officials will designate one of these days as "Electrical Day." The programme also contemplates the allotment of an entire day, if possible, for an excursion to Niagara Falls and the various electrical features to be seen at that place. Visits will also be made to various sub-stations in Buffalo. The closing meeting will probably be held on Saturday, Aug. 24. These dates, we are informed, have been selected because they are presumed to be those likely to suit the convenience of the greatest number, but in preparing the definite programme the council will note and consider all suggestions received, and will endeavour to make arrangements to suit and accommodate the greatest possible number of visitors. As it is desirable that the plans should be perfected as soon as possible, it is requested that those European engineers who intend to avail themselves of this opportunity will communicate with the secretary of the institute, Mr. Ralph W. Pope, 26, Cortlandt-street, New York, without delay.

Tube Vibration.—Incidentally in the proceedings of the Joint Committee of the Houses of Parliament which has under consideration the matter of the routes to be taken by the proposed new tube railways in London, Sir Courtenay Boyle on Friday last produced the report of Lord Rayleigh's Committee on the question of the Central London Railway vibration. The report, which is signed by Lord Rayleigh, is in these terms: "The committee have satisfied themselves by personal inspection of the fact that there is a serious vibration to be felt in many of the houses situate along the course of the Central London Railway. The observations so far made lead the committee to the conclusion that the vibration complained of arises chiefly from two circumstances—namely: (1) the large proportion of the weight of the locomotives not borne by springs; and (2) want of rigidity in the rail. A new type of locomotive, in which the above objection is obviated, has been ordered by the company, and will be tried in the next few months, and the engineers of the company are endeavouring to overcome the difficulties which have hitherto prevented a stiffer rail being tried. When the results of these experiments are known the committee will be in a position to give a more definite opinion than they can do now, both as to what steps should be taken on the Central London Railway to reduce the vibration and also as to what features should be introduced on new lines. The committee may, in the meantime, say, from the information already obtained, they believe that on new tubular railways, under proper conditions, no objectionable amount of vibration need be apprehended, but they abstain from a definite recommendation until the further experiments above alluded to are completed." On this report being submitted, the question immediately arose as to whether the present enquiry should cease or not, in view of the fact that Lord Rayleigh's Committee did not make any definite recommendation which could be acted upon. Lord Windsor, the chairman, said he took it there was little doubt that Lord Rayleigh's Committee would find some means of obviating any objectionable amount of vibration. Sir Courtenay Boyle pointed out that Lord Rayleigh's Committee was of opinion that the vibration "may be prevented." It did not follow that other lines constructed on a different system would produce vibration. Lord Knutsford expressed the opinion that the Joint Committee's report would have to be an interim report so far as the new lines were concerned. Sir Courtenay Boyle was then asked whether he was prepared to give evidence on behalf of the Board of Trade on such matters as the general control of the lines to be constructed, the question of rates, and the question of fares. He replied that he would consider the points, so we may expect before long to have the opinion of the Board of Trade upon these important questions given in the form of evidence before the Joint Committee.

Royal Institution Discourse.—The "Response of Inorganic Matter to Mechanical and Electrical Stimulus," was the subject chosen by Prof. Jagadis Chunder Bose for last Friday evening's discourse at the Royal Institution.

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The lecture is abstracted in the *Times*, from which it appears that Prof. Bose began by discussing the change of form exhibited by living muscle under stimulus, and showed how the character of the response depended upon the particular kind of muscle used and the surrounding conditions in which the experiment was performed. In other tissues, too, stimulus was followed by response, though not by the same sort of response as in muscle. Thus the eye responded to the stimulus of light, a current of electricity being produced in the optic nerve. This electric response had been looked upon by some authorities as the most general and delicate sign of life, but, in fact, it was given by inorganic bodies too, under stimulation, and these showed the most remarkable parallelism with living ones in both the form of the response and the conditions under which it was manifested. Thus, the tapping of a piece of metal—lead, for example—joined up in circuit with a delicate mirror galvanometer gave rise to a response in the form of an electric current, and, further, the curves representing the response and recovery of metals after stimulation were identical in form with those recording the behaviour of muscle under stimulus. Moreover, the character of the response was altered by precisely the same influences with inorganic as with organic bodies. Under a series of stimuli applied in quick succession, the metal was thrown into the same tetanic condition as a muscle. Again, its response was strongest at a particular temperature, decreasing at both higher and lower temperatures; this corresponded with the heat and cold rigour of muscle. Further, it was affected by drugs just as were living substances; it was excited by stimulants and depressed by depressors, the same drug sometimes acting with opposite effect according as the dose was large or small, while the response could be killed by the injection of poison and revived by the exhibition of the appropriate antidote. Prof. Bose, in the course of his lecture, showed an artificial retina, based on the facts he had described, which was sensitive to visible light, to ultra-violet rays, to electric waves, and, in fact, to every sort of radiation. This apparatus recovered from the effect of stimulus without external aid, and there was no reason, he declared, why the coherers used in wireless telegraphy should not also be made self-recovering, and so employed without the troublesome and sometimes destructive tapping device now in vogue. He concluded with the remark that this continuity between the organic and inorganic worlds enabled them to begin to understand the quotation from one of the ancient books of his race: "They who see one in all the changing manifoldness of this universe, unto them belongs eternal truth, and unto none else."

Progress of Electricity in India.—With the opening year of the twentieth century the Indian Section of the Institution of Electrical Engineers has been inaugurated, and, appropriately enough, at the first meeting of section in Calcutta, Mr. F. G. Maclean, Director-General of Telegraphs, gave an interesting review of the progress of electricity in India during the past 50 years. At the beginning he called attention to the fact that until the last few years electrical work in India had been practically confined to the telegraph, which had also been the pioneer of electrical engineering in other countries. Just 50 years ago it was that Dr. (afterwards Sir) Wm. O'Shaughnessy first carried to a practical conclusion his idea of an electrical telegraph in India, but to those acquainted with the conditions of the country it would be no matter of surprise that the record of progress, excepting as related to telegraphs, could scarcely be favourably compared with that of many other countries. It was in 1851 that the first practical telegraph line was built from Calcutta to Diamond Harbour, and in the following year it was extended to Kedgeri, making in all a total length of 82 miles. This line was made of iron rod $\frac{3}{8}$in. diameter, and on the overhead sections it was supported on bamboos, 200 to the mile. The great feature about this line was its remarkable strength, the bamboos bending to the storm, and thus preserving the line intact. Dr. O'Shaughnessy always adopted the plan of taking the line underground before entering an office in order to protect it from lightning effects. The problem of crossing rivers was one of the first that pressed for solution in India, and in May, 1851, Dr. O'Shaughnessy succeeded in signalling across a river over 5,000ft. in breadth without any conductor. This system, however, could not be maintained, although it remained a remarkable achievement in wireless telegraphy. Nothing practical was done till guttapercha-covered wire was imported from England, and then, after many trials, the system adopted was to secure this insulated wire in the angles of a strong chain cable. The success of the first pioneer line along the River Hughli decided the authorities in 1853 to commence the construction of a network of telegraph lines all over India, and at the present time the Department possesses 52,909 miles of line and 170,766 miles of wires, in addition to 283 miles of cable. Since 1853 the course of improvement had been the substitution of iron for wooden supports, the improvement in pattern of insulators, the gradual reduction in the weight of the wire used, and, finally, the use of copper instead of iron wires on main lines. In 1857 Morse instruments superseded the small horizontal galvanoscopes previously in use; in 1858 there were 10,000 miles of line in operation or under construction, in the same year the first cable between India and Ceylon, a distance of 25 miles, was laid; through communication with Burma was first established in 1865; the next year saw through communication with England by the Turkish route; while the route *vid* Persia was opened in January, 1870, and *vid* Suez and Aden in March the same year; duplex telegraphy was introduced in 1874; and in 1885 the quadruplex system was first used in India. Referring to the Marconi system of wireless telegraphy, the author expressed wonder at the Department not taking advantage of it, especially having regard to the practical success of the system in connection with marine communication. Turning to other applications of electricity, the first record of an electric light installation in India was to light a goods shed in the Howrah Station yard in 1879. Various isolated installations sprang up from time to time in different parts of the country, but the first application of modern electrical engineering on any large scale was the electric tramway in Madras, in 1894, on the underground conduit system. A change was afterwards made to the overhead trolley system on account of the tropical rains, which at times flooded the conduit. The next application of importance was the Darjeeling electric lighting installation, which was the pioneer of high-tension transmission in that country, and in the last year of the century the Calcutta Electric Supply Corporation commenced operations. The latest development would be a system of electric tramways in Calcutta. In conclusion, the author thought there were unmistakable signs that India was now thoroughly awake to the great advantages of electrical power, and that efforts would be made to employ the enormous natural forces which lay at their disposal, such as water power. The most important scheme which was at present proposed was for the transmission of power from the Cauvery Falls to the Kolar goldfields, a record distance of 100 miles.

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GLASGOW ELECTRIC TRAMWAYS.

(Continued from page 661.)

The two auxiliary engines driving the 600-kw. direct-current machines were supplied by Messrs. D. Stewart and Co., Glasgow. Normally they develop 800 i.h.p., but are able to work up to 1,000 i.h.p. as a maximum, running at a speed of 90 revolutions per minute. They are of the vertical cross-compound type, with the generator between the columns. Their normal indicated horse-power is 800, but they are capable of working continuously, with a slight sacrifice of economy, at 1,000 i.h.p., and for short periods they can indicate 1,200 h.p. The steam-cylinders are 22in. and 44in. diameter by 42in. stroke. The normal steam pressure is 150lb. per square inch above the atmosphere at the engine stop valve, and the speed is 90 revolutions per minute. The piston rods are 5½in. diameter; the crank pins 6½in. by 7in. in bearing. The main bearings are two in number, 18in. diameter by 36in. long, and the diameter of the crankshaft in the centre between the high-pressure and the low-pressure parts of the engine, where the fly-wheel and generator are keyed on, is 20in. A 6in. diameter hole runs through centre of the shaft, and the crank cheeks are of the disc pattern. The bearings are of cast iron with magnolia strips. The flywheel is 19ft. in diameter, and weighs about 34 tons, 68 per cent. of which is in the rim, 15 per cent. in the arms, and the remainder in the boss. The rim is in 10 pieces, and each piece is cast along with an arm. When these are assembled, the arms meet at the centre, but do not touch. The boss consists of two flat discs fixed one on each side of the arms, and secured thereto by fitted bolts, three in each arm. The governors are of the high-speed Porter type, and control the speed of the engines so that it cannot vary more than 1½ per cent. from the normal, and there is also an emergency governor, which cuts off the steam supply at the stop valve should the other governor fail and the speed get beyond the maximum allowed. The valve gear is of the well-known Reynolds-Corliss type, with wrist-plate motion, the trip gear being directly controlled by the governor. A feature of the engine is the reheater receiver fitted between the high and low pressure cylinders, and designed to reduce as far as possible initial condensation in the low-pressure cylinder.

Each of these engines drives a 600-kw. 500-volt direct-current 10-pole generator, supplied by the British Thomson-Houston Company. These machines are used for supplying current to the various motors driving the auxiliary plant, for the station lighting, and for supplying the sub-stations and car depôts directly with continuous current for nightwork, lighting, car handling, etc. The generators are suitable for operation as shunt machines at 500 volts no load and full load, and as compound machines at 500 volts no load and 600 volts full load, and are mounted directly upon the engine shaft. The fields are circular and of cast iron, with 10 inwardly projecting removable poles of high-grade cast steel. The field coils are wound separately on malleable iron spools, and well insulated with veneer board and oiled cotton. The armature is of the iron-clad slotted core type, with the winding consisting of copper bars laid in slots and insulated from the armature core by means of alternate layers of oiled linen and paper. The punchings are keyed in the cast-iron spider in such a way that no bolts pass through the core. The end connections are of the barrel type, and supported by and bound down upon extensions of the armature spider. This construction affords the best possible mechanical protection, and minimises the liability of damage from dust and oil. The commutator is supported on an extension of the armature spider, so that it is integral with the armature. The bars are of hard-drawn copper, and insulated from each other, and the spider by means of best quality of sheet mica. After 24 hours' run at rated load the temperature of the armature and field coils, as measured by thermometer, is guaranteed not to be more than 54deg. F., and the commutator not more than 81deg. F., above the surrounding atmosphere, the latter being assumed at 45deg. F. The machine will carry an overload of 25 per cent. for one hour without movement of the brushes and appreciable sparking, and 50 per cent. overload temporarily without flashing over or injurious sparking.

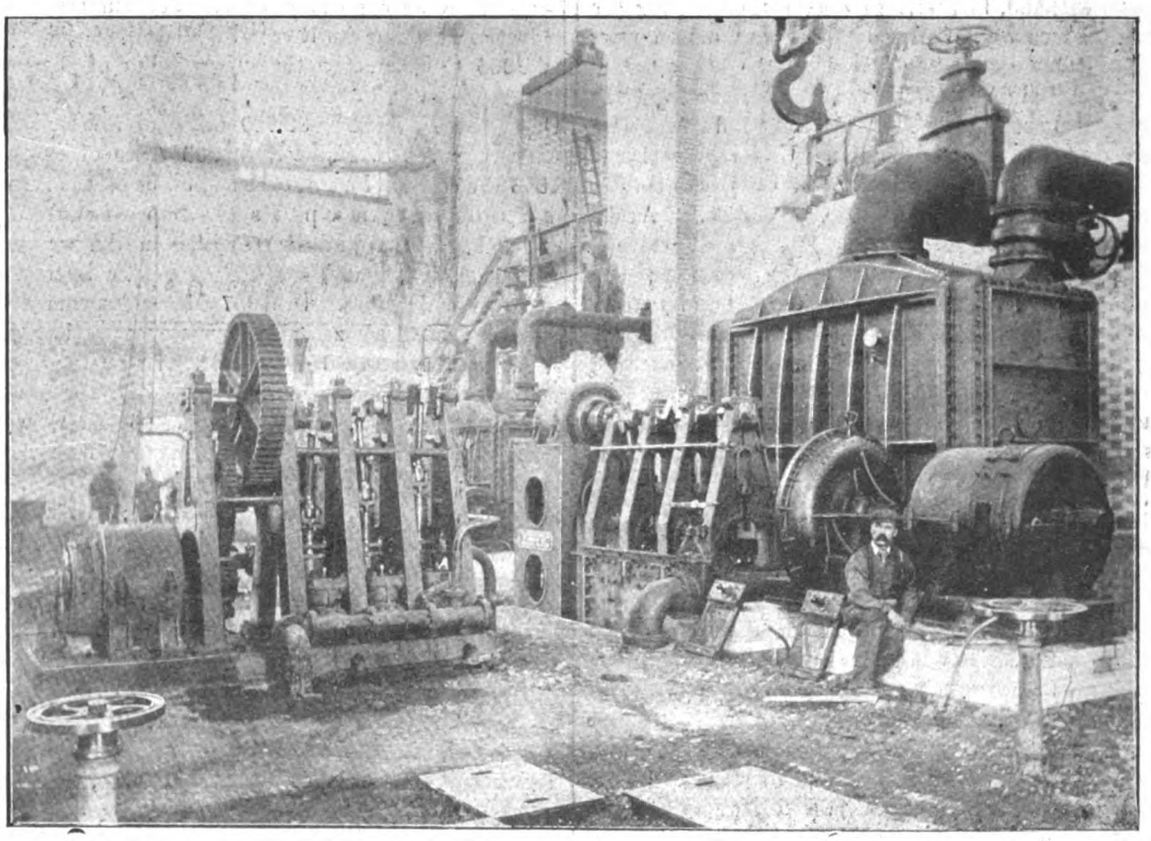

FIG. 6.—View of the Condensing Plant for one of the Large Engines. The Three-Throw Pump to the left is a Feed Pump.

The exciting current for the main generators is obtained from six 50-kw. 100-volt six-pole dynamos, each coupled to an 85 i.h.p. vertical compound engine running at 300 revolutions per minute. These engines are of the enclosed type, and were supplied by Messrs. W. H. Allen, Son, and Co., Bedford. The exciter dynamos were supplied by the British Thomson-Houston Company. This completes the

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plant in the engine-room, with the exception of two 50-ton electric overhead cranes, which were supplied by the Clayton Engineering and Electrical Construction Companies, Limited. The span of these cranes is 75ft., and they are each provided with three motors series-wound for 500 volts.

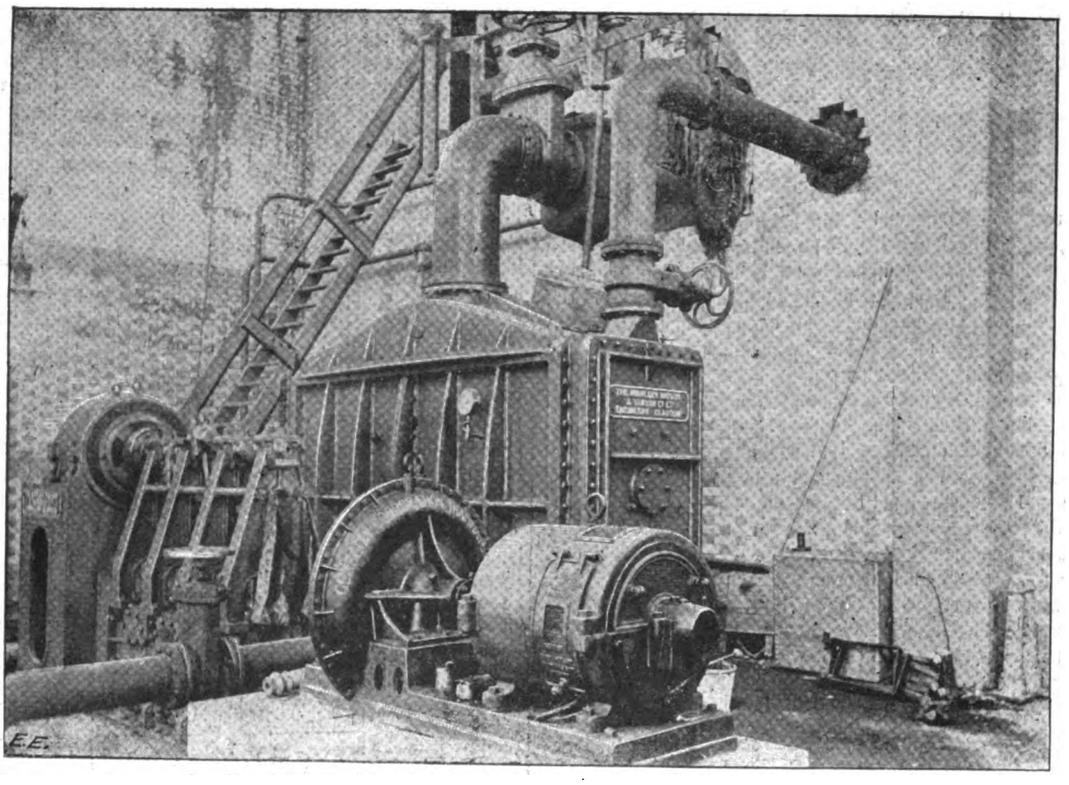

FIG. 7.—View of the Condenser, Air Pump, and Circulating Pump for the two Stewart Engines.

The starting rheostats are of the Electric Construction Company's metallic type.

In the auxiliary room are placed five surface condensers, one for each main engine, and one for the auxiliary and exciter engines. Each main condenser (Fig. 6) is able to deal with 60,000lb. of steam per hour, while the auxiliary condenser (Fig. 7) can deal with 24,000lb. of steam per hour. Four of the larger and one of the smaller size were supplied by Messrs. the Mirrlees-Watson Company, Limited, of Scotland-street Works. The condensers, which take up a rectangular floor space, have thick cast-iron shells, greatly strengthened by a network of ribs. The tube plates are of rolled brass, with solid-drawn brass tubes, expanded at one end and packed with cotton wick set up with screwed ferrules at the other. The larger condenser contains 2,690 of these tubes, and the smaller or auxiliary 1,072, and through these the circulating water passes twice.

The circulating pumps for the main condensers each pump 240,000 gallons per hour, and that for the auxiliary condenser has a capacity of 96,000 gallons per hour. These pumps are of the centrifugal type, and were made by Messrs. Drysdale and Co, Glasgow. In the large pumps (Fig. 8) the impellers are 24in. diameter, and are made of brass, the spindles being of steel. The pumps are each divided vertically so as to facilitate smoothing and polishing, and also have a cover on one side to allow of easy examination or removal of impeller. On the opposite side to the cover special arrangements are made, by means of which the shaft with the coupling can be withdrawn bodily

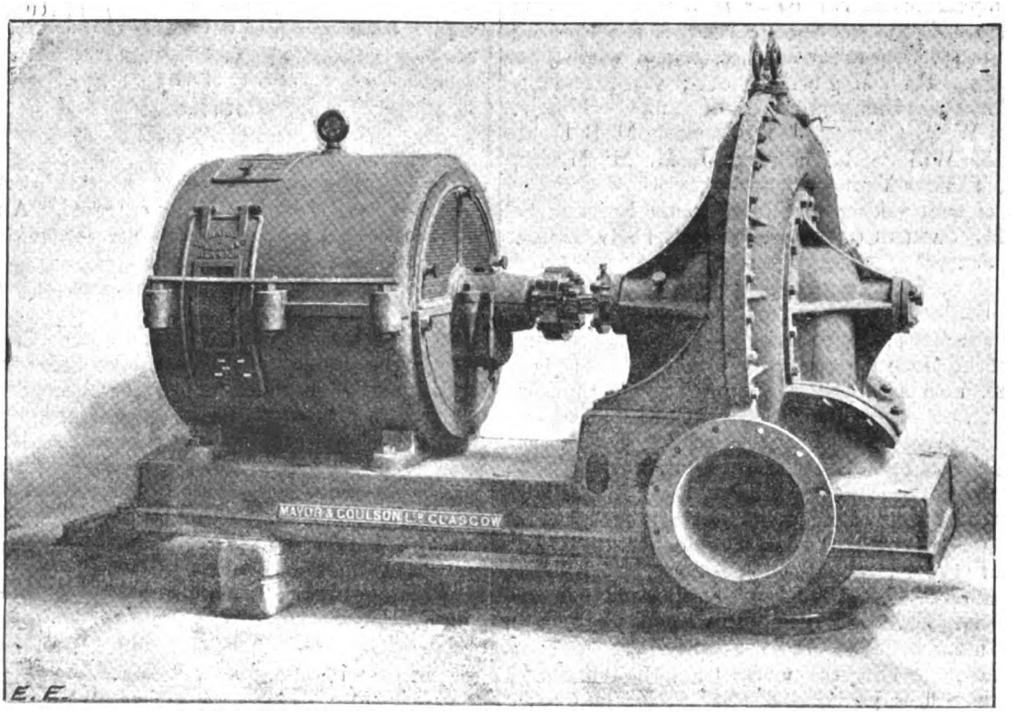

FIG. 8.—One of the Circulating Pumps and Motor.

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alongwith the fan through the cover on the side of the pump. All the stuffing glands are bushed with gunmetal. Each pump is driven by an electric motor direct coupled to the fan spindle of the pump. Messrs. Mavor and Coulson supplied these motors and pumps.

There are four three-throw air-pumps, designed and manufactured by the Mirrlees-Watson Company, of Edwards's well-known type, which has a very high efficiency and dispenses with foot and bucket valves. Each set of pumps are run in connection with one of the large condensers, and is capable of dealing with 60,000lb. of exhaust steam per hour. The arrangement for driving, as our illustration (Fig. 7) shows, is of the simplest description. The slow-speed electric motor is coupled up direct to the crankshaft, and in this way all waste of power, due to transmission through a series of spur wheels or other speed-reducing devices is effectively avoided. Besides this, the above arrangement provides a neat and compact machine occupying a minimum of floor space, which is a most important factor in the design of power stations. The pumps have 16in. diameter buckets with a stroke of 12in., and the crankshaft runs at 150 revolutions per minute. The electric motor is connected to a 500-volt circuit. Besides the four larger air-pumps, there is also one smaller auxiliary pump 11in. diameter by 10in. stroke, of a similar design to those described above. This smaller size can deal with 24,000lb. of exhaust steam per hour, and, like the larger size, its motor runs at a speed of 150 revolutions per minute. The auxiliary room also contains the boiler feed pumps already described, and is traversed by a 30-ton crane by the same makers as those in the engine-room.

(To be continued.)

THE GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The annual general meeting of this section was held at Glasgow on the 8th inst., when Mr. W. A. Chamen occupied the chair in the absence of the president, and proceeded to read out the list of office bearers which the council had nominated. No other nominations having been added since the list had been read at the meeting held on April 10, the following gentlemen were duly elected: president, Prof. Magnus Maclean; vice-president, Mr. Henry Mavor; ordinary members of council—Messrs. A. R. Bennett, W. A. Chamen, J. D. Cormack, M. B. Field, W. W. Lackie, William M'Whirter, J. M. M. Munro, W. B. Sayers, Thomas Young.

On the Chairman asking that any further business be brought up, Mr. JAMES COATS suggested the advisability of having the *Journal* of the Institution issued in a bound form instead of in separate parts. This is done by the Institution of Engineers and Shipbuilders in Scotland, who, of course, issue copies of the papers read from time to time to anyone wishing them for discussion purposes.

Mr. CHAMEN intimated that the council would consider the suggestion, and as there was no further business, he called upon Mr. Walter Jamieson to give his "Experimental Demonstration and Some Notes on High-Frequency Currents."

Mr. JAMIESON, before giving his experiments, compared the laws governing continuous and alternating currents, and treated of the effects caused by capacity and self-induction in a circuit. In explaining the nature of an oscillatory discharge, he referred to the well-known analogy of the U-tube filled with water to different levels, and the effect of suddenly allowing the water from the high-level side of the tube to flow round the tube to the other side, causing a true oscillatory motion in the liquid until it came to rest. He then referred to Henry's experiments on the discharge current obtained from Leyden jars, and explained how, when Henry passed the discharge round a magnetising coil in which was a needle, the needle was found to be polarised sometimes in one way and sometimes in the opposite way, showing the oscillatory nature of the discharge. The nature of oscillatory discharges was next explained shortly, the speaker showing by curves on the blackboard how the amplitude of the oscillations died away in a geometrical progression. He then described the conditions governing the production of oscillatory discharges, and the best forms of circuits for obtaining the most powerful effects. The difference between a simple alternating current and a pulsating or oscillatory current was explained, the former consisting of the alternate rise and fall in the current, following the sine law, the latter being a series of oscillations in which the current reached a maximum value and died down by very rapid oscillations, which diminished in amplitude down to zero, that taking place at a very rapid rate. The number of oscillations under certain circumstances was figured out by the speaker as reaching several millions per second. Mr. Jamieson then proceeded to show some very interesting experiments, most of which were carried out by means of apparatus constructed by the demonstrator himself. Experiment (1) was evidently arranged with a view to showing that oscillatory currents could be put to practical use. Two large loops of wire, each consisting of a single turn, were placed about 1ft. apart. One coil was connected to the outer coatings of a Leyden jar connected to an oscillator, the other coil had a 100-volt 16-c.p. lamp connected across its terminals. On oscillations being set up in the first coil, the lamp became incandesced. Experiment (2) was

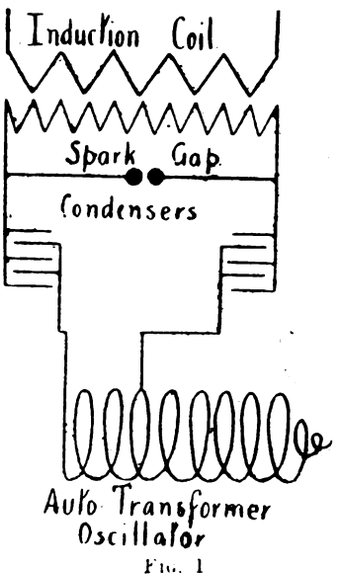

FIG. 1

designed to show the effect of "skin resistance" on oscillatory and high-frequency currents. An incandescent lamp (10 volts) was connected across the terminals of an oscillating current. While brightly lit up it was short-circuited by a thick copper wire, but, so far as could be seen, the lamp continued to be as bright as before. This result the experimenter attributed to the effect of skin resistance in the copper wire, and explained that an incandescent lamp could be incandesced with a much smaller current when that current is oscillatory than was required to light it up to the same brilliancy by means of a continuous or simple alternating current. That he attributed to the high-frequency current passing over the surface of the filament only, and therefore having a much greater heating effect than it could have if passing through the whole body of the material. In Experiment (3) a coil of 80 turns No. 12 copper wire, connected as in Fig. 1, produced powerful oscillations. These lit up any vacuum tubes in the neighbourhood of the coil, and could be passed through the body with impunity. The demonstrator explained the immunity from shocks or physical inconvenience which was a feature of working with currents of very high frequency, on the grounds that the current passed over the surface of the body, and did not proceed inwardly to the nerve tissues, as took place with continuous currents when applied to the human body. He also explained at this point some of the difficulties experienced in the design of transformers for oscillatory currents, and gave a few interesting points in connection

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with the design of high-frequency apparatus. Paraffin wax was not found satisfactory for very high frequencies and pressures, a mixture of vaseline and paraffin oil being found much superior. To prevent sparking across between adjacent turns of wire on his oscillators, Mr. Jamieson winds the coil with double wire on a glass core, fixes it firmly with shellac, and then unwinds one of the wires from the core altogether. This leaves a space between adjacent turns of the wire, which can be filled up with insulating material. This method of winding the coil also lessens the self-induction. The brush discharges from the coil, arranged as in Fig. 1, extended fully 18in. on all sides. Experiment (4) was designed to show the effects of high-frequency discharges in rarefied gases. A very powerful Tesla oscillator was connected as in Fig. 2. Current was taken from the supply mains through a Wehnelt interrupter to the transformer primary, which took 16 amperes at 100 volts. This was transformed to 8,000 volts in the secondary. The condensers were of about $\frac{1}{100}$ microfarad capacity. Two special vacuum tubes about 5ft. long were brilliantly lit up on being brought near the oscillator. On holding one of the poles of the oscillator in one hand and the vacuum tube in the other hand, the tube still lit up brightly. Experiment (5) illustrated the brush discharges obtained from rings, points, etc. Two serrated rings of zinc were fixed 2ft. apart and connected to the oscillator. The effect of the brush discharge was very well shown, and presented some beautiful effects. Experiment (6) showed the effects of unipolar discharges from the oscillator. An 8-c p. lamp with zig-zag filament was presented to one terminal of the

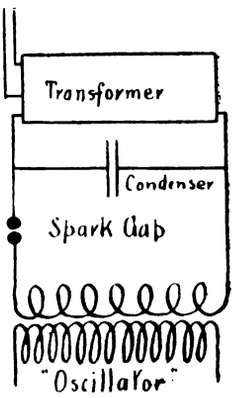

FIG. 2.

oscillator. The filament glowed brilliantly opposite those points where the fingers held the lamp. A double-loop filament lamp was then similarly treated; the fierce bombardment of the ions at once destroyed the loops and the free ends still continued to glow, vibrating violently from side to side of the lamp. In Experiment (7) two large electrodes (condensers) of 36 square feet area were fixed on oil insulators at each side of the platform. On these electrodes being connected with the poles of the oscillator, a powerful discharge was set up between the electrodes, so powerful that vacuum tubes placed between them lit up without any connection with the electrodes whatever. Special tubes gave enough light to enable the features of the audience to be recognised in the darkened room. The body of the demonstrator was also a centre of induced oscillations, which was shown by sparks being drawn from his fingers, etc., although 10ft. away from the oscillator and unconnected with it. An ordinary X-ray tube and a tube made by Nikola Tesla were shown, and Röntgen photos of several articles were thrown on a fluorescent screen. In conclusion, the lecturer reviewed the possibilities of power transmission by means of oscillatory currents. He referred to the possibility of having oscillatory current mains laid in the streets, and humorously described the convenience of having lamps which could be carried about anywhere without any connecting wires, the difficulty being that it would be impossible to switch them off, rendering it necessary to lock the lamp up in a box or cupboard when light was not wanted. Referring to Tesla's scheme for transmitting power from America to Europe by means of high-tension oscillatory currents, the lecturer did not seem very sanguine of its ever being accomplished, at least not by means of balloons, as suggested by Tesla. He described the effect which would be produced by transmitting high-frequency currents through the upper strata of the atmosphere, as being similar to the aurora borealis, and foresaw much trouble in this scheme of transmission, by unscrupulous persons sending up private balloons and obtaining a free supply of electricity for their own purposes. The difficulties of supply meters and measuring instruments would also be a serious matter. Looking at the present commercial possibilities of high-frequency currents, Mr. Jamieson stated that their use was of great value in the maturing of spirits—raw whisky spirit, for instance, acquiring a flavour equal to spirit seven years old by the application of oscillatory currents for a few hours. For the destruction of bacteria in brewing processes and for sewage schemes, the lecturer foresaw a good field. He explained that the application of an oscillatory current to the surface of a liquid containing bacteria caused a violent agitation in the liquid, which brought the bacteria to the surface, where they were immediately destroyed by the action of the current. For the commercial production of ozone he also thought oscillatory currents were eminently suitable, and in medical therapeutics they had done excellent service, especially in diseases of the skin, in which the action of these oscillations appeared to have a deadly effect on the micro-organisms which caused the disease.

Mr. H. A. MAVOR asked the lecturer if it was possible to light up an incandescent lamp from one terminal of the oscillator, and this was done at his request, the lecturer explaining that in this case the incandescence was due to the bombardment of the filament by the discharge, and not by a current passing through it.

Mr. W. B. SAYERS asked that the formulæ given by Mr. Jamieson be printed for the use of the members, and expressed a hope that the experiments shown would be described by the demonstrator and the description published in the *Proceedings* of the Institution. This Mr. Jamieson kindly promised to give, and at Mr. Chamen's request agreed to repeat his demonstration, with additions thereto, at some future meeting of the Glasgow Section.

A very hearty vote of thanks was accorded to the lecturer in the usual manner. Through the courtesy of Mr. Jamieson we are enabled to give the above notes of his experiments, and we hope at some future date to publish some details of his oscillators, which we understand are of special design and give exceedingly good results.

THE CLEVELAND AND DURHAM POWER BILL.

The enquiry into the merits of the Cleveland and Durham County Electric Power Bill before the Select Committee of the House of Commons presided over by Sir Wm. Houldsworth came to a happy conclusion last week, when the chairman declared that the preamble was proved. The advantages which will be derived by the whole manufacturing community in the area over which the Bill authorises the supply of electricity were too apparent to permit of opposition other than from the various local authorities interested, notably the Hartlepools, Darlington, Middlesbrough, and Stockton. These towns have their own electric lighting undertakings, and it was naturally urged on their behalf that having recently started electricity works it would be unfair to deprive them of the best part of their undertaking by the company stepping in and taking away the best work. As was pointed out, however, by the chairman in the course of the proceedings, the wording of the Bill—which is practically identical with that of the South Wales Power Bill of last year—gives ample protection to "authorised distributors." In giving the decision of the committee, the chairman said, of course, they had given very careful consideration to the position of the authorised distributors in the area, and had come to the conclusion that they were sufficiently protected under the Bill, except in one point,

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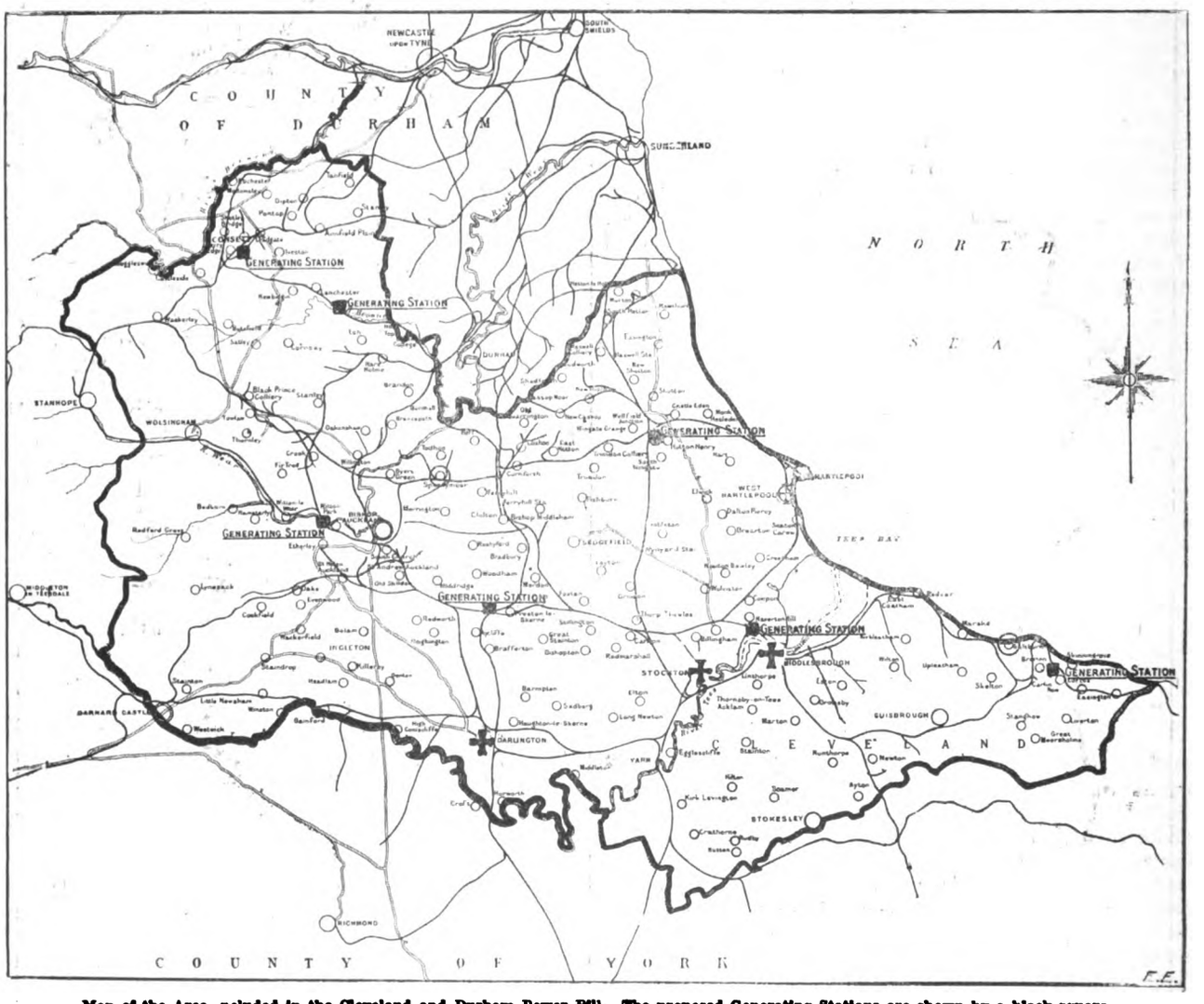
and that was in reference to the price which the company may charge the authorised distributor when he took in bulk under Clause 43 of the Bill. Following out the recommendations of the committee, a proviso was inserted to the effect that the company shall grant to any authorised distributor as favourable terms and conditions for a supply of electricity as those granted by the company to any other authority, company, or person whose circumstances are similar. This proviso, however, is governed by a further proviso, "That nothing in this section shall prejudice the provisions of Section 22 of the Electric Lighting Act, 1882." Then Clause 42 provides that the company "shall not supply energy in any area which at the time of the passing of this Act forms part of the area of supply of any authorised distributors without the consent of those distributors, which consent shall not be unreasonably withheld." In the event of any question arising as to whether such consent is "unreasonably withheld," a reference to the Board of Trade is allowed. In the case of the Durham Electric Power Supply Company special provision is made to the effect that, unless otherwise determined by agreement, the Durham Company shall give a supply of all energy required within the mutual district by the customers of the Cleveland Company (not being authorised undertakers) at such prices, terms, etc., as, failing agreement, shall be determined by arbitration under the Arbitration Act. Special clauses also appear in the Bill as amended for the protection of Stockton Bridge. In the area of 820 square miles to be supplied under this Bill, there are only at present 33 square miles in which there are powers to supply current. Out of this 33 square miles, the area of the districts in which generating stations exist is only some 15 square miles, while mains are laid only in some five square miles. In the whole area there are at present only 560 customers taking [illegible] while the population is upwards of 750,000. The average price charged per Board of Trade unit is now 4½d., whereas this Bill provides that the price to be charged shall not exceed 3d. for the first 400 hours of maximum demand, and 2d. for any further quantity. It is estimated, however, that the price which will actually be made will probably be less than one-half these amounts, or, say, 1½d. for the first 100 hours, and under 1d. for any further quantity. In the face of these conditions it is little wonder that the manufacturers in the area of supply are unanimously in favour of the scheme. As will be seen from the accompanying map, it is proposed to erect and maintain in all seven generating stations. The total number of collieries, factories, etc., in the area of supply is 369, and the total power now in use is estimated at about 180,000 i.h.p. The company has an authorised capital of one million sterling, with borrowing powers up to £333,000, and chief among the promoters is Mr. E. Lloyd Pease, a director of the South Durham Steel and Iron Company, which has a capital of close on a million, and a partner of J. F. Pease and Co. Other promoters are Mr. A. F. Pease, Mr. H. Pike Pease, and Sir Thomas Wrightson, the total capital involved in the concerns with which these gentlemen are connected being £14,834,000. It was stated in the course of the enquiry that these gentlemen would be large consumers of the electricity in the area involved, and they would find every farthing of the capital required for the undertaking without having any financier to act as middlemen between the promoters and their customers.

The engineers to the scheme, through whose courtesy we are enabled to present the accompanying map, are Messrs. Bramwell and Harris, of Great George-street, Westminster. The Bill as amended is reported for third reading.



Map of the Area included in the Cleveland and Durham Power Bill. The proposed Generating Stations are shown by a black square, and the present Supply Stations for Town Systems denoted by a cross.

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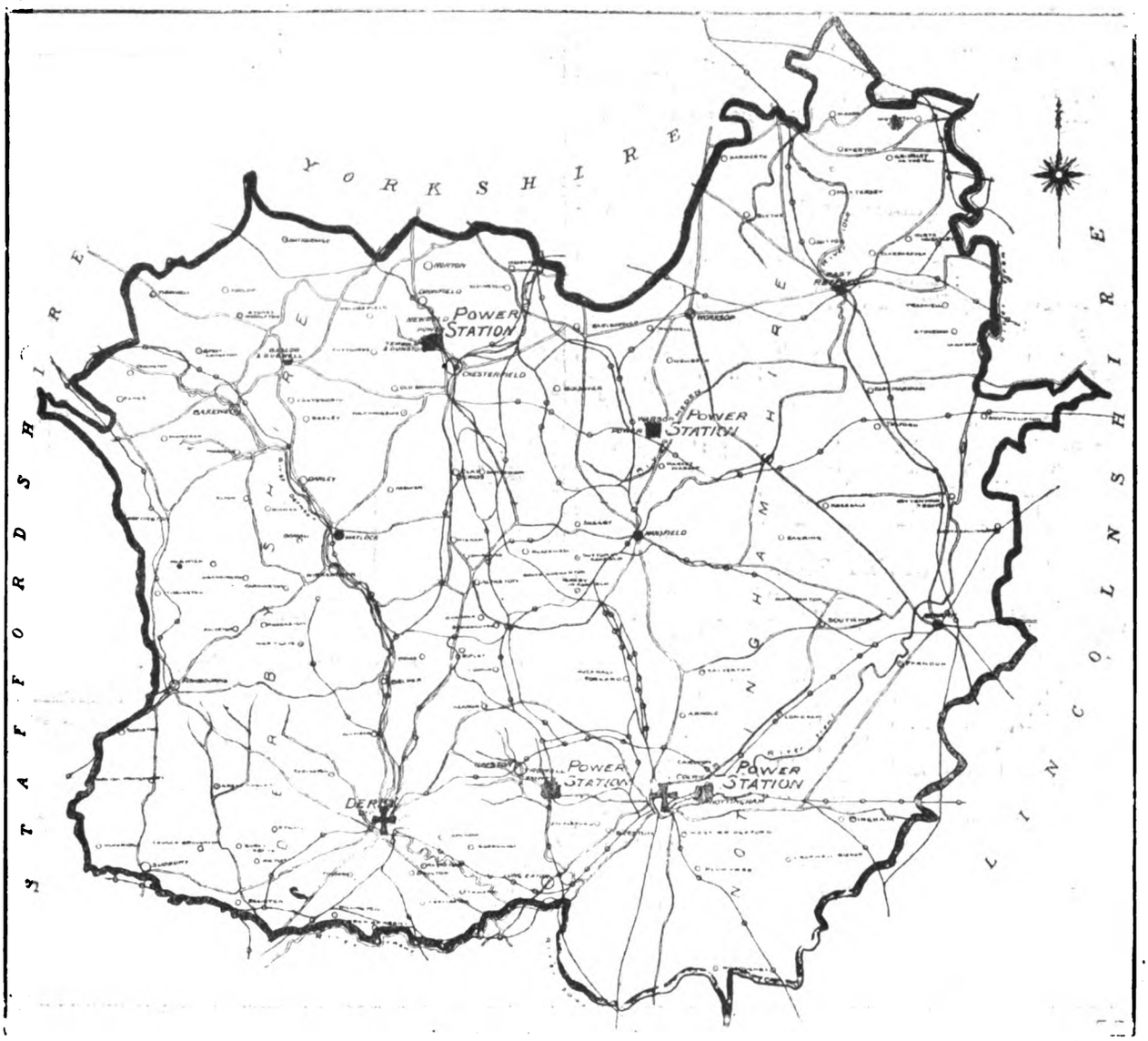
THE DERBYSHIRE AND NOTTINGHAMSHIRE POWER BILL.

This Bill, which has also been passed by the Select Committee of the House of Commons presided over by Sir Wm. Houldsworth, and which now stands reported for third reading, authorises the promoters to supply electric power over an area of no less than 1,570 square miles. The only important modifications of the Bill as presented before the Select Committee in regard to the area of supply are those in favour of the towns of Derby and Nottingham. In both these cases the promoters agreed to clauses being inserted prohibiting them from supplying power in the boroughs, or otherwise exercising their powers under the Bill except for laying mains to supply districts beyond. The arrangements with Derby and Nottingham are both to the same effect—viz., that they shall take power in bulk from the company. The scheme, therefore, embraces practically the whole of the counties of Nottingham and Derby, with these exceptions, and is supported by some 400 local firms representative of the different industries carried on in the Midlands, and with a total capital of about 20 millions. The population in this area of 1,570 square miles is over 1,000,000, and there are 564 works, comprising factories and collieries, including 159 pits. At the present time there are only three local authorities in the district in a position to supply electric power, although legal powers to supply have been granted to as many as 11 local authorities. The districts of these three authorities at present supplying power embrace about 31 square miles, but up to now only some 10 square miles come within the range of supply. The remaining eight authorities are authorised to supply electricity over an area of 97 square miles, so that out of the area of 1,570 square miles embraced by this Bill there still remain some 1,473 square miles totally unprovided with electricity for power purposes. The average price now charged per Board of Trade unit is about 3½d., and under this Bill the company propose to supply at very much cheaper rates. The sites chosen for the four generating stations it is proposed to erect are at Colwick, Trowell, Newbold, and Warsop respectively, which are conveniently near the railway and in the centre of a vast population. During the course of the enquiry, attention was called to the difference in the character of the opposition to the present Bill as compared with that against the General Power Distributing Bill of 1898. Then all the villages were opposed to the scheme; now they are all practically in favour of it. Among others supporting the scheme is the Duke of Newcastle as the owner of large estates in the districts affected.



Map of the Area included in the Derbyshire and Nottinghamshire Power Bill. The proposed Generating stations are shown by a black square, and the present Supply Stations for Town Systems denoted by a cross.

The intention of the promoters—who, it is stated, would be the principal consumers of electricity in the district—is to provide 60,000 e.h.p., of which 25,000 would come from Trowell, 15,000 from Colwick, 10,000 from Warsop, and 10,000 from Newbold. The estimates of expenditure are as follows: on land, levelling, etc., and preliminary and parliamentary expenses, £60,000; buildings of all kinds connected with boilers, chimneys, engine-houses, etc., £216,000; engines, etc., £301,000; boilers, superheaters, economisers, etc., £300,000; electric mains and some transformers, £783,000; floating capital, engineering contingencies, and reserve borrowing powers, £240,000—total, £2,400,000.

The petitioners against the Bill included, in addition to

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the Corporations of Nottingham and Derby, the Worksop Urban District Council, the Chesterfield Corporation, and the Mansfield Corporation, but during the course of the proceedings amicable agreements were arrived at between the promoters and these and other authorities. Towards the close of the enquiry the question of electrolysis was raised. It was urged on behalf of several of the petitioners that a clause should be inserted, as in the case of the Sheffield Corporation's Bill, to protect the gas and water mains from any injury which might be caused from stray currents coming from the promoters' works. On behalf of the promoters it was argued that the general law gave the petitioners all the protection they required, but the promoters did not care whether it was inserted or not. The committee eventually decided not to allow the clause, giving it as their opinion that the protection afforded by the general law was sufficient.

Among the clauses which have been inserted in the Bill, besides those in favour of the Corporations of Derby and Nottingham mentioned above, is one to the effect that "the company may charge for a supply of energy to authorised undertakers or persons supplied by them either by the actual amount of energy so supplied, or by the electrical quantity contained in the supply, or by such other method as may be agreed between the company and such undertakers or persons." A clause was also agreed to empowering the company to lay mains under railways and tramways without making in each instance a special application to the Board of Trade; and another clause for the protection of the Notts County Council with regard to the laying of mains, etc. Of course, as in the case of the Cleveland and Durham Bill, the company are prohibited from supplying energy in any area which, at the time of the passing of the Act, forms part of the area of supply of any authorised distributors without the consent of those distributors. In the event of such consent being "unreasonably withheld," there is a reference to the Board of Trade. Messrs. Bramwell and Harris are also the engineers to this scheme.

THE MAY-OTWAY FIRE-ALARM.

We have recently had the opportunity of inspecting at 53, New Broad-street, E.C., the automatic fire detector and position indicator of the May-Otway Fire Appliances, Limited. The chairman of this company is Sir Eyre M. Shaw, K.C.B., and Mr. G. H. Otway is the managing director. The device described below is the joint invention of Mr. Otway and Mr. C. E. May, the senior mechanical electrician to the New Zealand Government. The device as at first used consisted merely of a copper wire strung between two supports near the ceiling of the room to be protected. The wire could be practically of the same length as the room itself, and its sag is, of course, varied considerably for any alteration in temperature. This is made use of by the inventors by having a contact-maker attached to the middle of the wire in such a way that when the sag exceeds a predetermined limit a circuit is closed, which gives an alarm of fire. Arrangements were made at the one end for altering the tension on the wire, so as to vary the temperature at which the alarm was given. In the improved form this device has been modified, in order to compensate for variations in temperature of the room which are due to ordinary causes. The improved form is illustrated in Figs. 1 to 4. Instead of supporting the wire at either end on plugs driven into the wall, a metal support is provided. In the device we saw this consisted of a strip of angle brass, the front surface of which was polished and lacquered. At the one end of this strip, the length of which can be varied to meet local conditions, is placed a small wheel near the periphery of which the wire is attached. The other end of the wire is attached to a shackle which is at the end of the adjusting screw, *d*. This is to prevent the wire being twisted when the tension in it is altered by the adjusting screw. In the device we saw the shackle was made too small, as there was space for it to rotate, which should not be the case. The contact-maker shown in the illustrations is of the type which has been found to give the best results. It consists of a small cone of carbon, *q*, which, when the wire is heated, drops down between the two contact springs, *t t*. These springs are made so light that they are deflected by the carbon cone, which thus tends to keep the surfaces cleaned by a rubbing action. The object of the wheel and of the lever, *m*, which is securely attached to the same, is to provide a means of ascertaining whether everything is in working order. Thus, if the lever is pulled so as to rotate the wheel in the direction of the hands of a clock, the wire is slackened and the bell rung. It is suggested, in fact, that some such arrangement should be used as the ordinary bell in order to ascertain if the apparatus is in working order. It seems to us, however, that this would not be advisable, as a fire call might be treated as an ordinary call not requiring such urgent attention. We also think that a spring to keep the wheel always against a stop, would be a more convenient means of restoring the wire to its original position than the second handle shown. Coming back now to the object of the metal support in this later form of detector, the brass angle strip has considerable mass, and it takes some time for it to reach the temperature

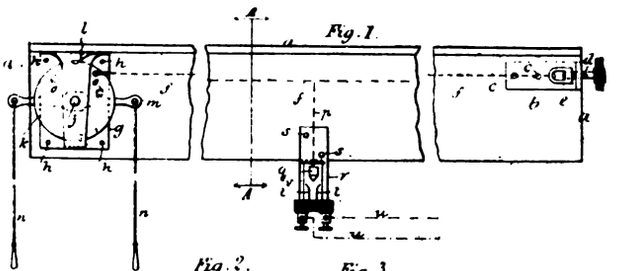
Fig. 1.

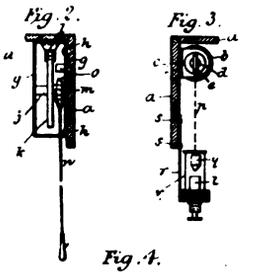
Fig. 3.

Fig. 2.

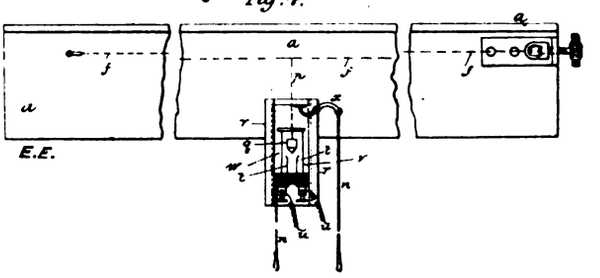
Fig. 4.

of the room. The copper wire, on the other hand, being thin, and having a good conductivity, responds much more readily to changes of temperature. In consequence of this, when the air near the ceiling of the room is gradually heated, the copper wire and the brass strip which support it expand almost together, and no alarm is given, although the temperature due to a number of gas-burners may be considerable.

If, however, there is a sudden increase in temperature, such as would be caused by an outbreak of fire, the copper wire heats up first and quickly gives an alarm. Quite apart, again, from this device is the arrangement of signalling which has been perfected by the inventors and used fairly extensively in New Zealand, Australia, and elsewhere. This consists of an automatic sender, which is started by the fire signal. It transmits by means of a cut disc a certain signal on the Morse code fixed upon by the chief of the fire brigade in the town. This signal is repeated three times, and would, of course, be recorded at the fire station. By means of this arrangement a single fire-alarm wire can be made to serve a number of business premises, and the alarm becomes absolutely automatic and recording. To sum up the whole matter, the advantage of the May-Otway fire detector is its length, which renders it quite free from the objection to most other electric fire-alarms—*i.e.*, that the zone they protect is an exceedingly limited area. We understand that the company working the

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system have a capital issued of £40,000, out of which there is sufficient working capital to render it unnecessary for them to seek financial support from the public. We wish the company success in introducing the detectors commercially.

INSTITUTION OF ELECTRICAL ENGINEERS.

On the Use of Storage Batteries in Connection with Electric Tramways

BY G. A. GRINDLE, MIEE.

(Concluded from page 599.)

In the second method mentioned before—namely, the adoption of regulating cells—various attempts have been made from time to time to increase the effectiveness of batteries installed either at power stations or at outlying sub-stations by employing a portion of them as regulating cells. Automatic apparatus for cutting cells in or out as the line potential falls or rises with variation of load has in several instances been adopted; the general result, however, has been a conspicuous failure. The method is an extremely expensive one, particularly in the case of large batteries necessitating the use of a great number of costly regulating leads and expensive switch gear to keep in order. It is almost impossible to charge the regulating cells correctly, and hence they deteriorate rapidly and become a constant source of trouble; the suddenness and rapidity of the current fluctuations being such as to make it impossible to follow them, at any rate by any automatic switches that have so far been devised. If anything at all in this direction is to be accomplished, I am of opinion that it will be by means of some automatic and interlocking rocking apparatus with mercury contacts, but I am very much afraid that the strongest feature about it will be the pyrotechnic display which will in all likelihood accompany its operations.

The third system—namely, the employment in conjunction with an ordinary booster—has met with a certain amount of success. In this method the battery is more usually employed as a store or reservoir of energy, the charging being effected for definite periods by means of the booster current being added to that of the line, or more generally, special feeder, and the battery discharged by being placed across the line either with or without regulating cells at times of very heavy load when the generators are running or when the load is as light as not to justify the generators being kept running. Under both these

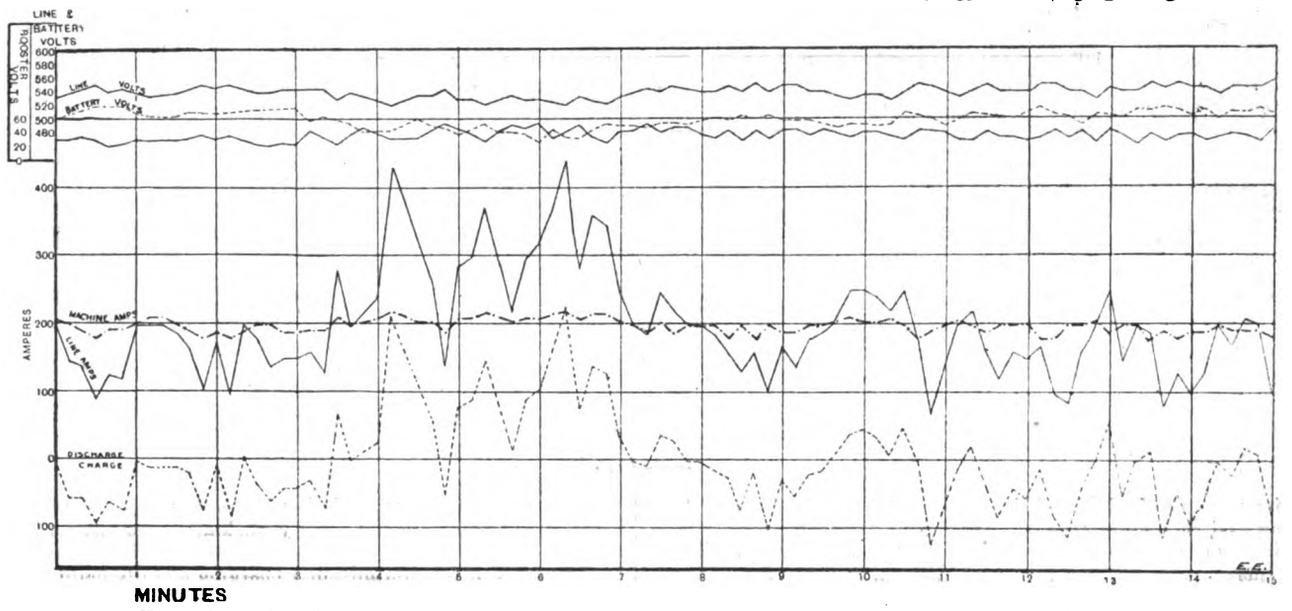

DIAGRAM No. 8.—Curves from Generator, Battery, and Special Booster on a Tramway Load. 125-kw. shunt-wound generator. Battery 1 hour rate of discharge, 450 amperes. Cars on line, 20.

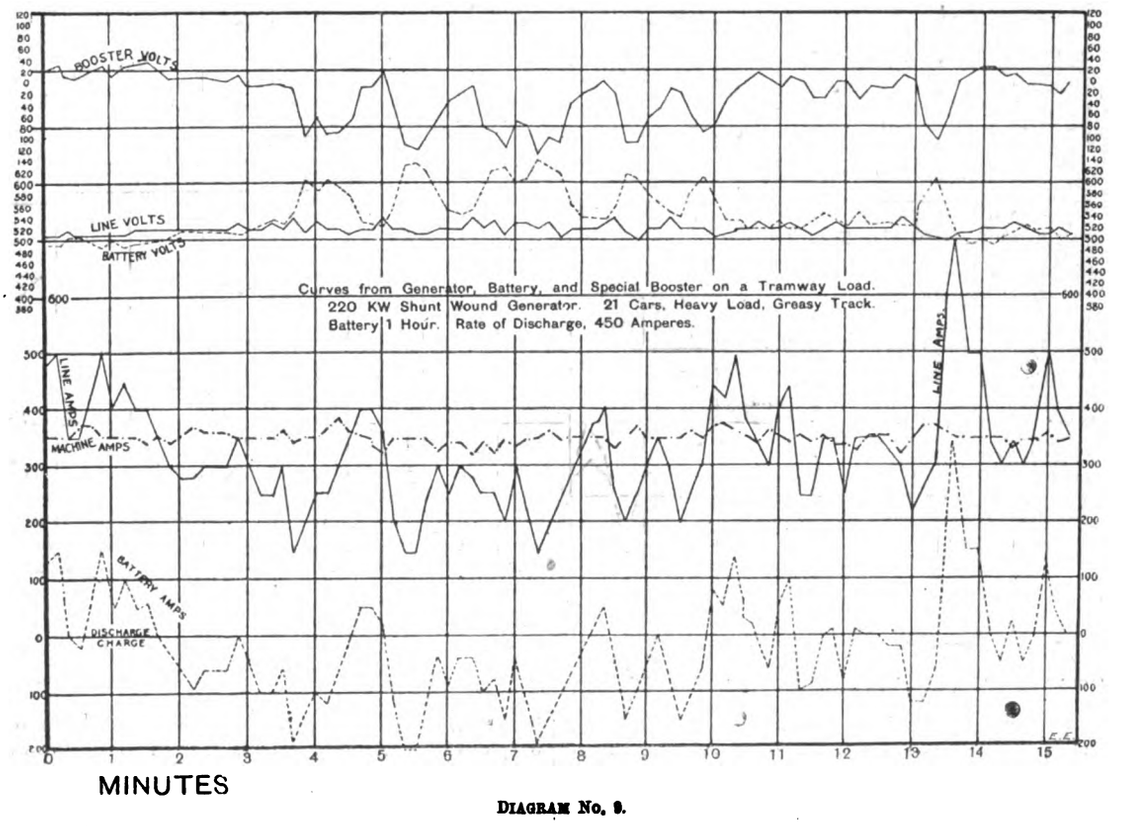

DIAGRAM No. 9.

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conditions a battery can often be employed with great advantage and material saving of running expenses, but the work generally is heavy on the battery and very liable to abuse. Except to meet very special circumstances this system has no special advantage to recommend it.

The fourth method—namely, when employed in conjunction with a differential or reversible booster—is undoubtedly, at any rate as far as our present knowledge is concerned, the correct and proper way of operating a battery on a traction system when the line load falls below the mean, and the battery discharging to line whenever the load exceeds the mean. The generator load will naturally be adjusted to be the mean load required to generate the total average output for the usual period of work. The general features of this arrangement which commend it as being of special value on a tramway system may be summed up as follows: The first cars run out in the morning, and under the precisely similar conditions of energy supply, can be worked entirely

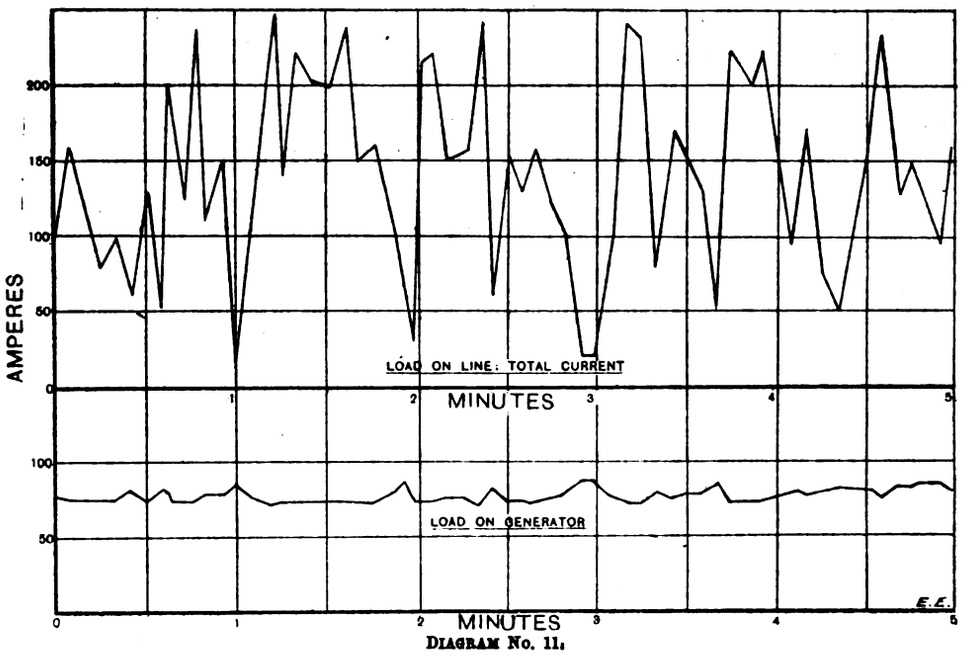

DIAGRAM No. 11.

irrespective of whether it is installed at the power-house or at an outlying station. Diagram No. 6 shows the general arrangement of plant at a power station. The arrangement may be thus shortly described: In series with the battery is connected the booster, which is provided with a variable field. The field is automatically controlled by the battery pressure, and the booster pressure varies exactly as the battery pressure departs from the desired constant, so that the pressure across the terminals of the battery and booster combined is constant, the from the battery, thus obviating the necessity of starting up the power station for a few early workmen cars some two or three hours before the general load comes on. During the day the battery will be intermittently charging and discharging, the output of the generator or generators being fixed at such an amount that at the predetermined time of shutting down the battery is fully charged. Should the battery be found not to be in its normal state of charge at shutting down, owing to any abnormal demand, the running time can be prolonged, or the

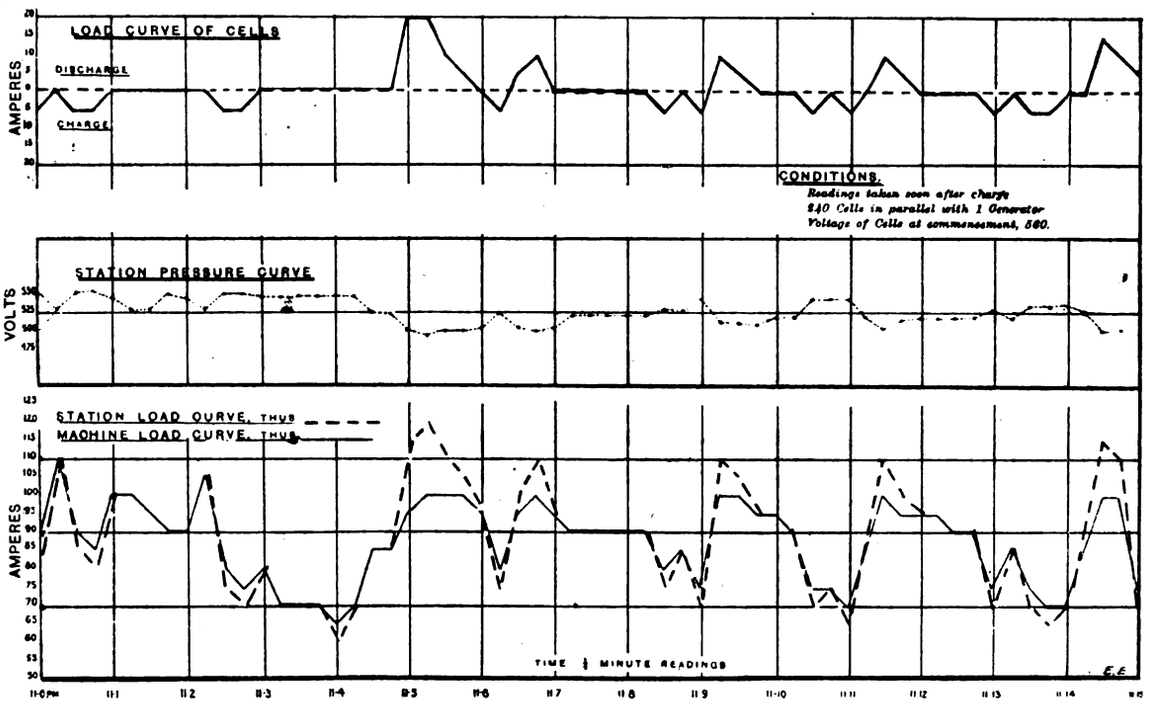

DIAGRAM No. 12. Curves from Generator and Battery Without Booster on Tramway Load. Hour discharge rate of battery, 190 amperes.

whole being perfectly automatic and controlled absolutely by the windings of the booster and the battery pressure. In the case of a battery and booster of this description employed on a traction system or any system where the load is of a rapidly varying character, the battery controlled by the booster serves to take charge of practically the whole variation, whether above or below the normal or mean load, so that the generator works at practically a steady constant load, the difference between the load and the mean, charging into the battery loss compensated for, by slightly increasing the generator output the next day; *vice versâ*, if the battery is overcharged, the output may be decreased. The power station can be shut down on the heavy load falling off, the remaining late cars being run as the early morning ones off the battery only. The advantages of working a plant under these conditions are self-evident: Working at full constant load, the greatest possible economy can be ensured; the actual running hours shortened, and the most uneconomical and unprofitable hours in every sense of the

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whole day's work avoided; the minimum of plant running necessary for operating the load; wear and tear on the plant generally will be much less, the load on the generators being practically constant—ordinary shunt-wound machines may be used, though the system works as perfectly with compound-wound machines; the switching gear is of the simplest description, and is reduced to a minimum, and the whole arrangement absolutely automatically controls itself. The general working conditions are most favourable to the life of the battery, the latter being kept constantly fully charged, and immediately charged after discharge. Diagrams Nos. 7, 8, and 9 give some highly interesting curves obtained under different conditions with a tramway system, in which a battery and booster of this description form part of the power station equipment. The steady generator load is particularly noteworthy, also the range of the total load curve, the variations of which are taken almost entirely by the battery. Diagrams Nos. 8 and 9, further, are interesting examples of how a load on the same system may vary, due principally to conditions of traffic and weather, practically the same number of cars running in both cases, while the mean load differs widely. The actual recorder curves—which I regret to say I have not been able to get reproduced—show very clearly the result which can be obtained on a system equipped with a battery and booster. The two most interesting curves are the two bottom ones on each sheet—namely, those showing the battery voltage and the line voltage; the difference between the two is entirely due to the booster. Employing a battery without a booster, the battery voltage, and probably rather worse, would represent the line voltage. The different curves on each of these sheets were taken simultaneously. The battery must, of course, be properly adapted for the work it has to perform. It must be capable of being charged at very high rates without injury, and of the minimum possible internal resistance, so as to ensure the least possible range of voltage. These conditions are best met with in plates of the Planté type, and [with such the battery losses amount to but a small percentage of the total load. As can readily be understood, a great deal depends on the design and construction of the booster necessary to properly carry out these functions. Up to quite recently the differential or reversible booster has been practically unknown, and those machines which did exist can scarcely be looked upon as being either highly effective or highly efficient. The extended adoption of batteries in connection with power plants has, however, created a demand, and of late considerable attention has been paid to the construction of this type of machine, and various methods and arrangements have been designed to meet the necessary requirement; in many instances the results have left very much to be desired, and in cases where the working may have been passable, the efficiency has been such as to preclude their being considered. There is very little doubt but that the most successful machine that has so far been introduced, is that for which Mr. J. S. Highfield is responsible. By this machine all the functions above mentioned are attained to a remarkable degree, and with the highest efficiency. The booster is a distinctly novel departure, in that it consists of three distinct machines—namely, a motor, generator, or booster and exciting controller—by means of which the unwieldy and waste windings, which have prevailed in all other machines, and which have seriously impaired their efficiency, have been avoided. The function of the third machine is to control the excitation of the booster, and runs in direct opposition to the battery current. By this means the requisite field reversals are obtained. Operating a traction or power system with a machine of this type practically results in the battery becoming as it should do.

The Real Regulator of the System.—The extent to which a battery should control or regulate a system is an interesting factor. Personally, I am of opinion that it should take the sole and entire charge and control of the whole, even to the extent of not excluding the engine—in other words, the engine should be run without a governor on a constant steam pressure and constant valve admission. This will doubtless by many be considered to be a bold departure, but I am convinced myself that the best curves on the accompanying diagrams or any hitherto obtained might be still better under these circumstances, and that the small generator variations that do occur are due to the governor attempting to follow the load instead of leaving it entirely to the battery to compensate for, as should be the case. The abolition of the governor on a power station engine is the consummation of an ideal devoutly hoped for, but I am certain in many instances with a proper equipment of battery and booster it is perfectly feasible.

In closing this paper, I must express my thanks for the kind assistance rendered me, both by information and curves, by Mr. McMahon, of Bispham, and Mr. Highfield, of St. Helens.

Books Received.—We have received a copy of Mr. F. B. Crocker's new work on "Electric Lighting" published by Messrs. E. and F. N. Spon, Limited, at 12s. 6d. From the same firm we have "Lintern's Motor Engineer's Handbook," published at 2s.

BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the discussion on Mr. W. Wyld's paper on "Polyphase Equipment of Factories," which appeared in our last issue (p. 686):—

Mr. Sewter, of Coventry, wrote giving some tests of single-phase alternating-current motors: One horse-power motor (English make)—Apparent watts at light load = 1,260; true watts = 282; ratio true to apparent watts = 22·4 per cent.; apparent watts at full load = 1,774; true = 773; ratio true to apparent watts = 43·6 per cent. Two horse-power motor—Apparent watts at light load = 2,020; true = 564; ratio true to apparent watts = 28 per cent.; apparent watts at full load = 3,200; true = 2,000; ratio true to apparent watts = 62·5 per cent. He thought that a good continuous-current motor could easily go 20 per cent. better than these, for both of which the makers stated the efficiency to be 70 per cent.

Dr. Sumpner said he was very much interested in the subject, and was sure they must all be grateful to Mr. Wyld for bringing it forward. With regard to the supposed saving of copper in the mains in connection with various systems of distribution, he wished to put his view forth that as yet no account of this supposed saving was very reliable. He had seen a number of statements in books to the effect that one system only used 70 per cent. of the copper, another only 50 per cent., and so on, but it seemed to him the main reason of the apparent differences was simply the alteration of voltage. Comparing the three-wire system of direct-current distribution with the two-wire system, there was no doubt whatever about the practical advantage of the three-wire system, but if they considered what it was really due to they would find it was due simply to the doubling of the voltage. If they took a three-wire system with 300 volts on the outers and considered its efficiency from a copper point of view, they would find it was not so efficient as a two-wire system with 300 on the outers. If they examined the statements made as to the efficiency of the different systems of distribution with three-phase currents, he thought they would find that in cases where one system was supposed to be more efficient than another, it was really due to the fact that in the one system they were using a higher voltage than in the other. If they had to deal with Board of Trade regulations restricting them to the use of certain voltages along certain wires, but by means of a device they were enabled to supply current from the station at a different voltage, they might obtain practical advantages; but he did not believe there was any difference in the efficiency of systems of distribution, whether by alternating or direct current, so far as copper was concerned, except such as arose from alteration of voltages. He did not believe the disadvantage of the alternating-current system involved in the power factor was anything like so serious as was indicated by the remarks to which they had just listened. He did not believe it was anything like as low as 60 per cent., although he thought in many cases it was something like 80 per cent. where motors were being supplied, but it seemed to him the whole question resolved itself into this: There were two main conditions of alternating-current supply. One was where they were transmitting power from a great distance. Then they had to use high voltages, and then alternating current was not in competition with direct-current systems, because direct-current systems were not proposed to be used at very high voltage. The other condition was when they were distributing at low voltage in a small district. There they were not cramped, or, at all events, controlled by questions of voltage, and then the question of economy of copper came in, but he would like to point out that advantage of the polyhase system in connection with motors in factories was that they could use higher voltage with the alternating-current system than with the direct-current system; by that he meant that a higher voltage was equally safe with alternating currents as a lower voltage would be for direct currents, the reason being that with polyphase motors they had fewer exposed metal parts. He imagined, therefore, that in factories there would be a greater economy of copper, so far as distributing the power to motors was concerned, with polyphase than with the direct-current system, simply from the point of view of safety.

Mr. H. D. Wilkinson, as a member of the parent Institution, said they were very much indebted to Mr. Wyld for bringing forward this interesting subject. He quite agreed with Dr. Sumpner's remarks that the main advantage was in the matter of regulation where they had to transmit current for lighting and power over long distances. In such cases as one which he had recently had under consideration, where power and light had to be carried over several miles, direct currents were scarcely to be used. He had worked it out, and found the highest pressure that could be used with direct currents was 500 or 600, and the regulation came out something wretched in consequence of the large amount of power to be taken off. In a system of that kind there were many advantages in polyphase motors and polyphase distribution. Starting, in the first instance, with polyphase generation and transmission, he was interested in a scheme connected with coal-mines in the Colonies. They were working now with electric coal-cutters driven by direct current, but there were many disadvantages. There were exposed parts, and fairly high tension was necessary for distribution through perhaps two miles of workings. He had found the polyphase motor excellently adapted for coal-cutting, and as he had seen from its successful working in the North, they could not only adapt them, but adapt them very well. There was this advantage: that anything that had to be

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touched in starting up was merely at a low tension. The rotor was a low-tension part of the machine, and the only high-tension was the stator circuit, which could be made mechanically absolutely free from danger. With regard to the power factor, he certainly agreed with Dr. Sumpner that the remarks read out were scarcely any guide, because the motors were more like eight day clocks, but the power factor became a serious question where they had a large number of motors distributed over a large area. He was still in hopes that some of their inventive electrical engineers would devise a simple apparatus whereby the power factor could be brought up automatically. He thoroughly agreed with the great utility of driving apparatus required in mines and factories by polyphase motors.

Mr. Rosevere maintained that in point of general management alternating currents gave much less trouble than continuous currents. On the continuous-current machines there was the commutator, whereas on the alternating-current they had simply the collecting rings, and there was nothing much could go wrong with them. The mechanical structure of an alternating-current machine was composed of fewer parts, and did not require so much attention. Three-phase generators for factory work were very economical, especially in dealing with large tools, where the mains could be carried through the shops and connected up as required more easily than with continuous current.

Mr. Mensing mentioned the results of observations he had made in the United States and on the Continent to show the advantages of the polyphase system, particularly emphasising its adaptability and safety. At Bremen he saw a large plant, and was told by the engineer in charge of the works that something like 50 per cent. was saved in distribution by the polyphase system as compared with continuous current. He had been told that the Russian Government had ordered a polyphase plant to replace the present continuous-current at the dockyards at Odessa.

Mr. Vaudrey said he did not pretend to see quite eye to eye with Mr. Wyld in regard to this system. Mr. Wyld had failed to give them any data regarding mains distribution, which was of supreme importance in large towns. As far as one could gather, the polyphase current had not been distributed in the network systems such as were to be found in London, Manchester, Liverpool, or Birmingham, and in that direction he thought they had a great deal to learn. No doubt the polyphase system in factories, and as dealt with in large areas of distribution, had its own field for useful work. With regard to motors, his own experience was that the direct current worked equally well. In Birmingham they had from 200 to 300 in connection with the electric lighting service at 200 volts, and he was sure he should have heard a good deal about it if those motors worked badly. He denied that commutators gave any trouble in a properly-made enclosed motor. The multiplication of sets of wires he thought disadvantageous in some factories, an instance having recently come under his notice in which a factory manager said the disadvantage of the system was the number of wires, and he (Mr. Vaudrey) thought the work could have been dealt with in a better manner with direct current.

Mr. Mousman thought most of them who had had much to do with looking after a number of continuous-current motors would hail the opportunity of dispensing with commutators. The possibility of getting rid of the troubles attendant thereon was a great point in favour of the polyphase motor, but they wanted more information upon other points. They knew pretty well what the efficiency of a continuous-current motor was, and they would like figures as to the efficiency of polyphase motors of various sizes at different loads. Then there was the question of price, and the question of balancing the three circuits. Suppose a lighting load was put on as well as a motor load, would it be simply a question of unequal heating, or would it derange the working of the motors?

Mr. Taylor said the important point to be kept in view in appraising the relative merits of the two systems was whether an installation in a factory was to be self-contained or supplied from some large power scheme. In the latter case it would obviously be an advantage to put down alternating polyphase motors, but he thought a good case could be made for continuous-current motors in factories. Supposing there was a small disadvantage against continuous-current motors in factories, the question arose whether that small difference was to be balanced by the trouble involved in taking power from a large system. A vital point was the economy in power. It had to be borne in mind that all the motors in factories were not loaded up to their full capacity. On an average, he thought they could not be loaded up much over 50 per cent. The question then arose, would the polyphase motor compare favourably with the direct-current motor under those conditions? From what he had seen, it gave 70 per cent. against 75 per cent. efficiency in an equal power continuous-current motor, and they must remember that in many cases where electric power had been introduced in factories, efficiency had been an all-important factor in determining whether the electric plant should be put in at all. The speed regulation of the polyphase motor, accomplished by putting in a resistance in the rotor circuit, was almost analogous to putting a resistance in the armature of a continuous-current motor. Whilst there were two other methods of reducing the speed, it seemed to him that they must fall back on the resistance in the rotor circuit, and that afforded only poor regulation as between normal and half speed, whereas with the continuous-current motor they could very economically vary the speed through a considerable range. However, he thought it would be found that though the power factor on the polyphase motor remained constant, the efficiency fell off more rapidly with the diminution of speed.

Mr. Bate said that Dr. Sumpner had pointed out that the saving of the polyphase system was due to the high voltage employed. It seemed to the speaker that the voltage was limited only by the breaking-down strain of the insulation. In taking the voltage of an alternating current the virtual voltage did not express that—*i.e.*, in the case given by Mr. Wyld the pressure between the phases was 350, whereas the breaking-down strain was nearly 500, so the saving would be about 25 per cent. in favour of continuous current. Was there a saving in the total cost of mains, taking into account the total cost of insulation? There might be a saving in copper, but was there a saving on the total cost of the mains by using the polyphase system? For it must be remembered that when the mains were scrapped, as they would be some day, the copper was valuable, but the insulation was not. In polyphase motors the torque was limited; with continuous-current motors it was practically unlimited, although there might be a lot of sparking. Whether that limit had any effect in practice he would like to know—*i.e.*, for overloading for short periods was it absolutely necessary to group the machinery together on to a polyphase motor, or would they work all right on single machines? In respect to the weights of polyphase motors, he had looked up the weight of a 10-h.p. motor, and found the favour was on the continuous-current side, but thought that that was perhaps due to the rating of the horse-power of the machine. Were motors usually rated at full, three-quarter load, or how?

Mr. Pearson said that with respect to distribution lines the weight of copper was slightly in favour of polyphase systems, but the actual cost of the mains was about the same. He would like to know how with the cables the induction effect was prevented—*i.e.*, were the cores laid in the form of a triangle? Was not the starting of the motors the cause of a drop of voltage? The reason continuous-current motors had been made enclosed was not on account of the sparking at the commutator, and he thought Mr. Vaudrey's recommendation of the continuous-current motor a very good one. The price of the motor ought to be taken into consideration with the speed, and he thought the prices were in favour of continuous current. Did not the reading of the load on a polyphase motor necessitate two ammeters, whereas with continuous current only one was required?

Mr. Vaudrey thought it would be an advantage if Mr. Wyld gave them his experience of different makes of polyphase machines. Could they be taken to be pretty nearly all the same?

Mr. Blackburn said he had not read the paper, but his firm were making polyphase motors, and they worked very satisfactorily. Whatever the polyphase motor could do, the continuous-current could do, and much more. With the continuous current they had the shunt and series machines. One instance given in the paper of polyphase plants had since been removed, but that was due to it having been put in a place that was not adapted at all for electric driving, and so was not necessarily the fault of the system. The starting current of the polyphase machines was somewhat more than that of continuous-current machines. He thought there were some disadvantages in the wiring for polyphase machinery, and that a great deal of caution ought to be exercised in adopting them. Any good maker could make an absolutely sparkless continuous-current motor. The clearance of a polyphase motor had to be kept small to obtain a good power factor.

Mr. Lea (chairman): Since our last meeting I have had the pleasure of seeing Mr. Wyld's polyphase plant in company with Mr. Vaudrey, and I was certainly struck with the appearance of simplicity. The polyphase system does not, however, do entirely away with commutators, as the exciters of the generators require a commutator. I think there must be an advantage in the high-pressure current being confined to the stator of the motor. The wiring did not suggest any difficulty, except that there were three wires instead of two, but as these were all bound up as one cable, the connections were quite as simple as with continuous-current machines. After all, however, the whole thing comes down to two points: (1) Would a polyphase system cost less than a continuous-current one? (2) What is the value of this commutator business? If the cost of the polyphase system is to be more than other systems, some other reasons must be found for its adoption. Not that Mr. Wyld had made a bugbear of commutators, but I have seen commutators that gave a great deal of trouble, whilst others I have seen have given none. I have eight motors for fans at the Birmingham Hospital; the largest is 7½ h.p., the others 5 h.p. and 6 h.p. These were started Oct. 16, 1897, and have been running day and night ever since, except for short stoppages necessary for the turning up of the commutators. The 7½-h.p. motor had its commutator turned up after 3½ years, and it has used 1½ pairs of copper brushes. Of the other two sets, the four 5-h.p. motors, two of them have had their commutators turned up three times, the others twice. Therefore, there were eight commutators turned up at 4s. each, and this works out at less than £1 a year, so that I do not think commutators and brushes are worth consideration. Mr. Wyld has said a good deal in his paper on the variation of speed of motors, but this is the exception rather than the rule, as few works require variable-speed motors, so that the objections against the polyphase motors on this score are not of very great importance. I now beg to call on Mr. Wyld for his replies to the questions which have been asked.

Mr. Wyld, in replying, said: The figures given by Mr. Sowter of tests made of very small single-phase motors hardly bear, I think, on the question of polyphase equipments, and instead of the low efficiencies which he gives, I think, with Dr. Sumpner and the other speakers, that, instead of the power factors being only 43 to 62 per cent., that they are more like 80 per cent. for polyphase motors. It is hardly to be expected that Mr. Vaudrey, who has so large and successful continuous-current supply in his charge *should* see eye to eye with anyone advocating another system, but I am afraid that in speaking he rather turned his thoughts and remarks on to the question of distributing energy over large areas,

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such as town supply, for he said I had entirely failed to give any data on mains distribution, which was of supreme importance in large towns, and that, as far as he could gather, the polyphase current had not been distributed in the network system as was to be found in London, Manchester, Liverpool, or Birmingham. I quite agree with Mr. Vaudrey that there is a great deal to be learned in that direction, but would remind him that the paper under discussion was not on this subject. With respect to his remarks upon the polyphase plant which he had seen with so many loose wires hanging about, I must say I think it an extreme case, and that this cause of complaint was more the fault of the person in charge of the works than the system. I am pleased to hear from our chairman that he was not so impressed by the number of wires whilst seeing over my plant, and I might add that whilst going through the shops he asked where all the loose wires were. I, of course, referred him to Mr. Vaudrey. I was pleased to hear that the commutators of the continuous-current motors gave no trouble in Birmingham, and I think many engineers throughout the country will wish theirs would behave as well. Mr. Housman evidently has not found continuous current motors to behave as well as Mr. Vaudrey had, and therefore hails the opportunity of getting rid of the commutator troubles. With respect to his enquiry for the efficiencies of polyphase motors, the commercial efficiency of a 20-b.h.p. motor is about 91 per cent. at full load and about 87 to 88 per cent. at half-load. With respect to the variation of load on different phases, this is only due to an alteration on the lighting circuits—*i.e.*, between any of the phases and the neutral—for all the motors are connected up to the three phases and thus balanced. Should, however, the lighting load get very much out of balance, it does not affect the motor load at all, and the variation in voltages on the lighting circuits is not nearly so serious as is usually thought—*i.e.*, if all the load be thrown off two of the three phases, the variation of voltage on the one left is only about 2 per cent., and this does not derange the working of the motors. In answer to the enquiry *re* the prices of polyphase motors compared with those of continuous-current machines, for small motors there is a difference in favour of polyphase, whilst for larger machines, with wound rotors, there is not much difference. Referring to the enquiry as to the monocyclic system designed by Mr. Steinmetz, of the American General Electric Company, this is scarcely a polyphase system, but an arrangement for enabling single-phase motors to start under load by the addition of a teaser winding, whereby a small current 90 per cent. apart from the main current enables the motors to act at starting as two-phase machines and start under load. Mr. Taylor asked if the efficiency of a polyphase motor at half load would compare favourably with a continuous-current motor at half load, and seemed to think that the continuous-current motor had at least 5 per cent. better efficiency. I have particulars of some tests of several polyphase motors of various sizes, and instead of the efficiency being, as Mr. Taylor said, only 70 per cent. at half load, it works out at more like 88 per cent. for half load and 80 per cent. for quarter load, so that the average efficiency on an all-day load for a polyphase motor is distinctly higher than that of a continuous-current motor, and is not nearly so bad as Mr. Taylor appeared to think. With respect to their efficiency at various speeds, however, though the power factor remains constant the efficiency is not so high at slow speeds, but it must be remembered that these variable-speed motors, such as are used on cranes, etc., are not run for long periods at slow speeds, so the loss is not so serious as is usually thought. In answer to the enquiry how I obtained the figure of 42 per cent. for the load factor on the generating station, I took it in the usual way—*i.e.*, $\frac{\text{units output} \times 100}{\text{maximum load} \times \text{hours}}$. In answer to Mr. Bate's enquiry as to whether the polyphase motor would stand overloading for a short time, it would stand it as well, if not better, than a continuous-current motor up to at least 50 per cent. It is not necessary to group machines together on a motor, for the reason that the polyphase motor can be direct-coupled to any individual machine if desired. With respect to the weight of polyphase motors, it must have been an exceptional case that Mr. Bate had taken, for, as a rule, the polyphase motor is lighter than the continuous-current motor. Mr. Pearson referred to the induction in the three cores. This is usually got over by twisting them round each other. The voltage is not appreciably varied by the starting of a motor, particularly one with a wound rotor and a starting resistance. Only *one* ammeter is required to measure the current taken by a motor, and not two, as suggested by Mr. Pearson. In reply to Mr. Vaudrey's remarks, I don't think there is very much difference in the makes of polyphase motors, not nearly as much as in continuous-current machines. I am sorry to hear from Mr. Blackburn that a polyphase plant is being taken out, but am glad he told us that it was not necessarily the fault of the system. With respect to the disadvantage of wiring for polyphase motors, I have not experienced any difficulty. I was glad to hear our chairman speak as he had done on the simplicity of the wiring. He certainly appeared to expect to see a lot of wires when he came round the works. In answer to the first point which he raised as to the cost of the polyphase system, I might say that when we were putting down our plant, we had tenders in for a continuous-current plant from several of the best makers, and the polyphase was below the other in cost. This, of course, may not be the general rule, but in this particular instance it was considerably lower on the whole than the continuous-current system. With reference to Mr. Lea's remarks about variable-speed motors, I may say that all of this class that we use are on cranes, and I think with Mr. Lea that they are usually of secondary importance in a factory.

LIGHT RAILWAYS.

The Colne Town Council have resolved to make strong representations to the promoters of the Colne and Trawden light railway scheme with reference to the delay in obtaining the order, the loss to the Corporation, and the public inconvenience caused by the delay.

The supporters of the Blackpool and Garstang light railway scheme have now emerged through the tangle of opposition, the Board of Trade order now having been received, and the actual construction of the line may be at any time expected. The raising of the capital has been arranged.

A scheme is being prepared for the construction of a light railway for the conveyance of passengers and goods between Retford and Haxey.

An enquiry has been held into the application of the promoters of the Loughborough and district light railways scheme for the confirmation of the order granted by the Light Railway Commissioners. It was stated that there was strong feeling in the borough on the attitude of the County Council to this scheme. The Town Council had been strongly in favour of it, while the County Council had appeared to be entirely hostile to it, and the Corporation would certainly object to the County Council having power to step in and purchase. The Chairman said he would reserve his decision on the point.

The Light Railway Commissioners have held an enquiry into an application for an order to construct a light railway or electric tramway between Warrington and Northwich and thence to Stretton. After a long sitting the Earl of Jersey intimated that the Commissioners had decided to recommend an order subject to the conditions agreed to being carried out.

The Middlesex County Council are about to apply for several additional lines of light railways in the county. An engineer will be appointed to prepare the working drawings and supervise the construction of the lines. The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the parishes of Edgware, Finchley, Friern Barnet, Hendon, Hornsey, Kingsbury, Little Stanmore, Southgate, Tottenham, Wembley, Willesden, and Wood Green.

The Board of Trade have recently confirmed the following light railway orders: Spen Valley, authorising the construction of light railways from Ravensthorpe to Cleckheaton, in the West Riding; Spen Valley (extensions), authorising the construction of light railways in the borough of Dewsbury, the urban districts of Cleckheaton, Liversedge, Heckmondwike, Gomersal, Birkenshaw, Hunsworth, and Thornhill, and (under certain conditions) in Bradford and Batley; Nuneaton and district, authorising the construction of a light railway in the urban district of Nuneaton and Chilvers Coton and the rural district of Atherstone.

The Jarrow and South Shields light railway scheme has been sanctioned by the Railway Commissioners.

The Cornwall County Council have assented to an application made by the promoters of the Lizard light railway to the Railway Commissioners for an amending order extending the time for acquiring land and constructing the line.

At a recent meeting of the Light Railways Committee of the Chatham Town Council, a letter was read from the secretary of the Chatham and District Light Railways Company to the borough surveyor, setting out at length the understanding arrived at between the company and the Corporation with reference to the paving of the several railways on the roads within the borough, and giving notice under Clause 27 that work would commence within about one month after the date of letter.

The Salop County Council have agreed to grant a further sum of £1,000 to the Tanat Valley Light Railway Company. The Council have already granted £2,000 to the company.

The scheme for a light railway connecting the heights of Southowram, a great centre of the stone industry, with the Lancashire and Yorkshire Railway system at Elland, is being proceeded with vigorously. The total length of the line will be slightly over four miles. Mr. J. H. Rhodes, of Leeds, is the engineer for the scheme; Messrs. Jackson and Fox, the surveyors; and Mr. Harold Marshall, the solicitor. It is thought that the cost will not exceed £30,000.

Sir Courtenay Boyle has heard at the Board of Trade an appeal from the Light Railway Commissioners against the confirmation of the light railway order which seeks to authorise the construction of light railways in the city of Wakefield, and the adjacent townships of Horbury, Alverthorpe, Sandal Magna, and Outwood. Long arguments having taken place between counsel, and protecting clauses asked for by several bodies, Sir C. Boyle said the decision would be deferred. There are several Bills before the Legislature at the present moment, and supposing the Board of Trade were to put in the Sheffield clause, that fact would be argued very strongly before the committees of the Houses in the next few days. The Sheffield clause referred to give damages to gas and water companies whose pipes are damaged by electrolytic action.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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BRIGHTON MUNICIPAL TRADING.

During the discussion before the Committee of the House of Commons on the Brighton Corporation Bill the question of municipal trading has been advanced another step. Of course, our opinions as to the advisability or otherwise of municipal trading have been long since stated, and we have found no reason to change. History, however, rather necessitates a careful recording of every new departure. The Brighton Bill is somewhat of an omnibus character, Clause 78 being worded to provide that "the Corporation may purchase and supply, sell and let for hire, but not manufacture, electric motors cooking, heating, and ventilating, and other similar apparatus, and things incidental to or connected therewith, and may provide materials and do all work necessary for the fixing, setting up, alteration, repair, or removal of such apparatus." According to the evidence, the aim of the Corporation was to induce the householders and business firms to instal electrical apparatus so that a greater amount of current would be required from the central station, and thus the electrical concern, which belongs to the Corporation, would benefit by such sales of current. If municipal electrical stations are to be recognised as business concerns, it naturally follows that those responsible for such concerns desire to obtain all the business they can. In furtherance of such desire, the Corporation contemplated the hiring out of the apparatus to those desirous of using such apparatus in order to overcome the difficulty of a large initial outlay, and, as a means of inducing business, it was suggested they even might allow apparatus to go out on trial, feeling pretty confident that if once tried, its advantages would be recognised and its use would be continued. An objection was made against this clause by the Brighton, Hove, and District Ironmongers' Association, but ultimately the opposing parties came to an agreement. It was agreed in reference to this Clause 78 to take out the words, "ventilating and other similar apparatus, and things incidental to or connected therewith," also to add at the end of the section the words, "provided that nothing in this section shall authorise the Corporation to provide or fix electric light fittings upon any consumer's premises." It was stated that the Corporation desired it to be clearly understood that they would not do any wiring or electric light fitting in consumers' houses. No doubt most people will look upon this result as a case of honours divided, neither party getting all they asked for. According to the clause the Corporation is restricted to the supplying, selling, and hiring of certain apparatus. It is needless to point out that even thus modified the clause may be provocative of considerable trouble It has been the case in more than one instance when the corporation was supplying apparatus that the consumers were unduly debarred from exercising their choice, and certain manufactures were, justly or unjustly, preferred by the corporation before others. We regret that Parliament ever permitted the insertion of a clause of this kind in any Bill, if only from one point of view. A great deal too much has lately been written about foreign competition,

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but, as a matter of fact, this and similar clauses tend to discourage English makers, and to leave the field open to foreign competitors—at least, our idea is that it works something in this way. The officials, or the responsible official, at any given station, after patient investigation, decides upon certain forms of apparatus. Within his area those forms become the only ones admissible, for it is hardly to be expected that the ordinary tradesman can compete against a municipality in hiring out goods, and, therefore, will be under no obligation to his customers to keep a selection from which they can choose. Further, the responsible official having adopted one form, will naturally discourage the introduction of any new departure. He is satisfied; why change? The English manufacturer will make the stereotyped edition, and be somewhat careless in the matter of improvements, till suddenly the position is assailed and carried by a foreign competitor with whom the necessity to succeed has been the mother of invention. If it could be proved in any particular case that the piece of apparatus was perfect, the question would assume a different character; but while improvements are to be made, the field should be left fairly open for the introduction of better types. However, we are hardly in a position yet to fully discuss this problem, because the Joint Committee has not yet reported, and these clauses may be really isolated cases in which they will be permitted. All depends upon the report. Still, a word of warning may be said as to a not improbable contingency. Businesses are not always successful, and what of these municipal businesses if they do not succeed?

FORTHCOMING EVENTS.

FRIDAY, MAY 17.

Society of Arts.—At 8 p.m., Howard lecture on "Polyphase Electric Working," by Mr. A. C. Eborall.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., closing meeting at Newcastle-on-Tyne. Presentation of engineering gold medal for last session. Mr. Walter Scott will reply to the discussion on his paper on "The Commercial Organisation of Shipyards." The discussions on Mr. Edwin Griffith's paper on "Water-Tube Boilers," and Mr. J. M. Thornton's paper on "A Simple Method for Preventing the Corrosion of Tail Shafts," will be resumed and closed. The names of the gentlemen elected to fill the vacancies in the council list will be declared.

SATURDAY, MAY 18.

Institution of Electrical Engineers.—At 10 a.m., students' visit to the works of Messrs. Elliott Bros., Lewisham.

MONDAY, MAY 20.

Institution of Junior Engineers.—At 6 p.m., visit to the works of the Renewable Electric Lamp Company, Brunswick-place, City-road, N.

WEDNESDAY, MAY 22.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., annual general meeting. A lecture, illustrated by experiments, will be given by Mr. J. D. Coales, B.Sc., on "High-Tension Discharge through Gases, including Cathode Rays."—(Birmingham Section): At 7.30 p.m., last meeting of session. Discussion on Mr. A. C. Eborall's paper "Some Notes of Polyphase Sub-Station Machinery."

Society of Arts.—At 8 p.m., Mr. R. Brudenell Carter on "Testing Distant Vision."

THURSDAY, MAY 23.

North-East Coast Institution of Engineers and Shipbuilders.—Visit to Middlesbrough Royal Institution; at 3 p.m., Prof. Dewar, F.R.S., first of three lectures on "The Chemistry of Carbon."

FRIDAY, MAY 24.

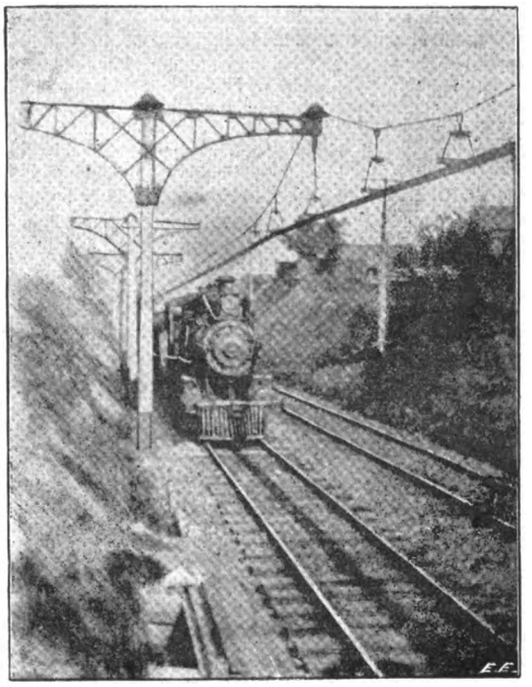
Royal Institution.—At 9 p.m., Dr. R. T. Glazebrook on "The Aims of the National Physical Laboratory."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC RAILWAYS.

SIR,—Owing to there being so much talk at present among electrical engineers regarding electric railways, I think the enclosed photo, taken by a friend in America, should prove very interesting to a great number of the readers of the *Electrical Engineer*. The subject was much discussed after Mr. W. Langdon's paper (Nov. 29, 1900) to the Institution of Electrical Engineers on "The Supersession of the Steam by the Electric Locomotive," especially with regard to the heavy suburban traffic around London. The railway people, of course, objected on the ground of not being able to convert their lines into electric tracks in a short time.



The enclosed photo shows how that difficulty is got rid of by having steam and electricity on the same line, as may be seen by the overhead electric wire and the ordinary steam locomotive coming along.—Yours, etc.,

E. C. HANDCOCK

1, Woburn-square, W.C., May 13, 1901.

ELECTRICAL ENGINEERS R.E. (VOLUNTEERS).

Regimental Orders.

1. **Oil-Engine Instruction.**—Portsmouth, Isle of Wight, and Milford Haven camps, at headquarters, Mondays, 6.30 p.m.; Harwich and Gravesend, Tuesdays and Thursdays, 6.30 p.m.; Sheerness and Plymouth, Wednesdays, 6.30 p.m.; Falmouth, Fridays, 6.30 p.m.

2. **Recruit Drills.**—Tuesdays, 6.30 p.m.; Thursdays, 7.30 p.m. to 8.30 p.m.

3. **Non-Commissioned Officers' Instruction.** — Wednesdays, 6.30 to 8 p.m.

4. **South African Contingent.**—The undermentioned volunteer has been accepted for service with the South African companies of the Electrical Engineers: Vol. No. 390 Sapper G. W. Peart, dated May 6, 1901. Promotion—No. 8577 Sapper G. W. Peart to be promoted second corporal in the S.A. companies Electrical Engineers.

5. **South African War Medal Ribbon.**—The General Officer Commanding Home District has approved of the Electrical Engineer Volunteers who are entitled to the South African war medal wearing the ribbon on "undress uniform." The ribbon will be worn on the left breast of the blue serge, and will be sewn on ½in. wide, no raw edges to be exposed.

6. **Enrolments.**—The undermentioned having been enrolled are taken on the strength of the corps: Regimental Nos. 540 S. E. Blakeney, 541 F. W. Jordan, 542 C. A. Proctor (bugler).

(Signed) R. S. ERSKINE, Major,
D.C.E.E.R.E. (Vols.)
C. T. RUSE, Acting Sergt.-Major.

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AMERICAN APPARATUS.

Another proof of American enterprise is to be seen at the Pall Mall Safe Deposit, St. Albans-place, Regent-street, where a room has been devoted to a show of American electrical apparatus manufactured by the General Incandescent Arc Light Company, of New York, and allied companies. Having regard to the firm foothold which American electrical apparatus has already obtained in the English market, there is, of course, nothing essentially novel about a show of this kind. But hitherto our purchases in this direction from America have been mainly confined to a heavy class of goods, and, so far as we are aware, some of the lighter accessories which we are about to note are new to this country. Of the many ingenious pieces of apparatus shown, that which may lay claim to the greatest novelty is perhaps an automatic switch designed to control any number of electric lamps, or motors, etc., from one or a number of distant points without running the heavy mains to the point of operation. Essentially the switch consists of a pair of solenoids held firmly in an iron frame, which acts as a return path for the magnetic lines, and thereby tremendously increases the "pull" during the time of opening or closing the switch. As the switch begins to move, the pull continually increases in strength until it reaches its maximum at the end of the stroke, whereby any tendency on the part of the switch to stop when partially closing is avoided. The current is broken in two places on each pole, making six breaks in a three-pole switch. Batteries may be used to operate the switch if it is not desirable to use the lighting circuit for that purpose. The switch undoubtedly has many useful applications, especially when it is desired to cut the lighting or power service entirely off the building at night. Another novelty is the G. I. push-button switch, which is designed so that the contacts are mounted on separate blocks of porcelain, which, being straight, can be moulded in such a way as to ensure uniformity after baking. The operation of the switch is such that the movable contacts tend to clean themselves, and thus ensure continued good contact. But the most important feature of the switch consists in that, after the buttons have been pushed a certain distance, the making and breaking of the contact is absolutely beyond the control of the operator's hand. The unusually large break distance provided enables the switch to be used with safety on 230-volt circuits. It has a removable metal face-plate, intended, of course, to fit flush with the wall. Where very high-class work is required, the neat effect obtained should recommend this switch, though it would, naturally, be too expensive an accessory for the ordinary run of work.

Several sizes of motors of the bipolar enclosed type are also shown. In these motors special attention has been bestowed upon the brush-holders, and the device employed for regulating the pressure of the carbon brushes against the commutator through the medium of an insulated handle is beautifully simple. Another useful feature in their design consists in that by simply removing two nuts the whole front of the motor may be removed, thus giving access to the armature, etc., without necessitating the handling of any heavy part. Provision is also made whereby the oil-wells of the ring lubricators may be readily moved round so as to be vertical in any position of the motor.

A very ingenious method of coupling a small motor to a sewing machine is also shown, whereby the driving power of the motor is transmitted to the sewing machine through the face of a friction disc, the speed of the sewing machine being controlled by regulating the relative position of the disc. With the face of the disc in the central or neutral position relative to the rim of the sewing-machine wheel, no motion is transmitted to the latter even with the motor running at full speed. But as the disc is moved so as to bring the machine wheel nearer its periphery, the speed transmitted is gradually increased until it attains a maximum at the extreme edge. The position of the disc, which is arranged to rock with the motor, is regulated through a lever attached to the pedal of the sewing machine. But the arc through which the motor and disc are allowed to move is limited both ways, so that reversal of the sewing machine or movement, on the other hand, beyond the maximum speed stop is impossible. There is no belting, no rheostat, and the arrangement can, moreover, be adapted to any machine. Reverting to switches, mention must not be forgotten of the firm's H.T. quick-break switchboard type. This is an ingenious form of lever switch in which the essential parts are two contact bars which engage in spring contact jaws. The main bar, which forms the lever and is arranged in the front, carries the current when the switch is in the "on" position, while an auxiliary bar attached behind the main bar by a spring and a link takes the spark at breaking. On the switch being opened, this auxiliary bar is held in the grip of the contact jaws against the pull of the spring, until at a certain point the pull is supplemented by direct mechanical force, transmitted from the operator, by a simple but effective arrangement through the lever and link. When this force has released the auxiliary bar from the grip of the jaw, the spring comes into play and completes the break. The same principle is applied to single-pole, double-pole, and two-way switches of the firm's manufacture. Many additional particulars relating to the above-mentioned and other apparatus shown are contained in the firm's catalogues, of which there is a plentiful supply to be had gratis.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

377. The supply from a large station fails suddenly near the maximum load through the breakdown of an armature. The output at moment of failure is 2,000 kw. from a number of shunt-wound direct-current machines in parallel. How would you restart the supply so as to restore normal pressure in quickest possible time?—E. M.

378. What is the best metal to make fuses of, and what is the best form for them to take on a main 500-volt switchboard carrying large currents?—H. W.

ANSWERS.

Question No. 371.—It is required that a 500-volt motor be run at a constant speed off traction mains where the pressure varies from 350 to 500 volts. Would a booster in circuit with the aforesaid motor get over the difficulty?

Best Answer to No. 371 *(awarded* 10*s.).*—The answer to the question would be easier to determine if the exact conditions of supply, etc., were stated. As these conditions are not stated, we shall have to make certain assumptions. We will assume that the drop of volts in the traction mains is proportional to the current flowing in the mains, the drop of volts being a C R drop, due possibly to overloading in some part of the system. If this is the case, any drop of volts at the terminals of the motor occurs simultaneously with an increase of current in the traction mains, the one being proportional to the other. Under these conditions a constant voltage may be obtained at the terminals of the motor by means of a series-wound booster connected mechanically to the same shaft as the motor, and being joined, as shown in the accompanying sketch. Booster B, it will be noted, must be placed in series with the traction mains, and must be sufficiently large so as to allow the main traction current to flow through it without undue heating. It must also be of special design, having a sufficiently low magnetic density in its magnets so as to

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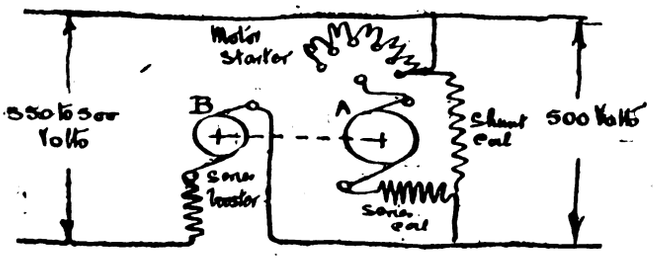
work on the flat portion of its saturation curve; then, since it is coupled direct to the motor, A, it will run at constant speed, and the volts added by the booster will follow an approximate straight-line law with regard to the increase or decrease of the current in the traction mains. The motor, A, having to run at a constant speed under *all* loads, must be compound wound so as to compensate for the drop of volts in the armature of the motor, and also for the armature reaction. It must be noted that when boosting up the motor, A, has an additional load over and



above its normal load, due to driving the booster, B, the output of the booster being at its maximum equal to $150 \times C$,

where 150 = the maximum drop of volts in the traction mains;

and C = the maximum current flowing in the traction mains.

We will now assume a different case to the above. Suppose that the variation of the voltage on the traction mains is not proportional to the current flowing in the mains, but be due to, say, the erratic running of the engine at the supply station; then, under these conditions, we are unable to compensate for the drop in volts by any feasible arrangement of a booster. One method which has been employed to meet the above conditions, is to have a shunt regulating switch in the field of the motor. The switch being operated automatically by a centrifugal governor attached to the shaft of the motor, so that on the motor slowing up due to a fall in the voltage of supply, the governor puts resistance into the motor field, and thus increases the speed; but this it will be seen is only a compromise with the object which is desired, and has never to the writer's knowledge been very successful in practice.

Another method, which would only hold good for a motor which is to run at *constant speed* and also on a *constant load*. In this case a motor of special design could be built so that it would have an approximate constant speed within given limits of variation of the voltage at its terminals; such a motor would have to be compound wound, the series winding acting in opposition to that of the shunt. Now, if the load on the motor was constant, when the voltage decreased the current taken by the motor would increase, so that the motor could meet the demands of its load. Now, this increased current flowing through the series winding of the motor would weaken the field, and thus increase the speed of the motor, tending to keep it at a constant value, and thus we should get fairly good constant running of the motor.—H. P.

Answer to No. 371 *(awarded* 5*s.)*.—A motor will always run at sufficient speed to generate a back E.M.F. almost equal to that of the mains off which it is driven, and this back E.M.F. will always be a little less than the supplied E.M.F., the difference increasing slightly with the load. In the case of a shunt-wound motor, when the supplied E.M.F. is reduced it weakens the magnetic field of the motor, as less current will be forced through the field coils, and it reduces the speed of the armature. Both of these changes working in conjunction weaken the back E.M.F. If the magnetic field could be kept constant, the speed would decrease more for a certain reduction in the supplied E.M.F., as it alone would have to alter the back E.M.F., and, on the other hand, if the speed is to be kept constant, the magnetic field must be weakened enough to have the same effect. The speed is required to be kept constant. The magnetic field, therefore, must be weakened, when any reduction in the supplied voltage takes place, enough to alone reduce the back E.M.F. sufficiently. For this a means is required whereby a correct amount of resistance can automatically be introduced into the shunt circuit when the supply voltage falls. This can be done by a small motor-regulator (shown in Fig. 1), which consists of a small shunt-wound motor (about 200 watts capacity), with its armature shaft extended and fitted with two weights that are connected by links to a fixed and a movable sleeve, and which are held closed to the shaft by a spiral spring, but are opened, when the motor, by centrifugal force. The movable sleeve connected to these weights is moved up the shaft when they open. It is fitted with a

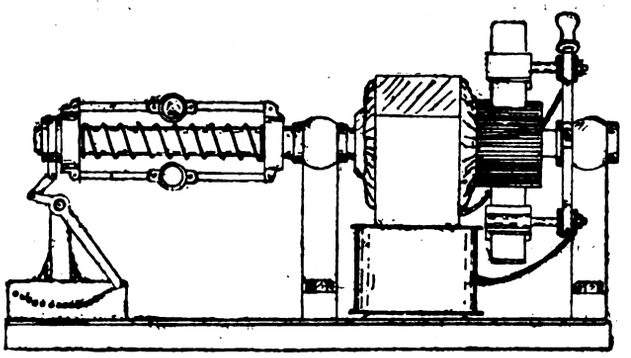


Fig. 1.

collar that does not revolve, but is connected by a link to a lever that works the resistance switch. The motor is run from the same mains as the large motor; its speed will vary with the supply voltage, and the position of the regulating switch arm will alter with the speed and cut in or out resistance in the short-circuit of the large motor when it is wanted. The amount of resistance required for any position of the switch arm is best found by experiment by keeping the supply voltage steady, then gradually reducing it and adjusting the amount of resistance to keep the main motor at a constant speed. Fig. 2 shows the connections of the motors and regulator.

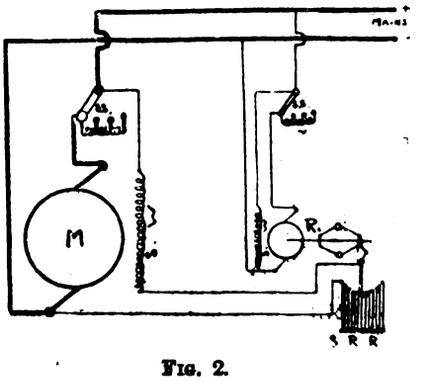


Fig. 2.

S S, motor-starting switches; S R R, shunt regulator resistance; R, regulator; S W, shunt windings; M, motor.

Series or compound-wound motors would not be suitable, as their speed is altered by the load altering. A booster would not get over the difficulty unless it was very complicated. It would require two separate field windings, and would have to be driven at a constant speed by the motor, and in addition it would have to have a small dynamo to excite one of the field windings. This small dynamo would be direct driven off the motor and give 500 volts. When the two field windings would be fully excited, the booster would give no voltage, but as soon as the supply voltage fell below 500 the field winding excited by it would be weakened and the booster would boost. By this arrangement three machines would be required on one bed-plate, and its success would be doubtful.—A. J., Swansea.

Answer to No. 371 *(awarded* 5*s.)*.—The steadiness of the motor voltage can certainly be greatly improved by the use of a properly designed booster. For this purpose the booster should consist of two separate machines mounted on one bed-plate—one machine being a shunt wound (or compound-wound) dynamo of sufficient output to supply the 500-volt motor, and the other machine a shunt-wound motor capable of driving the dynamo to which it is connected. The field of the dynamo part of this booster should

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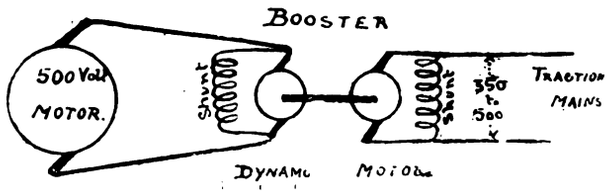
be worked as highly saturated as possible, while that of the motor part should be quite unsaturated so as to work normally on the straight portions of the magnetisation curve. The dynamo part should be wound so as to give out 500 volts when the motor part is supplied at the average voltage (in this case 425 volts). If, then, the booster motor volts increase to 500, its field-exciting ampere-turns will increase in the ratio 500 : 425, and, the iron being quite unsaturated, this will produce an almost equal percentage increase in magnetic flux through the armature. Say the flux increases in the ratio 475 : 425. At



the same time the booster motor armature voltage will have increased in the ratio 500 : 425, so that the booster speed will only increase in the ratio $\frac{500}{425} \times \frac{425}{475}$, or 500 : 475. This change in speed will raise the voltage of the booster dynamo rather more than in the ratio of 500 : 475 due to the slight increase of its own exciting current, the increase from this cause being, however, very slight on account of the saturated state of the dynamo magnets.

The net result of a rise of 75 volts (425 to 500) on the traction mains will, therefore, only be a rise of 25 or 30 volts in the supply voltage of the 500-volt motor. In the same way, should the traction voltage fall from 425 to 350, the whole of the process above described will be reversed, and the motor supply voltage will only fall some 25 or 30 volts. The arrangement of the booster is shown diagrammatically in the accompanying figure.

Another method of attaining the same result consists in using a motor booster much as above, but with a differential winding on the dynamo field, one of the two windings being excited in the ordinary way off the dynamo brushes, and the other depending for its exciting power on the difference between the booster motor and dynamo voltages. Or the necessary differential action may be produced by means of an automatic switch for inserting or withdrawing resistance from the dynamo shunt, according to the voltage on the traction mains. These arrangements, though capable of giving closer speed regulation on the motor if carefully adjusted, are more complicated than the first-mentioned method.—Q.

Question No. 372.—In a central station where turbines are installed to drive the generators the hot-well temperature (owing to the high vacuum) is only 70deg. F. It is not advisable to pump the feed into the economisers so cold as this. What is the best method of warming it up to about 110deg. F.?

Best Answer to No. 372 (*awarded* 10s.).—The best method could only be decided by acquaintance with local conditions. Where Green's economisers are installed there is usually, if not invariably, a by-pass from the discharge side to the inlet side; so that on the hot feed water coming through the economiser a small quantity is allowed to mix with the hot-well water, and thus raise its temperature. Another method would be to have a feed heater fitted similar to a surface condenser, so that the feed water passes through a number of tubes, and the exhaust steam passes on the outside of the tubes, thus raising its temperature. This plan would be objectionable to many on account of extra capital invested.

Another way is to use the exhaust steam of some auxiliary engine—*e.g.*, the feed pump. This is done by the air-pump discharging into a tank, and the exhaust steam, mixing with the water, is condensed, thus raising the temperature. The great objection to this arrangement is that the oil used for internal lubrication is carried along with the feed water through the economisers into the boilers. Another plan similar to the above is to use "live" steam instead of exhaust steam. By this method the water can be raised in temperature without any fear from oil in the steam, but it does not commend itself on the ground of economy, most engineers thinking that the feed-water temperature ought to be raised by some of the waste heat that is inseparable from the use of steam-boilers. Another drawback is that the pipes and fittings have to be made to withstand high-pressure steam, and are more expensive than those made for low-pressure steam.

The loss due to high-pressure steam can be approximately calculated from the well-known formulæ. The two formulæ are theoretically true. The loss of heat of 1lb. of steam in falling from t_1 to t_2

$$= 1 \times [H - (t_2 - 32)] \text{ B.T.U.}$$

The gain of heat in x pounds of water

$$= x \times (t_2 - t_3).$$

H = total heat of steam; t_1 = temperature of steam; t_2 = temperature of hot-well = 70deg.; t_3 = temperature of water to economiser = 110deg.

Assume the gauge pressure to be 160lb., then the equation becomes

$$\frac{1,226{\cdot}4 + {\cdot}3 \times 370{\cdot}8 - 110 + 32}{110 - 70};$$

$$\frac{1,259{\cdot}64}{40} = 31{\cdot}491\text{lb.}$$

of water raised from 70deg. F. to 110deg. F. by 1lb. of steam at 175lb. absolute pressure. The volume of 1lb. of steam at 175lb. absolute pressure is 2·56 cubic feet. From one cubic foot of water at 62deg. F. we get 159 cubic feet of steam. Again, 1lb. of coal will evaporate 8lb. of water from and at 212deg. F. in practice; therefore, it will take about 64lb. of coal to evaporate one cubic foot of water.

Volume of 1lb. of steam = 2·56 cubic feet; volume of 1lb. of water when turned to steam = 159 cubic feet.

$$\frac{159}{2{\cdot}56} = 62{\cdot}1,$$

that is, 62lb. of steam from 64lb. of coal, which gives, approximately, ·9lb. of coal per 1lb. of steam at 175lb. absolute pressure—thus,

$$64 : 62 :: 1 : x = 64\ x = 62;$$

$$\therefore x = \frac{62}{64}; \quad \therefore x = {\cdot}9.$$

In other words, we raise approximately 31·49lb. of water at 70deg. F. to 110deg. F. at the cost of ·9lb. of coal. This cost of coal would be rather a serious item at the end of the year.

Another plan from actual practice. A large tank is placed between the hot-well and the pump. The tank is fitted with an overflow pipe and a ball valve for filling purposes. There is a copper coil in the tank, and the pump draws the water through this coil from the hot-well. The exhaust from the pump is led into the water in the tank and is condensed, and thus heats the water. By this way the hot-well water is raised from 74deg. F. to 120deg. F. Another way would be to reduce the inlet water, as the vacuum is high, and with the use of a by-pass from the economiser this would be the least expensive and simplest way.—H. W. H.

Answer to No. 372 (*awarded* 5s.).—To increase the temperature of boiler feed water in either large or small stations both economically and effectively, is a matter that has received considerable attention from engineers within the last few years. The coal bill is such a serious item (especially at the present time) as to necessitate the units of an installation being of the simplest, reliable, and most economical form. The heating arrangement is one of these important units, and the less complicated it is, provided it is effective, the greater the advantage, for the ease of repairs and less liability of breakdown considerably reduces any risk. Such an arrangement that appears to cover the aforesaid points is shown in the sketch annexed. It will be seen that it merely consists of a galvanised iron tank of such a size as to suit the requirements of the station. A copper tube about twice the diameter of the engine exhaust pipe runs the whole length of the tank, securely bolted at either end to suitable flanges on the outside. The hole in the flange to receive the exhaust pipe is bored out of the centre, so that when the copper tube is coupled up there

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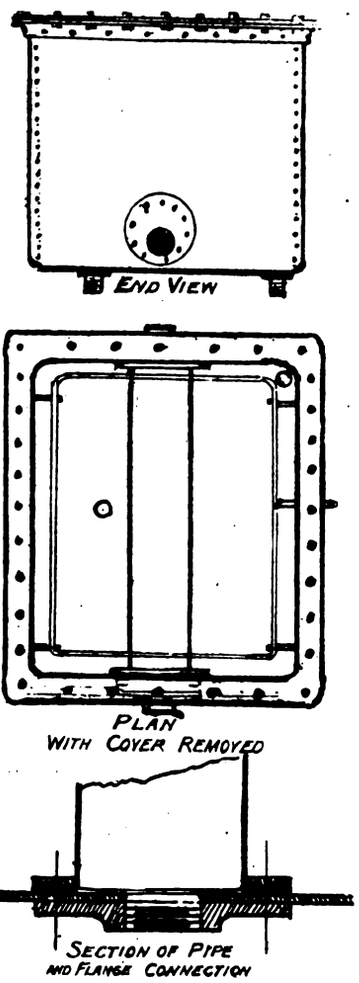
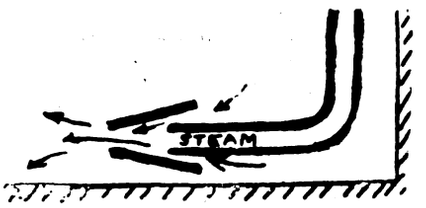
shall be no risk of any condensed water settling, and thus reducing to an extent its efficiency. The tank would be placed as near as convenient to the engine, the exhaust of which could be either screwed or bolted on. The outlet would be bolted to the pipe leading to condenser. One of the chief points is the free way for the exhaust that is attained in this arrangement, for to throttle the discharge from the turbine by passing through heating coils or a series of tubes means a loss of power immediately, besides increased wear and tear to the working parts of engine. The supply pipe to tank is fitted all round the upper part of same, securely attached to the sides, and perforated so that the spray may be distributed over the whole surface.



An overflow pipe and draw-off to economisers makes the tank complete. It is claimed that in small factories such an arrangement is the means of an actual saving of 15 to 20 per cent. in the cost of fuel. With so many points in its favour, the writer considers it one of the best methods of warming water that is on the market.—J. R.

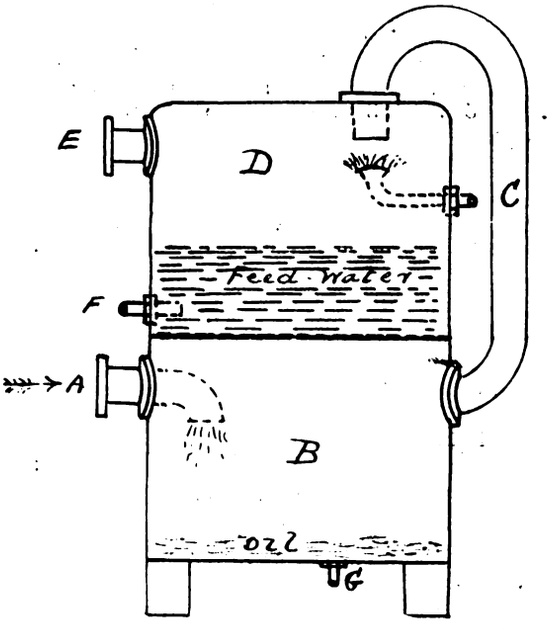
Answer to No. 372 (*awarded* 5*s.*).—The condensed water may be heated either by admixture with a small amount of live steam or by contact with the heating surface of a furnace of some description. The first method is open to the objection that one may possibly be using as much steam to heat the water through 40deg. F. as one saves by exhausting at such a high vacuum. It would be a matter of experiment to determine whether it would not be better to lower the vacuum (provided the engines will get through their work) by using less condensing water, thereby bringing the temperature in the hot-well up to 90deg. or 100deg. F.—a safe temperature for admission to the economisers. At one large central station the drivers have orders not to let the condensed water get below 90deg. F., even if the vacuum has to be reduced. If, however, it is decided to heat the water in this way, a small pipe (say 1½in. or 2in. bore) should be taken from the nearest steam-main and led to the bottom of the hot-well. A valve should, of course, be inserted to regulate the flow of steam. In order to avoid the excessive rumbling that ensues on steam entering the water, a cone can be fixed on the end of the pipe, as shown diagrammatically. The water will enter behind the cone and sweep the steam bubbles along with it, as shown by the arrows. Care should also be taken to avoid fixing the nozzle so as to throw the steam and water directly against a wall of the hot-well, as there would be an undue wearing action. A baffle plate may, however, be fixed in order to spread the current of hotter water throughout the tank.

Probably a more economical way of raising the temperature would be to utilise the waste heat of the flue gases after they have left the economiser. For this purpose a nest of tubes could be placed in the flue in such a position that the gases could pass between them on the outside, while the water from the hot-well to the economiser could



pass through them, the tubes being in "series" or "parallel," as was found best adapted to the object of raising the temperature of the water. In this way waste of the tubes due to sweating and caking of soot would be limited to this set, and the economiser would be spared. It should be noted that the coolest water should meet the coolest gas—*i.e.*, that cooled by the economiser—as it gets hotter, meeting the more intense heat of the gases coming straight from the boilers. In their more modern economisers Messrs. Green provide a special set of tubes arranged on the principle described above, to give a preliminary heating to the cold feed water.—J. A. S.

Answer to No. 372 (*awarded* 5*s.*).—There are several methods of warming up the water from the hot-well so as to prevent sweating of the economiser pipes by using water at a low temperature, but the simplest is to use the apparatus made by Thornton and Crebbin, Bradford, as herewith described and sketched, which, in addition to heating the feed water, extracts all the grease and



prevents it entering the condensers and boilers. The exhaust steam from the (turbine) engine enters a steam-tight chamber, B, by the pipe marked A, when the sudden expansion causes the oil and grease to be deposited to the bottom of the chamber. The steam then passes to the upper chamber, D, by the pipe, C, and entering at the top it is met by a jet of water from the hot-well (70deg. F.). The temperature of the steam leaving the engine will be about 176deg. F., therefore it is more than probable that the water will be raised to about 140deg. F. The pipe, E, is coupled to the condenser pipes, and the pipe, F, to the boiler pump, and the oil is taken from the bottom

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chamber, B, by means of a pipe, G, and a small pump, which can be driven from any convenient existing shaft or otherwise. When this apparatus is used with non-condensing engines, the feed water is heated to 210deg. F.—G. H.

CATALOGUES RECEIVED.

From Messrs. Ernest Scott and Mountain, Limited, we have received their flyleaf No. 1, describing the continuous-current motors manufactured by them at their works at Newcastle-on-Tyne. These motors are of the four-pole type, entirely self-contained, and appear from the illustration furnished to be of compact design. The bearings are fitted with automatic lubricating arrangements, and are lined with white metal of special composition. The armature is of the slotted-drum type, with embedded conductors, the core being securely keyed to the shaft. The commutator is of large diameter, with ample wearing surface, and carbon block brushes are fitted, with the firm's special type of holder. The position in which these motors are placed is immaterial, provided the spindle is kept perfectly horizontal, the end covers being easily turned round to bring the oil-well caps on the bearings to the top.

Messrs. Davies, Kent, and Stewart have recently issued a new catalogue of the various electric lighting accessories manufactured and standardised by them. In glancing through the same one is struck with the large selection of porcelain goods which the firm stock, and which are especially adapted for working on high-voltage circuits. Amongst these there appears a large number of wall and floor sockets, including a series of a flush type, which are exceedingly serviceable in many situations. In certain rooms a projecting plug or socket is most objectionable on the skirting or on the floors, as it is apt to be damaged every time furniture is moved. For such situations the flush wall or floor socket is exceptionally advantageous. We also notice, in the same pages a neat adaptor which allows of twin plugs being connected to the one-floor socket. As this is frequently required when altering the lighting of a room temporarily, we should think the firm will find great demand for the adaptor. The rest of the list deals with more articles than we can refer to even in sections, and contains information which will be of great service to the contracting electrical engineer.

The General Electric Company have just issued a complete list, dealing with the various apparatus they have standardised for use in electric fire-alarms and for fire-alarm work. These range from a connecting pillar to be erected in the street down to the mercury thermostats for giving an alarm of fire in an ordinary room. Amongst the articles in the list is an exceedingly neat portable pocket telephone for the use of policemen and firemen. It folds up into a space of 5¼in. by 3in. by 2in., the whole apparatus being contained in a leather receptacle which can be secured to the firemen's or policemen's waist belts. The same firm have forwarded to us some new particulars of their apparatus to be used in connection with the overhead wires of electric tramways. There seem to be a number of useful improvements in these accessories which are finding their way into general use.

LANCASTER ELECTRICITY ACCOUNTS.

The accounts of the Lancaster Corporation electricity department show a total expenditure on capital account to March 31, 1901, of £35,380. Abstracts of the revenue account and general balance-sheet are given below:

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgages	10,250	0	0
Lancaster Corporation 3 per cent. redeemable stock	24,680	2	4
Reserve fund account	1,200	0	0
Amount set aside for redemption of stock	1,792	14	10
Floating liabilities	752	5	6
Balance, being amount of debt extinguished	556	15	9
	£39,231	18	5

Cr. Assets.	£	s.	d.
Capital expenditure on works	35,380	1	7
Deduct premiums obtained on Corporation stock, less compensation	319	17	8
	35,060	3	11
Payment to "stock redemption fund"	1,792	14	10
Accounts due for current and fittings	1,901	19	3
Stores, etc., on hand	343	19	10
Amount due from treasurer and cash in hand	133	0	7
	£39,231	18	5

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	2,069	16	11
Distribution of electricity	506	3	10
Attending and repairs to public lamps	103	12	1
Rents, rates, and taxes	149	16	6
Management expenses	317	0	6
Special charges—insurances	16	11	4
Allowances and bad debts	69	6	0
Balance to net revenue account	2,705	12	5
	£5,937	19	7

Cr. Income.	£	s.	d.
Sale of current and rent of meters, less discounts	5,021	19	11
Public lighting	658	8	11
Sale and repairs of lamps and other apparatus	244	16	0
Proportion of apprentices' premiums	12	10	0
Cost of summonses (repaid)	0	4	9
	£5,937	19	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Current generated during year (B.T.U.)		370,607
Supplied to public lamps (estimated)	52,674	324,684
Supplied to private consumers by meter	272,010	
Quantity used at works		10,053
Total quantity accounted for		334,737
Quantity not accounted for		35,870
Number of public lamps of 2,000 c.p. each		31
Number of private lamps of 8 c.p. each		24,590
Maximum supply demanded during year (kilowatts)		366

Capacity of generating plant: 14,000 8-c.p. lamps=420 kw.

TAUNTON ELECTRICITY ACCOUNTS.

In the accounts of the Taunton Corporation electricity works for the year ended Dec. 31, 1900, the total expenditure on capital account to date is given as £47,626. Abstracts of the revenue account, general balance-sheet, and statement of electricity, generated, sold, etc., are given below:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,956	13	6
Distribution of electricity	68	15	11
Attending and repairs of public lamps	269	19	7
Royalties, etc., free wiring	193	16	1
Rents, rates, and taxes	112	0	4
Management expenses	646	10	8
Law and parliamentary charges	8	16	9
Insurance, etc.	36	6	3
Cost of materials and fittings, etc.	345	1	2
Total expenditure	3 638	0	5
Amount carried to net revenue account	2,965	12	7
	£6,603	12	10

Cr.	£	s.	d.
Sale of current per meter	3,792	3	4
Public lighting	2,126	5	6
Rental of meters and other apparatus	184	7	3
Rents receivable	5	4	0
Sundry installations and sales	495	12	9
	£6,603	12	10

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount raised by stock	25,996	9	9
Temporary loan	15,500	0	0
Sundry creditors	1,633	17	0
Balance at credit of net revenue account	50	6	4
Stock redemption fund account	3,852	7	7
Balance at credit of repayment of loans account	556	13	4
Balance at credit of reserve fund account	450	0	0
Amount due to treasurer	6,795	16	4
	£54,835	10	4

Cr. Assets.	£	s.	d.
Capital account—amount expended	47,626	16	6
Stores on hand	525	13	4
Sundry debtors for current supplied	2,407	19	5
Other debtors	416	11	10
Stock redeemed and stock redemption fund	3,852	7	7
Cash in hand	6	1	8
	£54,835	10	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			434,762
Quantity sold	Public lamps	128,979	307,179
	By contracts	240	
	Private consumers by meter	177,960	
Quantity used on works			52,060
Total quantity accounted for			359,239
Quantity lost in mains, transformers, etc.			75,523
Total maximum supply demanded (kilowatts)			320

Number of public lamps, 72 arcs, 185 incandescents.

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WALSALL ELECTRICITY ACCOUNTS.

From the accounts of the Walsall electricity department (just issued) it appears that the total expenditure on capital account to Dec. 31, 1900, amounts to £34,309. Appended are abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc, for the past year:

Dr. Revenue Account.	£	s.	d.
Generation of electricity	1,585	2	3
Repairs and maintenance of buildings, plant, etc.	760	8	0
Distribution of electricity	87	3	5
Attending and repairs to public lamps	88	14	8
Rents, rates, and taxes	245	10	1
Management expenses	309	19	3
Special charges—insurance	23	12	2
Total expenditure	3 100	9	10
Balance carried to net revenue account	1 592	16	9
	£4,693	6	7

Cr.	£	s.	d.
Sale of current for lighting and power, less discount.	4,122	5	1
Public lighting	488	0	0
Rental of meters	83	1	6
	£4,693	6	7

Dr. General Balance-Sheet.	£	s.	d.
Sundry creditors on open accounts	1,760	14	9
Deposits returnable	73	6	6
Amount due to borough treasurer	8,596	13	2
Sinking fund for loans and stock, less loans paid off..	2,783	5	2
Reserve for discount on current	141	19	4
	£13,355	18	11

Cr.	£	s.	d.
Stock on hand	68	8	4
Sundry debtors for current, rents, meters, and lamps	1,885	19	1
Amount in hands of engineer	5	0	0
Amount due on loans sinking fund	447	1	11
Consolidated loans fund	1,567	0	2
Accumulators account—balance carried forward	247	10	0
Balance at debit of capital account	8,859	15	11
Balance at debit of net revenue account	275	3	6
	£13,355	18	11

Statement of Electricity Generated, Sold, etc.

Quantity generated, B.T. units			404,682
Quantity sold	By public lamps	29 280	275,643
	Private consumers by meter	246,363	
Quantity used on works			17 606
Total quantity accounted for			293,249
Quantity not accounted for			111,433
Number of public lamps			19
Total maximum supply demanded (kilowatts)			301

LEGAL INTELLIGENCE.

LEYTON ELECTRIC LIGHT WORKS.

In the High Court of Chancery, on Tuesday, the case of Hawkes *v.* Leyton Urban District Council came again before Mr. Justice Buckley on the application of the defendant Council for suspension of the writ of sequestration which had been granted against them. It will be remembered that an injunction was originally granted against the defendants in respect of an alleged nuisance caused by the way in which they carried on their electric lighting works, especially by gas-engines. The defendants disobeyed the injunction, in consequence of which his Lordship directed a writ of sequestration to issue against them for their contempt. The Court of Appeal refused to interfere with this decision, as reported in last week's issue, and said that if any suspension of the sequestration was to be allowed it must be on a proper submission, and on such terms as Mr. Justice Buckley would grant, but they suspended the sequestration for a week to allow of the present application being made. An affidavit of the chairman of the Council was put in verifying a resolution of the Council expressing regret that the injunction had been broken, and stating their ignorance of what had been done and their desire to submit to the Court.

Mr. Justice Buckley he was willing to accept the defendants' submission. The order to be made would be expressed to be by consent, and would be for an injunction restraining the Council, their servants and agents, from working gas engines at all, so that in case the order was disobeyed some responsible person could be sent to prison. His Lordship suspended the writ of sequestration until June 17 to enable the Council to take professional advice and be able to tell the Court what they proposed to do to enable them to provide for their requirements without causing a nuisance. The motion would stand over until June 17, when, if satisfied, he should be prepared to grant a further extension of time.

Judgment accordingly

COMPANIES' MEETINGS AND REPORTS.

CUBA SUBMARINE TELEGRAPH.

At the general meeting of the shareholders of this Company held at the offices, Old Broad-street, **Mr. Charles W. Parish**, who presided, stated that the results shown in the revenue account for the half-year ended Dec. 31 last were not by any means of that excellent character to which they had been accustomed. It was disappointing to see their traffic receipts falling off so seriously, but the competition of new routes and the reduction of rates had naturally upset the unique position which the Company held for many years, and now the Board would have to work hard in order to meet the change of circumstances. Nothing that the Company could have done would have altered the march of historical progress in connection with the island of Cuba. The United States and Cuba were now negotiating as to the future status and government of the island, and some persons believed that with the end of Spanish rule there would be a rapid outburst of prosperous business, but that was scarcely reasonable, and both the United States and Cuba would require a full measure of patience to bring their joint interests into that complete accord which would produce the greatest amount of prosperity and happiness to the island. During the period under review the traffic receipts came to £8,904, the interest received was £2,059, and transfer fees £7, being a total of £10,970, as compared with £14,195 for the half-year ended Dec. 31, 1899. The expenses in the second half of 1900 were £5,502, and in 1899 £6,192, a saving of £690 which reduced the net decline in income to £2,535. Including the balance of £5,204 brought forward, there was £16 175 to be dealt with, from which it was proposed to pay a dividend at the rate of 4 per cent. per annum on the ordinary shares, in addition to the preference dividend at the rate of 10 per cent. By making these payments the carry forward would be reduced by £732. He regretted to announce that they had not yet succeeded in collecting the claim of £8,174 from the Government of the United States in respect of damage done to the Company's cables during the Spanish-American war, nor had the United States Government recognised the Company's concessions, or agreed to the subsidy being paid, the amount overdue now being £4,158. The Board's last communication from the Foreign Office referred to this unfortunate delay, connecting it with the negotiations proceeding between the United States Government and Cuba as to the future government of the island. He moved the adoption of the report and accounts.

Mr. George Keith seconded the motion, which was eventually adopted without opposition, as well as the proposed dividends.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING.

The directros' report for 1900 shows that the total capital expenditure to Dec. 31, on account of buildings and plant for electric lighting, amounted to £14,287. The gross receipts, including the amount receivable from the Kidderminstor and Stourport Electric Tramway Company for dividend on the shares held by this Company, amount to £1 778 which, added to £1,146 brought forward, makes £2,924. After deducting the expenses (including interest on loans), amounting to £767, there remains a net profit of £2,157. The directors propose that this amount should be applied as follows—namely, to dividend on cumulative preference shares for the year 1900, £1,449; to be carried forward, £708. The directors attach to the report a copy of the balance-sheet and profit and loss account of the Kidderminster and Stourport Electric Tramway Company. The net profits in respect of the tramways amounted to £2,108, which added to £92 brought forward, make a total sum available of £2,201. This amount has been applied as follows—namely, to dividend of 5s. 6d. per share on 5,720 shares, £1,573; to depreciation fund, £500; to be carried forward, £128. The public supply of electric energy for lighting and power was begun on Aug. 22, 1900. From the commencement there has been an active demand for light, the actual number of lamps connected to the mains being now equivalent to 5,760 of 8 c.p., and applications have been received for a further 162 8-c.p. lamps. Some of the manufacturers have been induced to try electric motors for driving their machinery, and the installations already made have been attended with most satisfactory results, so much so that the Company has now more applications for power than the present plant can supply. New generating machinery is on order and nearly ready for delivery, which will increase the available power by 600 kw., equal to 800 h.p. The above report will be presented at the meeting to-day.

SOUTH AFRICAN LIGHTING ASSOCIATION.

The report of the directors for 1900 states that the continuance of the war in South Africa has again affected the normal progress of the association at both of its stations, and the bad state of trade, due to the same cause, has prevented any extension of operations. Increased cost of coal has also had to be met to a considerable extent, and as the price of gas was reduced by 10d. in July, 1899, at Port Elizabeth, this factor must be also considered on a comparison of results of the last two years. Notwithstanding these drawbacks, the directors state the results may be regarded as satisfactory, due in a measure to the improved manufacturing results obtained, and a certain increase in consumption at both Port Elizabeth and Grahamstown. Capital expenditure during the year principally arises in connection with the completion of the new coal store.

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The balance of profit and loss account, including the balance brought forward, and after payment of interest on debentures and income tax. is £11,260. Out of this there has been paid an interim dividend of 4 per cent. (8 per cent. per annum) to June 30, 1900, amounting to £2,400. The directors have placed to reserve £2,000, leaving available a sum of £6,860. The directors recommend a final distribution of 6 per cent.. making 10 per cent. for the year, and the carrying forward of £3,260.

SALISBURY ELECTRIC LIGHT AND SUPPLY.

The directors' report for the year ended Dec. 31 last states that the progress made by the Company during the past year has been satisfactory. The number of consumers has increased from 148 with 6,228 lamps connected, to 210 with 9,795 lamps connected, whilst the sales have increased from £1.165 to £2,320. The profit on the year's working amounts to £1,568. 10s. 4d.. and after writing off the debit balance from last year, £206. 7s. 9d., and payment of £1,230. 19s. 6d. interest on debentures and loans, there remains a balance of £131. 3s. 1d. available for dividend on the ordinary shares. The directors recommend that a dividend be paid at the rate of 3 per cent. per annum on the ordinary shares carrying forward a balance of £21. 10s. 1d. to next account. Of the directors, Mr. Hammick retires by rotation, and being eligible, offers himself for re-election. The auditor, Mr. F. Aston Dawes, also retires, but is eligible, and offers himself for re-election.

Dr. Abstract of Revenue Account.	£	s.	d.
Generation of electricity	583	17	4
Distribution of electricity	45	12	8
Attendance and repairs of public lamps	5	6	7
Rates and taxes	65	7	0
Management expenses	230	6	4
Law expenses	15	17	9
Insurances	34	10	0
Total expenditure	980	17	8
Balance to net revenue account	1,535	18	0
	£2,516	15	8

Cr.	£	s.	d.
Sale of current per meter, less discounts	2,303	12	3
Public lighting	16	13	4
Rental of meters, wiring, and motors	137	2	0
Rents receivable and transfer fees	59	8	1
	£2,516	15	8

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	24 855	0	0
Sundry tradesmen and others for plant, etc.	10,715	16	6
Sundry creditors on open accounts	901	2	5
Balance at credit of net revenue account	131	3	1
	£36,603	2	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	34,526	5	4
Stores on hand	233	18	9
Preliminary expenses	358	19	6
Sundry debtors for current supplied	1,317	0	7
Cash at bankers £126 6 5			
Cash in hand 40 11 5			
	166	17	10
	£36,603	2	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		125,322
Quantity sold	Public lamps 2,500; Private consumers by meter 109,978	112,478
Quantity used on works		3,389
Total quantity accounted for		115,867
Quantity not accounted for		9,455
Number of public lamps		33
Total maximum supply demanded (kilowatts)		138

APPOINTMENTS VACANT.

Consulting Engineer, Waterford, May 28. Details in our advertisement columns.

Cable Foreman, Keighley, wages 35s., May 29. Details in our advertisement columns.

Resident Electrical Engineer, Maidstone, £250 per annum, May 30. Particulars in our advertisement columns.

Assistant, to take charge of testing continuous-current dynamos and motors. Details in our advertisement columns.

Lecturer in Electro-Technics, University College, Liverpool, £200 per annum, May 31. Details in our advertisement columns.

Engine and Dynamo Attendant, North Wales Counties Lunatic Asylum, 30s. per week. Particulars in our advertisement columns.

Electrical Engineers, South Shields, £350 per annum, May 22. Walthamstow Urban District Council, £300 per annum, May 24. Particulars in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Colne.—The Corporation invite tenders for a boiler, mechanical stoker, economiser, overhead crane, transformer, etc. Tenders by May 20.

Glasgow.—The Corporation invite tenders for the supply of electricity meters. Tenders by June 10. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the wiring of the new Council offices. Tenders by June 5. Details in our advertisement columns.

Worksop.—The Urban District Council invite tenders for the supply of 150 electricity meters. Tenders by May 29. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of steel plate coal bunkers and overhead gantry. Tenders by May 31. Details in our advertisement columns.

West Stanley (Durham).—Tenders for electric lighting are invited on inspection for new Catholic church, West Stanley. Apply to Rev. J. Thompson. Tenders by June 1

Rochdale.—The Corporation invite tenders for the supply and delivery at Rochdale, Lancs., of copper rail bonds. Tenders by 23rd inst. Details in our advertisement columns.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection of dry-back marine-type boilers. Tenders by June 8. Details in our advertisement columns.

Motherwell.—The Electric Light Committee invite tenders for cast-iron lamp columns, arc lamps, switches, fittings, etc. Tenders by May 18. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of special (permanent way) track work, cross-over tracks, etc. Tenders by May 25. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for the supply and erection of motors and motor-generators, accumulators, meters, and works wiring. Tenders by June 3. Details in our advertisement columns.

London.—Tenders are invited for a supply of wire copper, lead, zinc, etc. Particulars may be obtained from Mr. Julian Byrne, secretary of the Madras Railway Company 61, New Broad street, E.C. Tenders by May 22.

Hull.—The Electric Lighting Committee invite tenders for 12 direct-current street arc lamps, erected complete with cast-iron posts and spare parts and accessories. Tenders by May 23. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for the supply and erection of main switchboards, sub-station switchboards, transformers, arc lamps, and arc lamp pillars. Tenders by June 3. Details in our advertisement columns.

Exeter.—The Town Council invite tenders for erection of the buildings of their new electricity generating station. Specifications, etc., may be obtained from Mr. Donald Cameron, city engineer and surveyor. Tenders by June 14.

Newcastle-upon-Tyne.—The Corporation invite tenders for supply of 800 tons of tramway rails, fishplates, etc. Particulars may be obtained at the office of the City Engineer, Town Hall, Newcastle-upon-Tyne. Tenders by 18th inst.

Salford.—The Corporation invite tenders for the supply and delivery of additional steel poles, cast-iron bases, etc. (Contract No. 16), in connection with the electric tramways. Tenders by June 3. Details in our advertisement columns.

Long Eaton.—The Urban District Council invite tenders for the manufacture and delivery on seat of two steel Lancashire boilers, engines, dynamos, switchboard, and accessories. Tenders by May 20. Details in our advertisement columns.

Salisbury.—The Urban Sanitary Authority invite tenders for erection of a chimney shaft, 120ft. high and 5ft. internal diameter. Specifications, etc., may be obtained from Mr. Alfred C. Bothams, A.M.I.C.E., Municipal Offices, Salisbury. Tenders by May 25.

Aldershot.—The Urban District Council invite tenders for erection of buildings and shaft in connection with their electric lighting station. Specifications, etc., may be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., surveyor. Tenders by June 4.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the first portion of the Colinton Mains Fever Hospital, the number of lighting points being about 1,550. Tenders by June 12. Details in our advertisement columns.

Bermondsey.—The Borough Council invite tenders for the wiring, fittings, and other material required in connection with the installation at the Corporation's electricity supply station and stables, Neckinger, Bermondsey, S.E. Tenders by May 21. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of 5,000 tons of steel girder tramway rails and about 170 tons of steel fishplates, 110 tons of steel tie-bars for tramway rails and 35 tons of bolts and nuts for fishplates, and 5,000 steel tramway poles. Tenders by May 18. Details in our advertisement columns.

Stoke-upon-Trent.—The Guardians invite tenders for electric motors for driving new laundry machinery, also the wiring of laundry buildings, nurses' home, and farm buildings. Specifications, etc., may be obtained from the consulting electrical engineer, Mr. G. R. Peers, A.I.E.E., 96, Deansgate, Manchester. Tenders by 22nd inst.

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Exeter.—The Council invite tenders for boiler-house equipment, pipes, etc., engine-room equipment, switchboards, connecting cables, coal bunkers and conveyors, and feed and condensing water tanks. Tenders by June 14. Details in our advertisement columns.

Madrid.—Tenders are invited by the Spanish Government for a concession for working a system of electric tramways at Barcelona, the concession already granted having been annulled. Particulars may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by June 3.

Bradford.—The Corporation invite tenders for the construction and erection of a five-ton electric travelling crane for their new tram depôt, Leeds-road, Thornbury, to operate on a 500-volt direct-current circuit. Specifications, etc., may be obtained on application to Mr. C. J. Spencer, A.M.I.E.E., tramway manager, 5, Forster-square, Bradford. Tenders by May 18.

Madrid.—Tenders are invited by the Spanish Postal and Telegraph Department for the supply of 30,000 zinc cylinders for the service of the Government telegraph stations. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by June 1.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

London, S.W.—Tenders are invited for the supply of 13,400 tons of steel rails and 958 tons of fishplates for the Queensland Railways. Tenders will be received at the Queensland Government Office, 1, Victoria-street, London, S.W., until 2 p.m. on June 11, endorsed "Tender for Steel Rails and Fishplates," and accompanied by a preliminary deposit of 1 per cent. on the tender. Specifications, drawings, etc., may be obtained at the office of the Agent-General for Queensland.

Kingstown.—The Urban District Council invite tenders for the construction, supply, and erection of boilers, pumps, steam and water pipes, tank, economiser, ironwork, etc., engines, generators, balancer and booster, switchboards and instruments, battery of accumulators and accessories, supply and laying of insulated electric cables, conduits, road frames and covers, street work, drawing-in boxes, feeder switch pillars, etc., fitting of electric light at the electricity supply station, George's-place, Kingstown, supply of electricity meters, demand indicators, and main fuses, supply and erection of arc and incandescent lamps and fittings. Tenders by 30th inst. Details in our advertisement columns.

Ludlow.—The Corporation invite tenders for the supply and erection of one water-tube boiler to be erected and fitted for connection with a refuse destructor, with electric motor, injector, etc.; one ditto, ditto, for a coal-fired boiler, and furnace connected therewith; two quick-revolution compound two-crank self-lubricating engines, coupled direct to compound-wound dynamos, equal to an output of 35 kw. each, with motor-transformers and accessories; steam, exhaust, and feed pipes; overhead travelling crane (six tons); switchboard and instruments; accumulators; electricity supply mains; and public arc lighting and glow lamps, the latter on existing pillars. Tenders by May 20. Details in our advertisement columns.

Tonbridge (Kent).—The Urban District Council invite tenders for the supply and erection of (Section A) boiler-house plant—two Lancashire boilers and accessories, steam pump, injector, and economiser; (B) engine-house plant—two 50-kw. steam dynamos, motor-transformer, and accessories; (C) condensing apparatus and pipework; (D) overhead travelling crane; (E) switchboard and instruments; (F) accumulators; (G) electricity supply mains; (H) public arc lighting; (I) house meters; (K) public incandescent lighting, for the municipal electricity works. The whole bound up in one specification. Specifications, etc., may be obtained by manufacturers at the offices of Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders by May 30.

Tedmerden.—The Fielden Joint Hospital Committee invite tenders for the erection and maintenance of telephonic communication between the Fielden joint hospital, the workhouse, and the Urban District Council offices Hebden Bridge, and the Urban District Council offices at Mytholmroyd, and the house of the receiving officer at Hebden Bridge. The line to be a single line 14's copper wire, all Post Office insulators and creosoted poles, and the tender to include the cost of wayleaves, poles, and all necessary apparatus, including switching instruments. Each tender to contain a full specification of work to be done and materials provided, and to be stated in two amounts: (1) the tender for the installation or erection of the communication; (2) the sum for annual maintenance for a term of seven years; (3) also for annual maintenance for the present telephonic communication between the hospital, the workhouse, the gasworks, the market hall and the town hall. Tenders by 21st inst.

RESULTS OF TENDERS.

Watford.—The Electric Lighting Committee have accepted the tenders of Ferranti and Co. for supply of switch gear, at £733, and 12 junction boxes, at £210.

Ashton-under-Lyne.—The Corporation have placed an order for two 250-h.p. direct-current generating units with Siemens Bros. and Co., Limited, at £3,260, with Belliss engines. Fifty offers were received.

Middlesbrough. — The Electric Lighting Committee have accepted the tender of Messrs. Witting Bros., at £3,564, for the engine-house plant required for the extension of the works.

Jarrow.—The Town Council have accepted the tender of the National Telephone Company to put in four new instruments and batteries for £11. 10s., and to maintain the private telephone wire for £7 per annum.

Ayr.—The Lighting Committee have agreed to accept the tender of Messrs. Callender, amounting to £3,625, for the extensions necessary for the introduction of the low-tension continuous-current system into the central area.

Bushey (Herts).—The order for three complete sets of direct-coupled Taunton dynamos and Belliss engines for the Royal Masonic Institution for Boys, Bushey, has been placed with the Newton Electrical Works, Limited, Taunton.

Whitehaven.—The Town Council have accepted the following tenders: Proctor and Cottrill, supply of bitumen, subject to a guarantee of 84 per cent. of best Trinidad bitumen being given; Callender and Co., 200-gallon bitumen boiler, and 1,000 yards 7/18 cable and 1 000 yards 7/20 cable; Electric Construction Company, balancer; Ramsay and Co., two screw jacks; Clarke and Co., disconnecting boxes.

Kingston-on-Thames.—The Corporation have accepted the following tenders: Babcock and Wilcox, construction of underground flues and setting of economisers £1,273, one Wheeler condenser £1 086 one Blake-Knowles cross-compound vertical steam pump £185, one Cochrane oil separator £243, steam, exhaust, feed, blow off, and drain pipes £1,198. 4s.; Carter and Sons, Stalybridge, two Pimbley's economisers, £635. 6s.

Eastbourne.—The Corporation have received the following tenders for building six large and nine small underground transformer chambers, to be constructed of brick or cast iron: Six large (cast iron)—J. Every, Lewes, £519. 6s. 6d., erecting ditto £35 (accepted); Beck and Co., London, £611. 8s. Brick—C. E. Kemp and Sons, Hove, £1,380; Tapner and Co., Hastings, £1,266. Nine small (cast iron)—J. Every, £133. 10s. Brick—Tapner and Co., £121. (Neither tender for nine small accepted.)

Bradford.—The Electricity Committee have recommended the Council to accept the following tenders: British Insulated Wire Company, Limited, at £2,562, for the supply and delivery of lead-covered and armoured cable for lighting main extensions; Phœnix Dynamo Manufacturing Company, Bradford, at £1,403. 18s., to supply and erect at the Bolton-road electricity works a combined motor balancer and boosters, with the requisite switch gear for same; Phœnix Company, at £907. 10s., for the supply, delivery, and erection at the Valley-road electricity works of a 100-kw. motor-generator, with the requisite switch gear for same; Messrs. Lockerbie and Wilkinson, Limited, Birmingham, at £2,163, for the supply and fixing of overhead rails and fittings required at the St. James's Carcase Market.

Newport.—The Corporation have accepted the following tenders in connection with the new power station:

A. S. Morgan and Co., Newport, foundations	£9,349
Hemmingways, Limited, Middlesbrough, structural steelwork	11,955
J. Lysaght and Co., Limited, Bristol, steel flue	712
New Conveyor Company, Limited, Birmingham, coal and ash conveyor	1,987
J. Hitchin and Son, Halifax, overhead traveller	955
Babcock and Wilcox, Limited. London, steam boilers	5,893
Underfeed Stoker Company, London, mechanical stokers	1,198
A. Lowcock, Limited, Shrewsbury, fuel economiser	575
Westwood and Wright, Brierley Hill, water storage tanks	324
Markham and Co., Chesterfield, steam-engines	11,590
Witting Bros., for Kolben and Co., Prague, electric generators	5,170
Worthington Pumping Engine Company, London, condensing plant	5 056
J. P. Hall and Sons, Limited, Peterborough, feed-water pumps	292

The tenders were accepted with the amendment that two instead of three engines for producing 250 kw. be laid down, and the other plant be reduced in proportion. The Walsall Electrical Installation Company's tender for the light at the workhouse, at £1,600, was also accepted.

BUSINESS NOTES.

TRACTION.

Barcelona.—Traffic was resumed on the Barcelona Ensanche y Gracia lines on the 11th inst.

Newport.—The Town Council have decided to erect a power station on Corporation-road for traction purposes only.

Huddersfield.—It has been decided to take a poll of the ratepayers on the question of the running of trams on Sundays.

Wimbledon.—The Urban District Council have resolved to apply in the next session of Parliament for a tramways provisional order.

Steurbridge.—Some enquiry has been made as to the delay in providing the equipment for the electric tramways after setting up the poles.

Walker.—The District Council have decided to further oppose the Tyneside Tramway Company's Bill before the House of Commons.

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Chatham.—We understand that the British Thomson-Houston Company have now made a start with the work of constructing the electric tramways for the town.

Southend.—It is stated that there is no hope of the tramways being in a sufficiently forward state to enable a service of cars to be put upon the roads before Whitsuntide.

Burton-on-Trent.—The amounts to be borrowed under the Corporation Bill include £52,057 for the construction of the proposed tramways, and £41,900 for tramway purposes.

Cleator Moor.—The Urban District Council have decided that application be made to the Local Government Board for approval of the Council's opposition to the Tramway Bill.

Brierley Hill.—The following gentlemen constitute the new Tramways Committee of the District Council: Messrs. Hancox, Applebey, White, Guest, F. Cartwright, and Morgan.

Heywood.—A sub committee has been appointed to deal with matters relating to the existing tramways, and also to consider and report as to any proposed extensions of the tramways.

Cleethorpes.—In consequence of the tramway operations—the line is being extended to Sea Bank-road in connection with the projected electric service—certain street-widening work has to be done.

Durham.—The Rural District Council have appointed a committee to meet Major Tulloch, chief inspector of the Local Government Board, on the question of the laying down of tramway lines so far as the scheme affects their district.

Parliament.—The West Cumberland Electric Tramways Bill and the London United Tramways Bill have been read a second time in the House of Commons. The Dublin St. James's Gate Brewery Tramway Bill has been read a third time.

Richmond.—The Town Council have sealed a petition to Parliament against the London United Tramways Bill with a view to ensuring the amendment of the Bill in accordance with the agreement between the Corporation and the company.

Spennymoor.—The Urban District Council have decided to support the United Kingdom Tramway Syndicate in the promotion of a provisional order for the construction of tramways on the overhead electric trolley system in the district.

Aberdeen.—The Tramways Committee have decided that the whole of the Great Western-road shall be recausewayed and made ready for electric traction, so that the thoroughfare should be worked electrically from Mannofield to the Holburn junction.

Northfleet.—The District Council have approved the amended plans from the British Electric Traction Company for the proposed Gravesend and Northfleet tramways, subject to certain further amendments. It is intended, we understand, to start work very shortly.

Coseley.—The District Council have received a letter from the British Electric Traction Company, asking for permission to break up the roads under the control of the Council for the purpose of erecting tramway poles. The matter is in the hands of the surveyor.

Newcastle.—The Parliamentary and New Tramways Committee have recommended the Town Council to continue to oppose the Tyneside Tramways Bill before the Committee of the House of Commons, and to see that everything was done to defeat the object of the promoters so far as Walker was concerned.

Wigan.—The Bill promoted by the Corporation for the purpose of conferring on them further powers in regard to the construction of tramways, street improvements, and electric lighting, has passed Lord Morley's committee as an unopposed measure. The town clerk proved the preamble, and the Bill was ordered for third reading.

Jarrow.—The Light Railway Commissioners, in a recent communication to the Jarrow Town Council, intimated that they had recommended to the Board of Trade the Durham Electric Supply Company's proposed route for light railways so far as it applies to the borough, in preference to the alternative route suggested by the Corporation.

Ayr.—The Corporation have fixed upon the scale of wages to be paid their tramway employés. So far the weekly wages bill will amount to £42. The Town Council have decided that the trolley poles shall be placed between the tramway lines through the town. When the electric tramway is opened there will be a full service of cars on Sundays.

Leith.—The Corporation have received a letter from the secretary to the Edinburgh Street Tramways Company, asking if it be the desire of the Corporation to enter into negotiations with the company with the view of introducing electric haulage on the Leith tramways. The General Committee have resolved to take no action in the meantime at least.

Aston Manor.—Mr. Councillor Gittings has been appointed chairman of the Tramways and Electric Light Committee of the Urban District Council for the ensuing year. Steps are being taken to obtain the approval of the Board of Trade to the purchase by the Council of that part of the undertaking of the Birmingham and Aston tramway as authorised by the order of 1880.

St. Helens.—It was stated at the Town Council meeting on Wednesday that on the tramway account last year's estimate of £3,894 was overspent by about £1,700, including £800 for interest and sinking fund and £100 for ground rent. The estimate for next year was £6,937. The total expenditure on this account was charged against the rent and interest payable by the tramways company.

Ashton-under-Lyne.—A sub-committee appointed for the purpose has visited a great number of towns in kingdom, and it was stated at the monthly meeting of the Town Council had been much impressed by the general system in vogue at Southport. The Ashton scheme would be practically like the Southport one in regard to overhead trolleys, and both single Californian cars and double-deckers would be used.

Stockport.—The Market-place tradesmen are agitating for better tramway facilities. At a largely attended meeting recently it was resolved: "That the Tramway Committee of the Stockport Corporation be asked to adhere to their original pledge, that the trams from Bredbury should go by Newbridge-lane and Millgate to the Market-place; also that the Hall street trams should go down Churchgate to the Market-place."

Darwen.—At the quarterly meeting of the Town Council the Chairman of the Electricity and Tramways Committee stated that there was a loss in the electricity department during the past year of £886, and on the tramways of £604. The capital in the electricity department amounted to £38,000, and the receipts only totalled £3,000. He thought they ought to have a moderate profit at the end of the next financial year.

London County Council Tramways.—The Select Committee of the House of Commons presided over by Mr. Seale-Hayne continued this week the consideration of the Bill of the London County Council providing for numerous tramway extensions and junction lines, principally on the south side of the Thames, the whole to be worked, together with the existing lines, by electricity on the conduit system, under the powers of the Act obtained last year.

New York Tramway Strike.—Advices from New York state that serious rioting has broken out in Albany, New York, where the employés of the city tramway companies are on strike for higher wages. The rioters got beyond control of the local authorities, and the military had to be called out. In Troy, New York, the tramcar strikers are also spreading terror. It is said they have torn up the tracks and demoralised business. A large number of troops are on the spot.

Leigh.—The South Lancashire Tramways Company have notified the Town Council that they are prepared to enter into arrangements to provide a supply of electricity in bulk to the Corporation, and that the company's generating station would be at Atherton instead of at Leigh, and that they would lay the cables from Atherton to the borough of Leigh free of charge. The Town Council have decided to reply that they expect the company to fulfil their promise to erect their generating station at Leigh.

Dundee.—At this week's meeting of the Tramways Committee Mr. Wm. Mackison, the burgh engineer, reported satisfactory progress in connection with the tramways works. A recommendation that block signals should be placed at South Tay-street and West Port, at a cost of about £85, was approved. A suggestion by the manager to the effect that shelters should be placed at Ninewells of the same kind provided at Polepark also received the approval of the committee, and instructions were given accordingly.

Waterloo-with-Seaforth.—At the last meeting of the Urban District Council it was stated, in connection with the tramways, that the surveyor, having obtained the consent of the frontagers concerned to the construction of a new loop south of Cambridge-road, the Board of Trade had also given their consent. It was further stated that the Liverpool Overhead Railway Company had given instruction for overhead guard wires to be fixed in addition to the guard strips, in accordance with the latest ideas of the Board of Trade.

Liverpool.—An inquest arising out of the running over of a young child in Liverpool who strayed on the electric tramlines, resulted in a verdict of "accidental death." The tramway manager stated that the Corporation had carried one hundred million passengers since electric power was used, and, compared with horse cars, the percentage of fatalities were fewer by electric than by horse cars. As to the best kind of front guard to tramcars, the manager favoured a guard which pushed the object clear off the track instead of picking it up.

Scarborough.—At the monthly meeting of the Town Council attention was drawn to a letter from the British Electric Traction Company, Limited, making proposals for the introduction by the company of a system of electric tramways for Scarborough and district. The matter had been referred to the Tramways Sub-Committee, who were considering it. It must be remembered, however, that the Corporation had pledged its word to Parliament to introduce a Tramways Bill next session, and this meant that they must commence the work of preparation at once.

New General Traction Co.—The report of this Company for the year ended March 23 states that the gross profits were £41,087, and £37,031 was brought forward. The directors propose to transfer £7,000 to reserve against goodwill and £10,000 to the general reserve. A distribution is proposed of 4 per cent. for the year on the ordinary shares, leaving £41,136 to be carried forward. To meet the cost of the competition of the Philadelphian system, and to cover the amount of the outstanding loans, the directors propose to issue £200,000 of 5 per cent. redeemable debentures.

Darlington.—On the completion of the agreement between the Corporation and the Imperial Tramways Company for the purchase of the company's undertaking for £7,500, the Council will have to submit a scheme for electric tramways. It has been intimated by the Light Railway Commissioners to include Houghton-le-Skerne and Cockerton outside villages. An adverse

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movement is being promoted by opponents of municipalisation, and a requisition for a public meeting has been sent to the Mayor. A preliminary meeting of the ratepayers' association has been held to consider the matter.

Returns.—The Board of Trade's customary sessional returns shows the total number of Bills deposited for the present term of Parliament relating to railways, canals, and tramways, and electricity, gas, and water undertakings to be 190, representing £88,738,900, as compared with 213, representing £94,534,200 last year. The number of measures concerning electricity is 11, and the proposed capital amounts to £12,549 300. Tramway Bills number 36, and stand for £4,433,500. In addition to these measures there are 166 applications, requiring £4,101,500, for provisional orders, of which 108, taking £1,994,600, are for electric lighting.

Swindon.—The Corporation were engaged on Tuesday in considering the report of Colonel Yorke, Board of Trade inspector, with regard to his inspection of the routes selected for the proposed electric trams, and it was decided, subject to the arrangement of details, to accept the recommendations of Colonel Yorke. The chairman of the Tramways Committee, with the engineer (Mr. Lacey) and the solicitor, were directed to interview the Board of Trade on the subject. The plans of the building for the electric generating station have been approved by the Works and Plans Committee, and tenders for the erection of these buildings will be at once advertised for.

Paisley.—The enquiry under the Private Legislation Procedure (Scotland) Act into the rival Corporation and private tramway schemes for Paisley came to a conclusion before the Parliamentary Commission presided over by the Earl of Camperdown last week. The Chairman said the Commissioners had decided to recommend that the Corporation tramways order be refused and that Mr. Murphy's Bill might for the present proceed. At some time or another the Commissioners intended to require that in some form or another a guarantee be given for the completion of these tramways. Mr. Murphy announced, through his counsel, that he was prepared to give his guarantee.

Preston.—The Town Council have approved the report of the General Committee in regard to the proposed tramways recommending the adoption of the low-tension current system with overhead trolley wires, and suggesting as a convenient site for the generating station land near the Corporation destructor in St. Paul's-road. They further recommended that instead of taking advantage of powers for a 4ft. gauge already obtained, a gauge of 4ft. 8½in., as employed in most towns, should be adopted, and that the Corporation should construct and work the tramways themselves, "believing, although no trustworthy forecast could be made, that the service might be made to pay."

South Lancashire Tramways Bill.—This Bill came before the committee of the House of Lords last week, when the chief opposition raised was on behalf of the Corporation of Salford, who sought special clauses for the protection of their gas and water mains from the possible danger of electrolysis. For the promoters it was contended that the Board of Trade clause already inserted in the Bill gave the Salford Corporation every reasonable protection. In the end, Lord Ducie (the chairman) announced that the committee had determined not to insert the clauses asked by Salford, and passed the Bill in its original form, including the right to supply electrical power to local authorities within the area served by the company.

Speed of Motorcars.—At the annual general meeting of the County Councils' Association, held on Wednesday at the Westminster Guildhall, under the presidency of Sir J. T. Hibbert, the question of the relation of roads to motorcars was raised. It was stated that 12 county councils were in favour of the reduction of the pace of motors from 12 to 10 miles, and 13 were against any reduction. A letter from the secretary of the Automobile Club expressed the view that there should be no alteration in the regulation as to speed, but that vehicles should not be driven to the common danger, and that the proposed numbering would seriously injure the motor industry of the country. No resolution was put to the meeting.

Limerick.—The Town Council, having sanctioned the scheme of the Limerick Tramways Committee, have resolved that it may be modified as follows: "That instead of a period of 21 years for which the use of the streets is to be given, the streets are to be given in perpetuity, with the option of the Council to purchase at the expiration of 50 years or at any time thereafter, any difference in price to be settled by arbitration, and that instead of a revision as to wayleave every seven years the tramway company are to pay £50 per mile per annum wayleave, and in any event until they paid 6 per cent. dividend, and after that to pay to the Council £50 per annum for every 1 per cent. dividend paid by said company in addition to the above wayleave."

Blackpool.—The Corporation Bill came before a Select Committee of the House of Commons this week. The measure includes a proposal for the extension of the tramway from Waterloo-drive along Middle-lane to the borough boundary at Squires Gate-lane, and this was opposed by the Blackpool, St. Annes, and Lytham Tramways Company, on the ground that this tramway, running parallel to Lytham-road, was intended to compete with the line leased by the Corporation to the company, and would intercept and divert traffic from the company's line. Certain owners and occupiers of properties also petitioned against the Bill. Evidence testifying to the advantage attending the development of the tramways in the town was given, and the committee adjourned.

Bicycle-Carrying on Light Railways.—The question of bicycle-carrying on light railways was raised before Sir Courtenay Boyle on Tuesday in connection with the South Yorkshire light railway. On behalf of the Cyclists' Touring Club it was proposed that a bicyclist should be able to have his bicycle carried the whole distance—six miles—or any part thereof, for 3d. On behalf of the promoters it was urged that no great railway company or light railway company had been compelled to carry bicycles by passenger trains, and if they were carried as luggage, then the railway company would be liable if they were damaged. Sir C. Boyle said that he was favourably disposed to the bicyclist, but it would require careful consideration before deciding that a bicycle should be taken as passenger's luggage, and he should reserve the point.

Newcastle's New Trams.—At a meeting of the Tramways Committee last week, Mr. Hopkinson, the electrical engineer, reported upon the general progress of the work of the new tramways. He stated that the two boilers at the power station were already set, and that two more were ready for completion. The progress of the work was satisfactory all round. Twenty cars were completed and would be delivered within a week or two. It was thought they would be able to run cars in certain sections by the end of October. A proposal to introduce steam trams into districts where lines are now completed has been rejected, the strong feeling being expressed that whilst it might be necessary to make some arrangements to run cars on the completed lines, steam power was not considered suitable.

Leicester.—Mr. E. Manville, the expert called in to report on the question of electric traction for the Corporation tramways, has submitted his report, in which he recommends the adoption of the overhead trolley system and the erection of a separate power station for the purposes of the tramways on the Lero site. He estimates the cost of constructing the system on the overhead trolley system at £299,306, as against £644,925 on the conduit system. The difference in cost between the two systems is therefore £345 619, exclusive of feeders. Mr. Manville's estimate of the cost of the separate power station on the Lere site is £75,854. The Tramways Committee, we understand, after consideration of this report, have unanimously agreed to recommend the sub-committee's scheme to the Council for adoption, and also that Mr. Manville be appointed consulting electrical engineer.

Plymouth.—At the meeting of the Borough Council on Monday it was stated that the deficit on last year's working of the tramways, although reported to be £61, had been brought down to £7 by the payment of £54 regarded as doubtful. Practically, therefore, there was no deficit on the year's working, and that in spite of the fact that they were paying £600 a year more for the electric current than they ought to pay, the average price in other parts of the country being 2d. per unit, while they were paying 3½d. This year it was estimated the receipts from the tramways would amount to £25,000 and the expenditure £19,000, leaving a profit of £6 000, so that in 1903 they would be able not only to wipe off the deficit, but contribute a very substantial sum in relief of the rates. It was expected to get £2,000 extra from the Prince Rock section, £2,000 from the Sunday trams, and £2 000 from the ½d. and 1½d. fares, so that a great deal of the profit was due to new management and not to working on old lines.

Bolton.—The accounts of the tramways department of the Corporation have just been issued for the past year. The total income for the year ended March 31 in traffic receipts is £69,147, and the following are the items of expenditure: maintenance of line, etc., £3,094; rents, rates, etc., £2 143; interest account, £6,623; traffic expenses account, £735; management account, £1,616; maintenance of equipment, £680; and of cars, £3,011; miscellaneous expenses account, £634; charge for electric power, £10,107; compensation, etc., account, £508; wages of drivers, conductors, etc., £13.412; wages of car cleaners, labourers, etc., £4.405; track (construction), £8 227; land, buildings, etc., £2,684; electrical equipment, £2 454; cars, etc., £2,763. The total liabilities are stated at £281,353, against which the tramlines are estimated to be worth £94,621; land, buildings, and goodwill, £86,786; overhead equipment, £46,644; cars, £24,873. There is a cash balance of £25 798. The committee have decided to devote £5,742 to the relief of rates.

Carlisle.—Colonel Yorke, of the Board of Trade, has made an inspection of the tramway lines on Eden Bridge with reference to the question which has been raised as to the restriction at present in force preventing tramcars from passing each other or stopping to pick up passengers on Eden Bridge. Colonel Yorke indicated that the question of the regulation of the traffic on Eden Bridge was one rather for a by-law of the County Council than for an absolute regulation by the Board of Trade; and it was, therefore, taken for granted that if the County Council, with the concurrence of the tramways company and the parties concerned, framed a by-law which would so regulate the traffic of the bridge as would suit the convenience of the majority of the travelling public, it would be approved by the Board of Trade. It would be an improvement if the tramlines were made double from the bridge to the top of Stanwix Bank, or, at all events, some distance up the bank, and the cars could have waited there to pass each other instead of, as at present, at the cattle market or at Eden Mount. The inspector, speaking of the headlights carried by cars, said they ought all to be white.

Wolverhampton.—The Town Council have confirmed their resolution in committee to the effect that the proposed Corporation tramways be equipped with the Lorain underground system of electric traction, details of which were given in our last issue. On Tuesday afternoon a deputation of manufacturers, tradesmen, and others waited upon the Tramways Committee for the purpose of laying before them their views with respect to the break in the tramway communications between Wolverhampton

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and Bilston, Willenhall, Sedgley, and other adjoining neighbourhoods. The Chairman, in reply, said the points put forward would receive the very serious consideration of his committee. As to the suggestion with regard to making a temporary vehicular service between Wolverhampton and the outlying districts by means of 'buses, brakes, and so on, corporations had no power to subsidise any system of that kind. He feared also that it would be some time before the British Electric Traction Company would be of much use in regard to the conveyance of passengers between the boundaries of Wolverhampton and the adjoining townships of Bilston and Willenhall.

West London Tramways.—The 2d. fare charged by the London United Tramways Company for the journey from Shepherd's Bush to Kew has given rise to considerable local discussion. At a meeting of the Works Committee of the Chiswick District Council the opinion was reported that whatever the legal view of the case might be, there was no doubt that Mr. Clifton Robinson had a moral obligation to reduce the fares. It was decided that a full statement of the case be sent to the Kingston Corporation and the District Councils of Ealing and Isleworth, or any other local body which was included in the tramway company's Bill before Parliament at the present moment, with an intimation that, if desired, the clerk would attend and give evidence before the committee "as to the way the tramway company kept faith." In consequence of the annoyance caused to the inhabitants of the main roads through which the new lines run by the continual ringing of bells, and on account of the accidents which have recently occurred, the Hammersmith Borough Council have made representations to the company with reference to the speed at which the trams travel, and also as to the unnecessary ringing of the bells.

Cardiff.—At the Tramways Committee meeting the Town Clerk explained that the negotiations with the tramways company as to the terms of relaying the lines, which would affect the final purchase, had been delayed. Under Section 48 of the Local Government Act, the Corporation had power to refer to arbitration for settlement, and in case of difficulty it would be policy to refer. It was decided, however, to again communicate with the company and reopen negotiations, mentioning prices. At the Town Council meeting on Monday, on the motion that the town clerk be instructed to apply for the necessary provisional order authorising the extension of the tramlines on Cathedral-road northwards to a point on that road representing the junction (at the northern end) of Mortimer-road with Cathedral-road, an amendment was proposed, and ultimately adopted, that the committee be instructed to take into consideration the extension of the system in the whole district, and report thereon, with a view of obtaining a provisional order to include the whole. With reference to the reconstructing of a section of the Cathays tramline the company have agreed that the work shall be carried out in accordance with the Corporation's specification. It is hoped that a portion of the electric system—that to the docks—will be in vogue on Jan. 1 next year.

London Underground Railways.—On Tuesday Lord Robert Cecil, K.C., laid before the Joint Parliamentary Committee on Underground Railway Communication in London the proposals of the Central London Railway for making a single-line loop at each end to afford a more frequent train service. Sir Henry Oakley, chairman of the line, explained that the Central London Railway Bill of 1892 gave powers for the extension of the line to Liverpool-street, which had not been carried out. The Central London was now in the position of having its trains, morning and evening, greatly overcrowded. They had, therefore, come to the conclusion that it would be wiser, in the general interest, to have a loop, and so secure connection with Liverpool-street by a circle, and enable the trains to run continuously and the present delay be obviated. The manager believed that by the proposed improvement they would be able to work a service every two minutes in the busy times of the day, thereby adding some 60 or 70 trains a day. At present about 700 trains a day were run. The closest approach to any other service by the extension would be near by Liverpool street, where it would be 45ft. to 46ft. below the Metropolitan. It was proposed to make a subway to Broad-street and the Great Eastern Stations, and also give access to the street. Mr. Littler, K.C., then explained the scheme of the Charing Cross, Euston, and Hampstead Railway. The new proposal was to extend the line from Kentish Town, by an interchange station, to Highgate, and to continue the Hampstead branch to Golder's Hill. It was proposed to have 13ft. tubes to prevent vibration. Sir Douglas Fox, C.E., explained that with a 13ft. tube ordinary locomotives would be replaced by motors attached to the axles of the cars, but not necessarily to every car. Unless parliamentary sanction was given for the change from the 11ft. 6in. tube to the 13ft. tube, the promoters would be at a loss of £50,000 to £60,000, the orders having been given for the machinery for the larger tube. The case of the City and North-Eastern Suburban Railway was next considered, and the committee adjourned.

Sheffield.—With reference to the threatened strike of the Corporation tramways employés in consequence of the summary dismissal of Mr. G. E. Francis, the depôt foreman at the Tinsley and Queen's-road car-sheds, on the ground of discourtesy, the following is the statement of Alderman Clegg, the chairman of the Tramways Committee, to the Town Council on the subject: "For some considerable time past Mr. Fell (the tramways manager) has complained to me about the conduct of Francis towards himself, and also as to his dissatisfaction at the way Francis's department at the Tinsley car-shed had been managed. Certain orders were given to endeavour to remedy this state of affairs. As, however, matters did not improve he again spoke to me, and as I saw it was necessary to take some decisive step to enforce discipline, it was with my entire sanction and approval that a month's wages in lieu of notice should be paid to Francis and his services dispensed with. The grounds for this action were as follows: (1) insubordination; (2) inciting the men to needless agitation; (3) undermining the authority of the manager; (4) personal discourtesy; (5) untruthfulness; and (6) mismanagement. It is well known to the Council that I have always been most favourably disposed towards the employés, always giving a sympathetic hearing to any of the supposed grievances and complaints, and have at all times done whatever I could to promote their advancement and welfare. I am greatly disappointed at the attitude which the employés have taken up in interfering with a question which did not affect themselves in any way whatever, and can only conclude that similar influences were brought to bear on them as on a former occasion when they indulged in a similar threat. I desire, however, that it should be distinctly understood, so long as I am chairman of the Tramways Committee, that we shall be masters, and we shall allow of no interference or dictation with the working and regulating of the undertaking, or as to our dealing with any of the officials or men, and that I shall advise the committee to act on the following lines: (1) that the committee or manager have the right to terminate the services of any official or employé without giving their reasons therefor if they think it is to the interest of the undertaking to do so; (2) that any interference with the exercise of this right by the employés will be looked upon as unjustifiable and subversive of discipline; (3) that the doctrine that employés are entitled to know the reasons of the termination of a man's service or dismissal either by the committee or manager is untenable, and cannot and will not be recognised or tolerated; (4) that so long as the committee have confidence in their manager they will support him in his actions and his management. At the same time I can say, speaking not only for myself, but, I believe, for every member of the committee, that I am prepared to receive and consider impartially any complaints or grievances the men may think they are suffering under if they are brought forward in a legitimate and proper manner. I desire to express my warm thanks to Mr. Councillor Copley (secretary of the Enginemen and Cranemen's Society), and Mr. Temperton (secretary of the Hackney Carriage Association), and also to Messrs. Councillors Hobson and Shaw, for the efforts they put forth, and for the sound and sensible advice they gave to the men." The expressions of opinion embodied in this statement, with which we entirely agree, were unanimously adopted.

Warrington.—In the report submitted by Messrs. Preece and Cardew at last week's meeting of the Town Council, they gave their reasons for selecting the overhead trolley system as that most suitable for the proposed tramways in the borough. They first pointed out that the available systems of electrical working of tramcars are: (1) the overhead trolley system, (2) the conduit system, (3) the surface-contact system, (4) the accumulator system. The first system had incontestably the following advantages over systems 2 and 3—viz., much lower first cost, greater simplicity, less liability to derangement, greater facility for repair, far less disturbance of streets during construction. The only objections that could be lodged against it in comparison with the competing systems were the æsthetic objection that the overhead wires were a disfigurement to the town, and the possibility of danger. The first objection was not a serious one, except in the case of fashionable resorts, where the attractions and amenities of the place were the first consideration. The overhead construction, if properly erected and maintained, was not offensive, and was certainly less open to objection than the overhead wires of the Telephone Company, which cross at all angles, and with no order or regularity. The second objection was far more reasonable, and had been lately emphasised by the unfortunate accident at Liverpool. The prevention of all risk of accident to the public using the streets had engaged their serious attention. This subject, moreover, was one which Major Cardew, as electrical adviser to the Board of Trade, had especially to study. The only accidents that had occurred had been due to the use of imperfect guarding arrangements against the fall of crossing wires, either with or without such a fall occurring. In the case of Warrington, no such heavy spans of crossing wires as in the case of Liverpool existed, and the guard wire which had been specified were amply strong and thoroughly earthed. They suggested that these crossing wires should be carefully watched. If possible, they should be put underground by arrangement between the Corporation and the Telephone Company, as had been already provided for in the centre of the town, or should this not be practicable, the Telephone Company should be requested to cable their wires in all cases where more than a few wires cross at one spot. In referring to the other available systems, the engineers pointed out that with regard to the accumulator system, wherever it has been tried it has been found to be excessively costly in working and maintenance, and to have many other objections, such as the discharge of disagreeable acid fumes in the cars, the rapid corrosion of all ironwork, the great increase of dead-weight to be carried, loss of time in changing, etc. Proceeding to refer to the conduit system, it is pointed out that the advocates of the open-conduit system themselves state that where a single-track line cost £5,300 per mile for an overhead trolley road, the conduit construction would cost £11,000. In the above price no allowance was made for obstructions, such as sewers, gas and water pipes, which had to be diverted, and this might vary from several hundreds to several thousands per mile. During construction the road in question had to be entirely blocked for several weeks, an inconvenience to trade which nothing but the greatest after advantages could warrant. It was further pointed out that the

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rails forming the side of the slot usually exposed a width of 6in. of iron, and was objectionable to horses and ponies, whose shoes varied from 3¼in. to 6in. in width. From the engineers' point of view the open conduit was more difficult to work satisfactorily than the trolley wire, because the mains, being hidden, were so difficult to inspect. The draining of the conduit was a very important matter, and even in the most carefully designed conduits cleaning at prescribed intervals was necessary. The cost of this cleaning varied a good deal in different localities, but it was between £50 and £100 per mile of track. In conclusion, Messrs. Preece and Cardew referred to the surface-contact system stating that the greatest defect of surface-contact systems hitherto has been the risk of one of the studs remaining charged after the car has passed over it, involving great danger of a serious accident from a horse stepping on it.

The Manchester-Liverpool Monorail.—The enquiry into Mr. Behr's scheme for the construction of an electric express railway between Manchester and Liverpool was again before the House of Lords Committee presided over by Viscount Falkland this week. On behalf of the promoters, Mr. Balfour Browne made a statement in regard to the possibility of the proposed monorail line being turned into an ordinary railway. On that point he was authorised to say absolutely that the promoters did not intend to use their powers for any purpose but the monorail, and that the word "may" in the Bill should with that view be turned into "shall." It had further been suggested that if they constructed the carriages in the way proposed, the centre of gravity would, contrary to what their witnesses said, be above the monorail, and that in that way there would be danger. As to that he was perfectly willing to agree that no carriage should be run upon the railway unless the centre of gravity was below the monorail, and this should be proved to the satisfaction of the Board of Trade before any carriage was run on the railway. Among the witnesses called in support of the opposition of the Salford Corporation were Mr. Joseph Corbett, borough engineer; Mr. W. Melville, engineer-in-chief to the Glasgow and South-Western Railway Company; and Sir Douglas Fox. The last-named gentlemen stated that the number of persons displaced and the interference with property were just as great under the present scheme of cut-and-cover as was the case last year with the viaduct proposal. Replying to questions as to the mechanical details and arrangements of the scheme, Sir Douglas said he did not think it would be safe to run round curves of 30 or 37 chains radius at the high speed suggested unless the structure were tilted. Where they had, as there was here, a car with a great number of wheels of varying diameters, and running, therefore at very different speeds, the effect would be to produce great vibration both on the passengers and on the permanent way. It was a misnomer to call Mr. Behr's proposal a monorail, for there were really five rails. The monorail system, so far as it had been applied, was mechanically complicated, involving a large number of wheels of different diameters, and he could not see where the advantage came in. He believed that electrical traction, when properly applied, had a great future, but he did not consider that Mr. Behr's was a practical method of applying such traction at high speeds. The proposed method of transmitting the power by chains was not, in his opinion, practical. If high speeds were to be obtained by means of electricity, it must be by taking advantage of rotary motion as against reciprocating action. The permanent way, he believed, would be extremely difficult to maintain in proper working order. The car was the weakest in design he had ever seen. It was cut in two by the running wheel and rail, and it was caught only at the top. It was easy to conceive that with a severe or sudden pressure it might come in halves. Taking all the circumstances into consideration, he was of opinion that a speed of at least 120 miles an hour would have to be attained in order to cover the distance between Liverpool and Manchester in 20 minutes. With regard to brake power, they knew what was possible at speeds up to and between 60 and 80 miles an hour, but he believed there was nothing known with certainty as to the action of brake power at higher speeds than those. As far as he knew, everything was experimental. Speaking with an experience of 40 years of railway matters, he was of opinion that the proposed line could not be constructed for the estimate of £50,000 a mile. He did not say that Mr. Behr's system might not work very well at slow speeds for certain purposes, such as running up a mountain side, but he looked upon it as purely experimental as applied to traffic of this kind, and he could not see how it could possibly be made to succeed. He was afraid that if this Bill were sanctioned, the proposed railway would be a failure, and it would set back what they all so much desired to see—the introduction of electrical traction at high speed. Mr. Francis Fox, C.E., Mr. C. A. Rowlandson (chief engineer of the Great Central Railway), Mr. A. Ross (chief engineer of the Great Northern Railway), and Mr. S. H. Short (technical director of the English Electric Manufacturing Company, Preston, and formerly professor of electrical engineering at the University of Denver, Colorado) gave corroborative evidence. Mr. Stephen Sellon, chief engineer of the British Electric Traction Company, Preston, gave it as his opinion that if the Bill were sanctioned it would be detrimental to the best interests of electric traction. The scheme now before the committee he considered both crude and impracticable, fanciful and doubtful, and as absolutely valueless for the purpose for which it was intended. With the high speed of 120 miles suggested and the small curves proposed, the action due to centrifugal force would be sufficient, he said, to turn over the whole structure on which the running rail was held. Prof. C. A. Carus-Wilson also gave evidence against the scheme. He did not see how the car could fail to come off the rail if it ran at a speed of 110 miles an hour round curves of from 30 to 47 chains radius, as proposed in the Bill. Sir W. Pollitt, general manager of the Great Central Railway Company, saw no justification on any ground of public convenience for the proposed line, and, in view of the efforts which the existing companies had successfully made to give a good service, he thought it would be a great hardship if they were to be deprived of the very moderate return they now received by the possible success of this experiment. He also believed the line would be a huge financial failure; but, nevertheless, it would do a great injury to the Cheshire Lines. The committee adjourned.

LIGHTING AND GENERAL.

Leyton.—Sanction has been obtained to the borrowing of £5,000 for electric lighting.

Wheatley.—The Urban District Council intend to support the Yorkshire Electric Power Bill.

Darwen.—The Corporation are to spend £15,000 in additional works and mains for electric lighting.

Manchester.—Mr. W. E. Warrilow has been appointed as junior mains assistant to the Corporation.

Bristol.—The Electrical Committee have found it desirable to spend £850 on an addition to the site of the Avonbank estate.

Ashford.—The Council are consulting Mr. Thos. Hesketh in connection with the carrying out of their electric lighting provisional order.

Cable Rates.—The rate for telegrams to Madeira and St. Vincent (Cape Verd Islands) has been reduced respectively to 1s. and 2s. 2d. per word.

Bath.—The surveyor has been instructed to report upon the question of replacing at a certain hour the large arc lights by two incandescent lamps.

Doncaster.—The Corporation have withdrawn their opposition to the South Yorkshire Electric Power Bill and the Yorkshire Electric Power Bill.

Thornhill.—Mr. Brown has been empowered to give evidence in support of the Yorkshire Electric Power Bill without prejudice to the opposing measure.

Heywood.—We understand that the erection of machinery at the generating station will be commenced almost immediately. The crane has already been fixed.

Kinver.—The British Electric Traction Company have been asked if they intend to light up their terminus, and also on what terms they would supply the current to Kinver.

Willesden.—At the last meeting of the Willesden Guardians Mr. Morgan Williams, M.I.C.E., was appointed to the post of consulting engineer to the new Willesden Infirmary.

Middlesbrough.—The Electric Lighting Committee have decided to borrow £34,100 for electrical work, and to accept a number of tenders, details of which appear in another column.

Eastbourne.—Combined arc and ventilating columns of an ornamental pattern like that adopted by the Brighton Corporation are to be purchased for the front, at a cost of £28. 10s. each.

Pemberton.—Mr. Moorfield has been appointed chairman of the Electric Lighting Committee, who have just completed a loan of £10 000 at 3§ per cent. Steps are being taken to obtain another £10 000.

Ealing.—An extension of mains is to be made to Stephen's-road at a cost of £262. 10s., the owner of the houses there having expressed his willingness not to fit them for gas except for heating purposes.

Farnham.—The Urban District Council have decided to consult Sir William Preece with regard to the offer received by them from Edmundsons' Electricity Corporation to carry out the electric lighting of the town.

Commercial Telegraph Construction Syndicate, Limited.—At an extraordinary general meeting of the above syndicate Mr. Cecil Quennell, 77, Angel-court, Throgmorton-street, E.C., was appointed liquidator.

Brandon.—The special committee of the Urban District Council appointed to consider the electric lighting question so far as it concerned Esh and Waterhouses have recommended 55 lamps of 32 c.p. each at a cost of £2. 5s. each.

Dublin.—A further expense of £333 on extensions in connection with the added lighting area, which was finally agreed to, caused as much or more debate at the City Council on Monday as the previous resolution affecting £234,500.

Keswick.—It appears that the electric light company are stopped in their work of placing arc lights in the town owing to the lamps not having been delivered. The company are ready to place them as soon as they are received.

Chefoo-Taku Cable.—The Eastern Extension and Great Northern Telegraph Companies' repairing steamer left Woosung a few days ago for Chefoo to lay the first portion of the proposed duplicate cable between Chefoo and Taku.

Trowbridge.—At the last meeting of the Urban District Council the Clerk reported the receipt of a letter from the parliamentary agents, Messrs. Baker, Lees, and Co., enclosing a print of the Bills confirming the provisional order.

Malling.—The National Telephone Company are quoting £105 for connecting the hospital to the clerk's office, also to the doctor's house, and on to the workhouse, with free maintenance for the first six months and an annual charge of £4 afterwards.

Barnet.—The Urban District Council have asked the electrical company to light the new area (as at present lighted by gas

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lamps), including May's-lane-road, up to and including Duck's Island, and also to state terms for further extensions.

Christ Church, Oxford.—The governing body of Christ Church have decided to carry out the electric lighting scheme of their consulting engineer, Mr. Morgan Williams. The contract has been placed with Messrs. Hill, Upton, and Co., of Oxford.

Dundee.—A sub committee has been instructed to make enquiries with regard to the proposed municipal telephone system. If necessary, the Glasgow engineers will be invited to Dundee to inspect and give estimates of the cost of municipalisation.

Fulham.—The Council propose to enter into an agreement with the Postmaster General, in respect of the laying of telephone mains and distributing pipes in future, providing for a deposit of complete plans with the Council before any works are carried out.

Engineers' Wages.—The Amalgamated Society of Engineers recently approached the employers in the East London district with a request for 2s a week increase in wages, and obtained an immediate advance of 1s. a week, the other 1s. to be discussed six months hence.

Hove.—A motion in regard to revision of charges for current which was on the agenda for last week's meeting of the Town Council was withdrawn, as negotiations are on foot with regard to the electric light company, and the Council will deal with the whole question.

Burton-on-Trent.—The Gas and Electric Light Committee reported at the last meeting of the Town Council that an extension of the electric mains along Horninglow-street had been decided upon, to supply seven houses and a motor, a return of 20 per cent. on the outlay being guaranteed.

Horsham.—The Local Government Board have informed the Urban District Council with regard to the proposed exchange of sites for the electric lighting station that they will issue fresh sanction to the borrowing of £13 706 for the purposes of electric lighting, and £300 for the purchase of land for depôt purposes.

London Gazette.—The first meeting in the estate of G. F. Cook (trading as G. F. Cook and Co.), lately residing at Lightcliffe, Yorkshire, will be held on May 21, at 11 a.m., at the official receiver's chambers, 31, Manor-row, Bradford, and the public examination on May 22, at 10 a.m., at County Court Manor row, Bradford.

Metropolitan Electric Supply Co.—When the Bill "to confer further powers on the Metropolitan Electric Supply Company, Limited, with respect to the supply of electrical energy and for other purposes," came before a Select Committee of the House of Commons this week, Mr. John Conacher, general manager of the promoting company, said that they were now increasing the capacity of that station at a cost of £85,000. The preamble was proved on Wednesday.

St. Pancras.—The accounts of the Electricity Committee of the Borough Council for the past year show a gross revenue of £49,329, making an increase of £4,449 compared with 1899. £3 207 of which is due to public lighting and £1,242 to private lighting. The total units sold during the first half of the year were 1,056,613, at an average price of 4·48d. per unit; and in the second half, 1,239,773 units, at 3·63d. The net profits amounted to £2,921, increased to £4,056 by the balance brought forward. A sum of £2 916 has been placed to the reserve, and the remainder is carried forward.

Stock Exchange.—The Stock Exchange Committee have ordered the Notting Hill Electric Lighting Company's further issue of 2,200 ordinary shares of £10 each, fully paid, Nos. 10,001 to 12 200, to be quoted in the official list. Applications have been made to the committee to allow the following securities to be quoted in the official list: Aron Electricity Meter, Limited, 125 000 ordinary shares of £1 each, fully paid, Nos. 1 to 125 000 (special application, renewed); the British Columbia Electric Railway Company's further issue of 6,400 non-cumulative 5 per cent. preference shares of £10 each, fully paid; and the Eastern Telegraph Company's further issue of £103,919 3½ per cent. preference stock.

City of London.—In his annual report to the Corporation the electrical engineer of the City (Mr. A. A. Voysey) states that the number of consumers supplied in the City by the City of London Electric Lighting Company last year was 9 855 compared with 8,738 in 1899. In addition to that, up to the beginning of the year about 27 miles of mains had been laid by the Charing Cross and Strand Electricity Supply Corporation in streets in the City, and the equivalent of 3,427 8-c.p. lamps was connected with those mains. The Charing Cross and City Electric Company, which was formed for the purpose of constructing the works necessary under the City of London Electric Lighting Order, 1899, have, he understands, obtained from the Charing Cross and Strand Electricity Supply Corporation the sum of £73,670. 16s. 10d.

London County Council.—At the meeting of the Council on Tuesday next the Bridges Committee will recommend that £6 000 be set aside for supplying and fixing single lifts in the shafts of the Greenwich footway tunnel; that tenders be invited for the erection of the lifts; and that advertisements be issued in the usual journals. Sanction has been given to the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along a portion of Charlton-street, Euston-road. Permission has also been granted to the General Post Office to lay a 3in. cast-iron telephone wire pipe across a portion of Tooting Common, subject to the Post Office authorities obtaining any other necessary consents, and to the work being carried out and the ground of the common restored to the satisfaction of the chief officer of the Parks Department.

Islington.—At to-night's meeting of the Borough Council the Lighting Committee will recommend that the laying of mains in Hornsey-road be proceeded with, at a cost of £10,530. They will also submit the following report: "We have had under consideration the difficulties which confront us in connecting consumers in streets where supply mains are laid owing to the restriction contained in Standing Order No. 12 that 'no contract shall be entered into or liability incurred for works proposed to be paid for out of capital until the consent of the sanctioning authority to the borrowing has been obtained.' We recommend that Standing Order No. 12 be altered by the addition of the following words: 'except in the case of low-tension distributors and services required to connect consumers of electricity with the Council's mains which may be laid, after being sanctioned by the Council, as and when authorised by the Lighting Committee.'"

Bolton.—A satisfactory margin of profit is shown by the accounts of the electricity department of the Corporation, which have just been issued, for the year ending March 31 last. The revenue account gives an expenditure of £13,549 (against £6,196 last year), of which £3,036 is represented by wages and £7,751 by fuel; whilst the income amounts to £24 103 (against £12,098 last year), leaving a balance of £10,554. The sale of electricity by meter has produced £12,444, and by tramways £10,107. The capital expenditure has increased from £34 909 in 1896 (the first year of the undertaking) to £145,125 in 1901, whilst the total Board of Trade units generated at the periods named were 149,507 and 2,937,171 respectively. The number of consumers has increased from 65 to 888, and the number of 8 c.p. lamps supplied from 5,100 to 74,395, whilst the price per unit charged has decreased from 5 4d. to 2·22d. The gross profits amount to £10,554, interest on loans figures at £3,815, the sum of £5,881 has been placed to depreciation account, and £857 has been allocated in relief of rates.

Yorkshire Electric Power Bills.—The following have presented petitions in favour of the Yorkshire Electric Power Bill: the Urban District Councils of Ardsley, Bolton-on-Dearne, Burley-in-Wharfedale Calverley, Castleford, Cleckheaton, Darfield, Elland, Guiseley, Holmfirth, Honley, Horsforth, Ilkley, Kirkburton, Kirkheaton, Lepton, Linthwaite, Liversedge, Methley, Netherthong, New Mill, Rawdon, Rothwell, Soothill, Thurstonland, Whitley, Whitwood, and Yeadon; the Rural District Councils of Hunslet, Keighley, Kiveton Park, Leeds (Roundhay and Seacroft), Skipton, and Wharfedale; the Leeds and District Engineering Employers' Association, the West Yorkshire Coalowners' Association, and the ratepayers and inhabitants of Sheffield, Rotherham, and Masborough. The following have withdrawn their petitions against the Bill: the Corporations of Rotherham, Ossett, Pontefract, and Pudsey; and the Urban District Councils of Rawmarsh and Skipton. The following have withdrawn their petitions against the South Yorkshire Electric Power Bill: the Corporations of Rotherham, Ossett, and Pontefract; and the Urban District Councils of Birstall, Rawmarsh, and Skipton.

Woolwich.—At its meeting on Tuesday evening the Woolwich Borough Council decided to offer the Woolwich District Electric Lighting Company, Limited, £80,000 for the purchase of their undertaking which supplies that part of the parish of Woolwich south of the Thames, the Council to take the profits from Dec. 31 last and control the capital of the company, paying 4 per cent. interest on £80,000 from that date until the completion of the purchase, which is to take place at the earliest possible date. The offer is subject to the usual conditions as to the Council's obtaining the necessary powers and loan. The company's directors will recommend the shareholders to accept the offer of £80,000, with £5 000 or thereabouts which is about to be expended on the erection of new plant already ordered. On June 6 the Council will hold a special meeting to consider the advisability of giving notice to the Blackheath and Greenwich District Electric Lighting Company to sell that portion of their undertaking and works as is within the borough—that is to say, in the parish of Eltham. The borough surveyor was instructed to engage a clerk of the works for the buildings to be erected under contract in connection with the electricity and dust destructor works.

Birmingham.—The report of the Electric Supply Committee, to be presented at the next meeting of the City Council, states that the units sold during the year were 3 040,822, realising £55 810. 4s. 2d., as compared with 2,357,806 units, and £45,247. 7s. 6d., for the previous year, being an increase of 28 9 per cent. in units sold, and 23·3 per cent. in money value. The revenue account shows a gross profit for the year of £15,352. 18s. 7d., but had only the usual charges in connection with the generation of electricity and maintenance been debited against it there would have remained a balance of £27,233. 10s. 4d. wherewith to meet the interest and sinking fund charges, which amount to £21,838. 17s. 9d. The exceptional charge against revenue is the cost of altering and improving a portion of the feeder mains and of changing over sections of the department's system from 110 to 220 volts. The first complete year of the working of the system by the department may be considered satisfactory. The works are in excellent order, and operations have been carried on throughout the year without stoppage or serious accident of any kind. The lamp and motor additions during the year on the various circuits, reduced to a 16-c.p. factor, amounted to 11,855, bringing the total number of lamps to the end of the financial year to 78 293, being an increase of 17·8 per cent. The total number of motors now connected amounts to 260, equal to about 710 h.p. The relaying of the older mains in the centre of the city has been completed, and a uniformity of the system has thus been effected. The committee mention that any large extension of the area of supply will necessitate the establishment of new power stations.

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Shoreditch.—The Borough Council will from July 1 increase the price of current from 4½d. to 5d. per unit, and alter the scale for large consumers (from 2d. to 4d.) to a fixed charge of 4d., and raise the scale for power (from 1½d. to 2d.) to 2d. per unit for all consumers.

Bransksome.—The Urban District Council have granted the request of the National Telephone Company to extend their line of poles at Ringwood-road to Alderney Manor. The Council are conferring with the Bournemouth and Poole Electric Light Company with respect to an electric light supply to the Council's new offices.

Bangor.—At the quarterly meeting of the City Council last week the phenomenal success which had attended the electric light undertaking was referred to. It was stated that a profit of £880 had been made during the first five months. There had been put down as deficit £600, but it should be remembered that £475 of that sum belonged to capital.

Barrow.—The County Council are urging the Local Government Board to hold the enquiry with reference to borrowing powers for electric lighting at the earliest possible date, as certain of the works are extremely urgent—viz., the street and private lighting for the coming winter—and tenders have already been provisionally accepted for about half of the amount.

Tonbridge.—Major F. H. Tulloch held an enquiry on Thursday last week into an application of the Urban District Council to borrow £20,400 as a first instalment towards the cost of the land on which the suggested electric lighting station and works are to be erected. There was a strong opposition to the scheme, and finally the enquiry was adjourned till Friday, the 17th inst., at 10.30.

Morecambe.—The West End Pier Company and the Central Pier Company having asked for a substantial reduction in the present price charged them for electric current, the Council have decided that the present price of 7d. per unit be still charged, but if the annual consumption should amount to £250 for each company, 5d. per unit would be charged for all current consumed above that amount.

Stratford.—The Charing Cross and City Electric Company, Limited, are erecting new works at Stratford. Two sets of counter-current jet condensing plants for 25 000lb. of exhaust steam per hour each, and six circular iron natural-draught cooling towers, each for 75,000 gallons of water per hour (all Balcke's patents), have been ordered from Mr. Arthur Koppel 27, Clement's-lane, E.C.

Northfleet.—The District Council are consulting Messrs. Preece and Cardew with regard to a suggestion which has been made that some scheme should be devised whereby the Council should enter into an arrangement with the Town Council of the borough of Gravesend, which adjoins Northfleet, for taking from Gravesend a supply of electricity during the infancy of their proposed electricity undertaking.

Harrogate.—The Council have decided that where electric motors can be used without in any way interfering with the effective lighting supply of the surrounding neighbourhood, current be supplied at 2d. per unit, providing that the motor be not used for a less average period than six hours per working day, based upon a maximum demand of one third the rated power of the motor.

Shrewsbury.—The Town Council have adopted a report from the Lighting Committee stating that the demand for electric current had increased by 76 per cent. in 12 months, and in two years the profits had been £2,200. New plant was being laid down, and the committee recommended the Council to sanction a further loan of £16,526 for additional cables to meet the ever-increasing demand for the light.

Worcester.—The City Council have appointed the chairman of the Electricity Committee (Mr. Parker) and Mr. Ernest Day to represent the city at the Municipal Electrical Association's convention at Glasgow. The Council have decided to apply for sanction to a loan of £230 for laying an electricity main in the London-road from the end of the existing main to the city boundary at Red Hill.

Lowestoft.—The resident engineer (Mr. Bruce) in his last report states that on April 26 the equivalent of 5 608 8-c.p. lamps (public and private lighting) were connected, representing 103 consumers. Mr. Hawtayne, the consulting electrical engineer, has been asked to furnish particulars of the extension of mains in North-parade, Lyndhurst-road, Corton-road, and Belvedere road, to be included with the application for sanction to the loan of £20,000.

St. Marylebone.—The Council have agreed to a notice from the Metropolitan Electric Supply Company as to laying a 5in. cast-iron pipe along the north side of Crawford-street, from York-place to Gloucester-place, and along Durweston-mews and Spring-mews to new flats; also along the south side of Crawford-street and west side of Spring-street from 128, Crawford-street to present pipe at Montagu mansions, and across Crawford-street at the east side of Spring-street.

Dewsbury.—At the last meeting of the Town Council it was stated that all the protective clauses they asked for in regard to the Yorkshire Electric Power Bill and the South Yorkshire Electric Power Bill, both of which proposed to come into the district, had been obtained. The Yorkshire Company had gone so far as to give up the right of supplying electricity to railway and water companies in the borough, which at first they could not see their way to do.

Hanley.—The electricity mains are to be extended to Trafalgar-street and to Wellington Church, subject to the payment by two consumers of 3½ per cent. on the outlay, until such circumstances arise as will justify a reduction being made. The statement of accounts for the past year's working shows a profit of £3,630. 13s. 8d. on the receipts and working expenses, or revenue account, which sum is insufficient to meet the charges for interest and sinking fund by £641. 9s. 3d.

Southwark.—The wayleave difficulties which have hitherto prevented the provision of a private wire between the infirmary and the Dulwich fire station have been overcome, and the work of erection will now be proceeded with as quickly as practicable. Telephone apparatus of the special make required by the London County Council requirements is to be provided, and as the alteration will enable the Postmaster General to reduce the rental originally agreed to, a fresh agreement is being prepared.

King's Lynn.—The engineer's report states that during the month of April applications for 379 lamps of 8 c.p. or equivalent have been received, making a total of 8 529 lamps of 8 c.p., and that seven new street lamps had been fixed in Wisbech road and Diamond-street. His proposal that a 2in. centrifugal pump and motor combined be fixed in the engine room over the well at a cost of about £70 has been agreed to. This will set at liberty the gas-engine pump tank and pipe, which are to be sold, and much less water will be used.

Wolverhampton.—The annual report of the Wolverhampton Chamber of Commerce states that the local electrical trade has been well supplied with orders during the past year. The works are fully occupied, and the prospects for the present year are good. Electricity is receiving constantly widening application, and promises to be one of the great staple industries of the country. There is room for considerable extension of this business in Wolverhampton, when the advantages of the application of electricity are appreciated.

Newport (Mon.).—The committee of the Corporation charged with the erection and equipment of a station for supplying power for electric trams and for other purposes are firm in their opposition to the new works being placed on the same site as and being at all identified with the existing works, which practically supply light only in Friar street. The new generating station is recommended to be built in Corporation road on a site for which £8,000 has already been paid to Lord Tredegar's trustees. Mr. Parshall, who is advising the Corporation, was invited to be present at the meeting of the Corporation which was called for last Tuesday for the purpose of further discussing the question.

Hammersmith.—The Brook Green works of the Incandescent Electric Lamp Company, Limited, where about 40,000 lamps are turned out every week, were visited last week by the Mayor of Hammersmith and the members of the local Electric Lighting Committee, who after a tour of inspection, expressed delight at all they had seen, both of the company's system of manufacture and of their method of treating their employés, whom they have provided with all the most modern appliances in their work, and for whom they have, in their extension of the premises recently opened, provided an immense dining-hall and clubroom—open to them when the ordinary labours of the day are terminated.

Handsworth.—The Urban District Council's Bill has passed Lord Morley's Committee as an unopposed measure. Under it the Council propose to construct certain lines of tramway and connections to join up with the Wednesbury and West Bromwich, the South Staffordshire, and the Birmingham Suburban and Birmingham Central Tramways systems, and in order to work these they ask powers either to buy electricity or start works for its supply, and also to supply electric light. The cost of this scheme is put at £107,750 and £49,050 for the electric light installation. Prof. Kennedy explained the estimates for the electric installation and laying down of plant, erecting generating station, etc.

Guildford.—The Guildford Electricity Supply Company, Limited, have informed the Town Council, with regard to the paving of footways where permanent paving was to be laid down by the borough authorities, that if the company were not to be charged any part of the cost of permanent paving after they had laid their main in such road they would make special efforts to get their main laid down before the paving was done, but that if they were to be charged for the permanent paving it was not worth their while to do this, as experience showed it was cheaper to them to have the pavement broken up and relaid and pay for the breaking-in in the first instance. The letter is being considered by the Paving Committee.

Malton.—We understand from the *Yorkshire Herald* that no visible practical steps have yet been taken to supply the electric light to Malton, despite the fact that the engineer of the recently-formed electric supply company told the Urban District Council that they would "be there" in July last. As it has been said to take "at least 12 months to get the plant into working order," it may now be assumed that Malton will have to wait much longer than the time originally promised for the light to be in operation. The engineer of the scheme put the initial cost of the installation at £10,000, and the total cost of the supply for the whole district at £40,000. No doubt the new company wish to "see their way" before committing themselves.

St. Albans.—The City Council have adopted a report of the Urban Committee stating that they were of opinion it was desirable that the rights, powers, and liabilities of the Town Council under the electric lighting provisional order should be transferred to a company willing to accept the same, provided proper terms could be arranged, in preference to the Corporation undertaking to carry out the work themselves. The committee further reported that they had considered the offers they had

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received from the North Metropolitan Electric Power Distribution Company, the British Schuckert Company, and the St. Albans Gas Company, but they were not in a position to make any recommendation with regard thereto at the present time, as they desired to have a personal interview with Mr. Hammond on the subject.

British Electric Works Co.—The British Electric Works Company, Limited, formed in May, 1899, to take over the Stellite Works, Cheston-road, Aston, has decided to go into voluntary liquidation. The Company was floated with a capital of £135,000—£50,000 in cumulative preference shares and £85,000 in ordinary shares—the vendor being Mr. J. Basnett Atherton, who had acquired the concern from R. F. Hall, Limited, for whom the works were erected. Nearly the whole of the capital is held in Liverpool and the district. Mr. Abbot (of Chambers, Wade, and Co., Liverpool) and Mr. Spencer, both chartered accountants, have been appointed liquidators. There is also a petition for compulsory winding up, presented by Messrs. S. Walker and Sons, Limited, of Birmingham, the proceedings on which are still pending.

Walker.—Sanction has been obtained by the Urban District Council to the borrowing of £18,559 for electric lighting and £14,700 for a refuse destructor, the loans to be repayable in 25 years. At the last meeting a letter was read from several manufacturers in Walker, objecting to the erection of the refuse destructor now that the Council had made certain arrangements with the Newcastle Electric Supply Company respecting the supply of electric energy, and intimating that under the circumstances the refuse could be more economically dealt with by sending it to sea. The clerk was directed to state in reply that the whole matter had been fully considered, not only by the Council, but by the Local Government Board, and the latter authority had granted their sanction to the raising of the loan. The Council were of opinion that no good purpose could be served by reopening the matter.

New Malden.—Mr. F. J. Warden-Stevens has submitted to the District Council the following arrangements for a scheme of electric lighting for the district: the Council to apply for a provisional order and obtain the necessary loan for carrying out the work; a responsible company to construct the works and carry on the undertaking, guaranteeing to the Council an interest on the loan and the payment of the sinking fund; the Council to have the option to take over control of the works at the expiration of a period of 14 years. Mr. Warden-Stevens added that the company he had in mind had suggested similar arrangements to a local authority for whom he had acted, and it appeared to him that these would meet the views of the Council, as he believed they were desirous of having some considerable control in the undertaking themselves. The Council have asked for further particulars.

Hull.—Colonel W. Langton Coke has held an enquiry into the application of the Corporation to borrow £17,000 for purposes of electric lighting. In July, 1897, the Corporation applied for £40,000 for the purpose of laying down the installation on the high-tension system in the Sculcoates-lane district. The Corporation erected a large station in Sculcoates-lane, and put down generating plant—as they had in the first instance in Dagger-lane—which was for the Old Town. The application of last week provides £9,575 for high-tension feeder mains from the Sculcoates-lane works to the Dagger-lane works. The other items are for new distributing mains and for a new plant from the Sculcoates station, including a new steam dynamo and switchboard, and lamps for the new streets, which the Corporation were constructing, and the purchase of additional land adjoining the Sculcoates-lane works. Mr. Barnard, the electrical engineer to the Corporation, submitted the plans and explained the extensions.

Luton.—The Council have decided to charge 6d. per unit for the first 100 hours, and 3d. per unit afterwards. They have invited Lord Kelvin to perform the opening ceremony in connection with the electricity works on June 24. The battery-room is nearly completed, the engines are fixed and the boilers in position. Mr. W. H. Cooke, of 35, Crawley-road, Luton, has been appointed resident electrical engineer; he will be allowed the privilege of having one pupil. The town clerk's estimate of the receipts and expenditure of the Electric Lighting Committee for the period ending March 31, 1902, shows a total expenditure of £2,174; the estimated income from sale of current and rent of meters is put at £853. 15s.; leaving a deficiency to be met by the general district rate of £1,321. 3s. 6d. The Free Wiring Company has been informed that the committee have reduced their maximum charge to 6d. per unit, the minimum 3d. per unit, in order to ascertain whether they would submit terms and conditions as to free wiring of premises within the borough.

Brierfield.—The Urban District Council have received from the town clerk of Burnley a letter on the electricity question to the following effect: (1) That it is unpracticable to give a satisfactory supply of energy in bulk for lighting and traction purposes from same cable. (2) For lighting purposes they were willing to put down the plant and supply Council at the rate of 5d. a unit for a maximum consumption of 30,000 units per annum, the latter quantity to be paid for whether consumed or not. If the consumption largely exceeds 30,000 units per year they would revise the price. (3) They were not prepared to quote a price for the supply of energy in bulk as the cost would be prohibitive. "Mr. Birkett's scheme for supplying electricity was," says the letter. "to transmit energy at 2,400 volts to a sub-station in the centre of Brierfield where the voltage would be transformed to 230 volts. Brierfield would receive this energy at the lower voltage and distribute it at their own cost." The Council, however, have decided not to consider the offer.

Whitehaven.—The Council have made arrangements with the Earl of Lonsdale for the use of a portion of the shipyard for the purpose of carrying on the necessary work in connection with the electric lighting works. The electrical engineer has been authorised to purchase a wheelbarrow and two separate battery cells for use at the station. The question of the committee joining the Municipal Electrical Association has been deferred for 12 months. Notice is to be given to the consumers and tradesmen of the intention of the Council to double the pressure on the mains, and application is to be made to the Board of Trade for their consent. At the last meeting of the Harbour Commissioners the amount of the bill for electric lighting was commented upon, and it was said the arrangement between the Harbour Commissioners and the Corporation was to give the Harbour Commissioners certain lamps, and if the Harbour Commissioners thought they could do without a lot of those lamps they might ask the Electric Lighting Committee to put in switches at various points, so that the harbour officials could switch off any lamps not required at the time.

Warrington.—Application is to be made for sanction to the borrowing of a further sum of £15,000 for extensions of the electric lighting station. The total receipts for the quarter ended March 31 have amounted to £457. 4s. 5d. and the expenditure to £417. 1s. 9d., so that on the revenue account there is a balance of £40. 2s. 8d. to credit. In addition to this, there has been a certain amount of expenditure in connection with the lighting of the street lamps. Altogether, the account will show on working expenses account a balance to credit of £100. Considering the circumstances under which the committee have carried on the work during the quarter when they only had two or three customers at the commencement and the majority only towards the end of the quarter, a consumption of 21,000 units may be considered fairly satisfactory. Mr. Grimsdale, the electrical engineer, in his last report states that no fewer than 8,607 8-c.p. lamps have been actually connected, that applications have been received equal to 857 more, and a further 639 lamps are to be put on as soon as arrangements can be completed for the purpose; so that there will be no less than 10,103 8-c.p. lamps within the next month or two. In the report originally submitted, Mr. Preece based his estimate of the probable income and expenditure upon 10,000 8-c.p. lamps. The Council are already supplying a quantity in excess of this estimate.

Jarrow.—Messrs. Palmer's Shipbuilding and Iron Company, Jarrow, have just had completed for them a very fine electric driving plant, the object of which is to work the whole of the machinery in the engineering and shipyard departments, and which will enable the company to do away with a considerable number of boilers, etc., thus effecting a great saving, and will undoubtedly prove a very powerful addition to their present great resources for executing their work with dispatch and cheapness. Messrs. Clarke, Chapman, and Co., in conjunction with the Westinghouse Company, have carried out the electrical part of the work. The three-phase alternating-current system of 440 volts has been adopted. A large number of motors has been placed throughout the works to drive the various section of the shops and separate machines. The current is generated in a large central power station, placed near the riverside, in which are two complete sets of plant, each having a generator of a normal output of 750 kw. The driving power is obtained from two sets of vertical triple-expansion engines, with three cranks, of marine type, each provided with a heavy flywheel, this part of the work having been done by Palmer's Company themselves. The generators are driven directly, with only the flywheel and shaft intervening between them and the engines. The normal revolutions are 164 per minute. Steam is supplied by four Lancashire boilers, fitted with an economiser and with induced draught. Altogether the plant is probably the largest and most complete of its kind so far that has been fitted to any works in the United Kingdom.—*Jarrow Express.*

Sheffield.—An instance of the enterprise of the electric light department of the Corporation (says the *Sheffield Daily Telegraph*) is furnished by the installation of the light in the large hall of the corn exchange, where the fruit and flower market is now held. The town hall has, of course, been lighted by electricity since its opening, but the corn exchange is the first important public building in which this illuminant has been fitted since the works in Commercial-street were taken over by the municipal body. Mr. Fedden, the general manager, hopes that the departure now made will prove the first of a series, and that before long electricity will be installed at the other markets and also at the baths. The substitution of electricity for gas at the corn exchange will be advantageous, apart from the question of superior illumination, as the atmosphere will be less heated, and more favourable to the flowers and fruit stocked in the hall. The size of this room is 150ft. by 75ft., and for lighting it 15 enclosed arc lamps are suspended from the roof, and are 13ft. 6in. from the floor. Each lamp lights a space of 750 square feet. They are of the Davy type, with single globe and reflector. Each takes about 6½ amperes of current, and gives approximately 1,000 c.p. They will burn for 50 hours with once carboning. This is an advantage over the ordinary arc lamps, which only burn about eight hours, and which, if used at the corn exchange, would need carboning in the winter time every day. Once a week will suffice in the case of the new lamps, so that the cost of carboning is reduced to one-sixth. The whole of the lamps are controlled from one position, but each switch governs two lights. The work of installation has been carried out during the last three weeks

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by the wiring and fittings department, under the supervision of Mr. J. W. Barnes. The light was switched on for the first time on the 11th inst.

PROVISIONAL PATENTS, 1901.

MAY 6.

9311. Improved fuse head for electric blasting. Frederick Render, 6, Bank-street, Manchester.

9326. Improvements in X-ray tubes. George Henry Smith, 37, Daniel-street, Cathays, Cardiff.

9330. A device for quickly connecting the trolley wheel of electrically-driven tramcars or other vehicles with the overhead wire supplying the power, and which is usable in any position of the trolley arm. Edward John Simmonds, 3, Wesley-villas, Hyde Park-road, Mutley, Plymouth.

9350. Improvements in and relating to electric furnaces for heating or reheating objects to a predetermined degree. Adrien Grobet, 11, Southampton-buildings, Chancery-lane, London.

9384. Improvements in electric arc lamps. Walter Claude Johnson and William Beedie Esson, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

9388. Improvements in electric arc lamps. Helios-Upton Company and Thomas Spencer, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 7.

9405. The training of guns by electric motors without the use of resistances. Harry Egerton Wimperis, Gonville and Caius College, Cambridge.

9445. Improvements in the rectification of high-tension alternating electric currents. Russell Stuart Wright, 52, Cromwell-avenue, Highgate, London.

9502. Improvements in telephone transmitters. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Charlton E. Yocom, United States.) (Complete specification.)

9512. Improvements in solenoid and other electric coils. John Allen Heany, Norfolk House, Victoria-embankment, London. (Complete specification.)

9527. Improvements in connection with electrical fuses. James Yate Johnson, 47, Lincoln s-inn-fields London. (The D. and W. Fuse Company, United States.) (Complete specification.)

MAY 8.

9532. Improvements in motor-starting switches. Frederick Joseph Arundel Matthews, Revidge, Bowden-lane, Marple, Cheshire.

9547. Improvements in electric stop motions of drawing frames. Thomas Chadwick, Penny Bank-chambers, Halifax.

9574. An instrument for the testing of the magnetic qualities of materials in bulk. Charles Vickery Drysdale, Clairville, Hadley-road, New Barnet, London.

9586. An invention for extending the present range of wireless telegraphy. Florence Lacon and Arthur Foster, 11, Great Cumberland-place, London.

9593. An improved electric switch for starting motors or like purposes. Siemens Bros. and Co., Limited, and Maurice Hird, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9605. Instantaneous device for securing telegraph, telephone, or other wires. Quelez Austen, 64, Grange-road, Hove, Sussex.

9610. Improvements in electrical exercising machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Albert Williamson Courtney, United States.) (Complete specification.)

9611. Improvements in trolley heads for use in connection with the overhead system of electric traction. Anthony Metcalfe, 46, Lincoln's-inn-fields, London.

9616. Improvements in and relating to electrical time switches. Wilhelm Rausch, 60, Queen Victoria-street, London. (Complete specification.)

MAY 9.

9619. A new or improved method of conveying electric current, a new or improved apparatus in connection therewith. John Iron, Harbour House, Dover.

9651. An improved method for the protection of overhead systems of transmission of electric currents. Cecil John Reginald Le Mesurier, 19, Perrymead-street, Fulham, London.

9674. Improvements in electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, Adrian Denman Jones, and Bernard Mervyn Drake, Hartham Works, Hartham-road, Holloway, London.

9675. Improvements in the regulating mechanism for electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

9676. An improved electric smelting process and apparatus to be used therein. The British Aluminium Company, Limited, 6, Bream's-buildings, Southampton-buildings, Chancery-lane, London. (Alfred Hutchinson Cowles, United States.) (Complete specification.)

9692. Improvements in underground systems for electric traction railways and the like. Carl Haggenmiller, 6, Lord-street, Liverpool.

9697. Improvements in or connected with wireless and other telegraphic signalling. Jagadis Chunder Bose and Sara Chapman Bull, 53, Chancery-lane, London.

MAY 10.

9718. Improvements in electrical heating apparatus. August Eckstein and Charles Herbert Archer, Peel Works, Adelphi, Salford, Manchester.

9731. Improvements in the method of lighting oil and other lamps by electricity. William Patterson, 5, Lord-street, Lower Broughton, Manchester.

9740. An improved ceiling switch. Augustus Reckenzaun, 165, Queen Victoria-street, London.

9745. An improvement in or relating to electric current circuit breakers. Ernest Francis Moy and Percy Henry Bastie, 37, Essex-street, Strand, London.

9769. Improvements in current collecters or contact-shoes for electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (McElroy-Grunow Electric Railway System, United States.) (Complete specification.)

9770. Improvements in electrical sparking devices for firing the charges in internal-combustion engines, and for similar purposes. Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

MAY 11.

9781. An improved insulator for use with bracket suspensions of overhead trolley systems, and the like. Robert Cornelius Quin and John Berry Smith, 5, Blakiston-street East, Fleetwood.

9785. Improvements in reversing apparatus for electrical devices. Robert Joseph Hughes and Alexander Bruce Shaw, Fife House, Kingston-on-Thames. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 13, 1900, being date of application in United States.)

9801. Improvements in electric telegraphy. Sidney George Brown, 9, Putney hill, Putney, London.

9812. An improvement in controllers for electric motors for lifts and other purposes. John Bush and Matthew Thomas Medway, 175, Shardeloes-road, New Cross, London.

9829. Improvements in automatic electric circuit breakers. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, Bush lane House, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 1.

1900.

6312. Apparatus for the production of soda and chlorine by the electrolysis of chloride of sodium, also applicable for the production of potassium, sodium, aluminium, or other metals of the same class. Cohu and Geisenberger.

8315. Electric switches. Jones.

9633. Strap coils for electrical machines. Mallett. (Date applied for under International Convention, Oct. 7, 1900.)

10639. Electric controllers. Thompson. (Fraser Electric Elevator Company.)

12466. Construction of rail bonds for electric railways and mode of applying same. Hardingham. (Felten und Guilleaume Carlswerke Actiengesellschaft.)

13951. Electric muffles or furnaces. Weiss.

1901.

1611. Apparatus for testing electric meters. Del Nero and Camino.

1339. Electric trolleys. Allison. (Pemberthy Injector Company.)

1488. Electric measuring instruments. Brooker and Russell.

1660. Electric tramways on a sectional conductor closed-conduit system. Hore, Rydl, and Vsětecka.

2570. Electric signalling apparatus. Mildon.

4096. Railway electric signalling apparatus. Hume.

4767. Cable for supplying the electric current to electrically-driven ploughs, and for like purposes. Meissner.

7113. Apparatus for rectifying alternating electric currents. British Thomson Houston Company, Limited. (Green.)

7114. Electric regulators. British Thomson-Houston Company, Limited. (Everest.)

7224. Apparatus employed for covering telegraph cables and wires with lead or other metallic substance for electric purposes, or for manufacturing metallic pipes or tubes or like uses. Claremont and Stratton.

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7338. Electric furnaces. Schneider.

7497. Contact boxes for the distribution of electricity. Chruvellier. (Date applied for under International Convention, Nov. 21, 1900.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	—	—	—	—	—	—
Birmingham Trams.	May 11	4 402	4 293	+ 109	78.114	—
Blackburn Corp'rat'n	,, 10	530	446	+ 84	8 312	7.451*b*
Blackpool Corporatn.	,, 9	357	285	+ 72	2.617	2,191
Blackpool-Fleetwood	,, 11	335	332	+ 3	4 285	4 584
Bolton Corporation..	,, 12	1,425	1,034	+ 391	25.680	16,843
Bradford City Trams	—	—	—	—	—	—
Bristol Tramways Co.	,, 10	4,306	2 850	+1,456	—	—
Carlisle Tr'mw'ys Co	,, 11	158	—	—	2.504	—
Central London Ry.	,, 11	6,514	—	—	117 537	—
City & South London	,, 12	2,015	1,380	+ 635	37.731	23,626
Cork E. T. and L. Co.	,, 9	514	420	+ 94	7,034	6 196
Dover Tramways ...	,, 11	197	177	+ 20	3 268	3,020
Dublin & Lucan E.R	,, 11	96	106	— 10	1,586	1,473
Dublin U.T., elec. cars	,, 10	3,523	3,452	+ 71	—	—
Dublin S.D. Electric	,, 10	779	822	— 43	—	—
Dundee Tram Co. ...	—	—	—	—	—	—
Glasgow Corporation	,, 11 1	0,691	9,183	+1,504	—	—
Halifax Corporation	—	—	—	—	—	—
Huddersfield Corp'n.	—	—	—	—	—	—
Hull Corporat'n E.S.	—	—	—	—	—	—
Liverpool Corporat'n	,, 4	8 964	7,465	+1,499	146 242	125,281
Liverpool Overhead	,, 12	1,616	1,416	+ 200	29,167	26,752
Portsmouth Corpn...	,, 14	493	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 12	3,503	—	—	—	—
Southampton Trams	,, 9	722	462	+ 260	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—

b Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported :

Anglo-Argentine, £91 increase.

*Barcelona Ensanche y Gracia, £242 decrease. *Barcelona, £1.779 decrease.

Brisbane, £249 increase.

Buenos Ayres and Belgrano Electric, £468 increase.

Calcutta, £233 increase.

Cape Town (month of February), receipts, £13,463 ; expenditure, £6,004.

Mexico Electric (month of April), receipts, £17,500 ; expenditure, £10,000.

Perth Electric, £227 increase.

Port Elizabeth (month of February), receipts, £3,043 ; expenditure, £1,803.

* Strike all the week.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	—	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	—	85-90
British Insulated Wire, Ord., 1-70,000	5	—	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1⅞-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	103-108
—— 4½ per cent. 2nd Debenture Stock	100	..	101-103
Callender's Cable, Debentures	100	—	109-113
—— Ordinary	5	—	14½-15½
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	2	—	3¾-4
—— 5 per cent. Debentures	—	—	101-104
Edison and Swan United, Ordinary	2	—	1½-1¾
—— 5 per cent. Debentures	5	—	5-6
—— 4 per cent. Deb. Stock, Red	100	—	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	—	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	—	2⅜-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-130,000	1	..	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	—	15½-16½
—— 4½ per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	—	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅞-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	—	70-75
Bournemouth and Poole, Ordinary	10	—	11½-12½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7⅞-8¼
—— 7 per cent. Preference	5	—	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	7¼-7⅝
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5-5½
Chelsea Electricity Supply	5	—	5¾-6¼
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	—	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	—	101-103
County of London and Brush Provincial, Ordinary	10	—	8-9
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	5-5½
—— 6 per cent. Cum. Pref.	5	—	5¼-6
—— 4½ per cent. First Mort. Deb.	100	—	103-106
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	—	4¾-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5-5¼
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7½-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	—	11-12
—— 4 per cent. Debenture Stock, Red.	100	—	102-105
Kensington and Knightsbridge and Notting Hill	100	—	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10½
London Electric, Ordinary	2	—	1¼-1⅜
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	12½-13½
—— ,, 85,001-98,769	5	—	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15½-16⅝
Oriental, 1879	1	—	1¼-1⅜
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	—	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	—	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	—	2¼-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15
—— 7 per cent. Pref.	5	—	8½-9½
—— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9¼-9¾
—— Pref. Half-Shares	5	—	4¼-5
—— ,, ,, deferred	5	—	4¼-5
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	113-118
City and South London, Consolidated Ordinary	100	—	52-54
—— Ordinary	10	—	5-5½
—— 4 per cent. Debenture Stock	100	—	113-118
—— 5 per cent. Pref. Stock '91	100	—	132-137
—— ,, ,, ,, '96	100	—	122-127
Liverpool Overhead, 5 per cent. Pref.	—	..	12-13½
—— Ordinary, 1-50,000	—	..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,760	—	..	102-104
Waterloo and City, Ordinary	100	—	94-97
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	3¾-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	124-129
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2½-3½
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	..	4¼-4⅝
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	—	6½-7
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	..	9¾-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	..	99-101 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	..	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	119-122
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	..	1½-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	100	—	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	—	1⅝-1¾
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	..	98-102
Imperial Tramways, Ordinary	all	..	22-22½
—— 6 per cent. Cum. Pref.	all	..	14½-15½
—— 4½ per cent. Deb. Stock	100	..	112-114
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	..	103-105
New General Traction, Ordinary	5	—	3½-3⅝
—— 6 per cent. Cum. Pref.	10	—	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10⅝
—— 5 per cent. Cum. Pref.	10	—	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
—— 4½ per cent. Debenture Stock	100	..	107-109
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £51,132 6 per cent. Preference	6s.	..	5/16
—— £50,000 ,, ,,	1	..	1
—— £500,000 4½ per cent. Debenture Stock	33½	..	33½
Telephones.—			
National Telephone, Ordinary	5	—	3⅜-3⅝
—— 6 per cent. Cum. First Pref.	10	..	10-12
—— 6 per cent. Cum. Second Pref.	10	..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	4¼-4⅜
—— 4 per cent. Deb. Stock, Red.	100	—	95-98
—— 3½ per cent. Deb. Stock, Red.	100	—	87-90
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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NOTES.

The German Visit.—We understand that the preliminary arrangements for the Institution visit to Germany are now almost complete, and that the date of departure—namely, Saturday evening, June 22—remains unchanged. The circulars giving the completed programme will, we are informed, be issued immediately after Whitsuntide.

New Book.—Mr. J. H. Rider, the recently appointed chief electrical engineer to the London County Council, has been engaged for some time on a treatise on "Electric Traction," which he is writing for Messrs. Whittaker and Co. It is to be published, we understand, in the autumn, and will treat very fully on the different systems of electric tramways.

A Novel Electric Lamp.—A novel and most useful contrivance of an electric lamp for use especially in reading meters is the invention of Mr. Oster, of Urdingden. As usual in this class of lamp, the accumulator is carried in the pocket, but the lamp in question is so made as to allow of its being carried in the mouth. A squeeze with the teeth sets it in action, with the obvious advantage that both hands are left entirely free.

National Electrical Contractors' Association.—We are asked to state that a meeting will be held at 46, Queen Victoria-street, E.C, on Tuesday, the 28th inst., at 2 p.m, for the purpose of forming the National Electrical Contractors' Association, already referred to in these columns. The attendance of members of electrical contractors' associations already formed, and of electrical contractors disposed to identify themselves with the movement, is cordially invited.

The Electro-Harmonic Society. — The annual general meeting of the above society will be held on Wednesday, the 29th inst., at the Institution of Electrical Engineers, 28, Victoria-street, Westminster. We understand that during the past season 80 gentlemen have been elected and placed on the register of members of the society, and 19 old members have resigned. In the same period the society has lost three members by death, while four have been struck off the register for non-payment of subscriptions. The membership roll now includes 332 names.

The Pacific Cable.—We regret to note that the arrangement made between the Government of New South Wales and the Eastern Extension Telegraph Company, which was adversely criticised in our columns some time ago, is having an injurious effect on the prospects of the scheme for an all-British cable across the Pacific. The last instance of this is the determination on the part of the Canadian Government to hold back the Pacific Cable Bill until it has been decided as to what will be the actual effect of the arrangement above mentioned with the Eastern Extension Telegraph Company.

Institution of Junior Engineers.—On Monday evening last the members of this institution paid a visit to the works of the Renewable Electric Lamp Company at Brunswick-place, City-road, E.C. We are informed that, in addition to the renewing of old lamps by the introduction of a new filament, the company are manufacturers of incandescent lamps, the filament being prepared in a special way. Its consumption of current claimed is as low as 2·7 watts per candle-power, and it is guaranteed to burn 1,000 hours. In the renewal process the bulb is reopened, the old filament is detached, and a new one inserted, thus avoiding the wastage of the bulb, the cap, the platinum, leading-in wires, etc. The visit concluded with a vote of thanks to the managing director of the company, Mr. H. E. Kershaw.

National Telephone Dinner.—The eighth annual dinner of the staff of the National Telephone Company took place at the Trocadero Restaurant on Friday last. Mr. W. E L. Gaine, the general manager of the company, presided, and as showing the position of the company he gave the following figures in the course of the evening: Last year they had 968 exchanges, while this year they have 999, and "notwithstanding all the threats of competition and suggestions of inefficiency," they now have 205,000 subscribers, compared with only 176,000 in 1900; while, although the increase in inland telegrams during the 12 months was 2·88 per head, the increase in telephonic messages was 15·3, the total of the former being 90,000,000, while the total of the latter was 712,000,000. The company was also addressed by Sir Cuthbert Quilter, M P., and Lord Kelvin.

Explosives on the Line.—What was at first regarded as a serious attempt to disorganise the Corporation electric tramcar service occurred last week at Liverpool, when two American cattlemen were arrested on a charge of placing explosives on the tramlines. Reports were heard in the centre of the city on two successive evenings, and on investigation it was found that revolver cartridges had been placed on the tramlines and exploded by the cars. On the second occasion a young man was struck in the cheek by a bullet $\frac{3}{4}$in. in length. When charged with wilful intent to endanger life and property, one of the cattlemen admitted having placed cartridges on the track, but pleaded that he "only wanted to hear them go off, and had no idea that there was any danger." This explanation was evidently accepted by the magistrate, who took a most lenient view of the case, imposing a fine of 40s. and costs on the first man and discharging the other.

Municipal Supply in Bulk.—The conference which was held on the 16th inst. between the representatives of the various local authorities in Greater London and the London County Council was kept private. In spite of that, the actual resolutions, or, rather, the gist of them, have leaked out. We gather from this that the conference reaffirmed a resolution which was passed at a similar gathering some three years ago in favour of the London County Council supplying electricity in bulk to local authorities. The conference further decided by resolution that the Council should be asked to draft a suitable Bill in order to obtain powers to this end. It remains to be seen how this Bill can be drafted in such a way as to avoid interfering with present interests, and also as to what proposals the London County Council will incorporate in the same as to joint control of the stations which would be used for supplying local authorities in bulk.

Pole-Setting in Swampy Ground.—The difficulties of pole-setting vary with the nature of the ground in which it is required to place the poles For instance, electrically-driven pumps are now used for draining the low land around New Orleans, and these are located at different pumping stations, which are supplied with current from a large central generating station established for the purpose. The difficulty here was that the New Orleans soil tends to rot timber very rapidly, and some method had to be devised for preserving the poles underground. The plan adopted was to first put a box of about 1in. larger dimensions than the pole in a concrete setting. Then, after the base of the pole had been placed in the hole in the concrete left on the removal of the box, sand was poured in around it, which effectually preserved it from the effects of the swampy soil. In the case of very soft ground it was found necessary to fasten the poles to piles

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driven 26ft. below the surface in order to preserve them upright.

Niagara Power.—We gather from a note in one of our American contemporaries that the Niagara Falls Power Company intend to proceed at once with the development of the power of the Horseshoe Fall, the present plan being to obtain some 35,000 h.p. Of this about one-third is required to operate an industrial establishment in the vicinity, while another third is to be transmitted to Toronto. The remaining third will be held in reserve for the use of the company itself on the American side of the river. According to the present intention, the two power-houses of the company in Niagara Falls, New York, and the new power-house on the Canadian side, will be connected. The development of the power will necessitate the construction of an inlet canal from Cedar Island to the power-house site, where the wheel pit will be sunk, a tunnel carrying the water to the lower river below the Horseshoe Fall. This pit and tunnel, it is said, will suffice for turbines having a capacity of 100,000 h.p.

Mechanical Engineers' Conversazione.—The conversazione given by the Institution of Mechanical Engineers as the closing function of the session passed off last Friday with complete success. The large company, numbering over 800 ladies and gentlemen, were received in the great hall of the institution building by the President and Mrs. Maw. Among those present were the Earl of Rosse, Sir J. Aird, M.P., Sir Edward Carbutt, Sir W. White, Dr. Alexander Kennedy, the Hon. C. S. Rolls, Sir Hiram Maxim, Sir Frederick Bramwell, Sir Benjamin Baker, Prof. Henry Robinson, Mr. J. A. Thornycroft, Mr. Charles Hawksley, Mr. J. A. Aspinall, Mr. W. H. M. Christie, and many other gentlemen interested in different branches of science. The band of the Coldstream Guards gave various selections in the library, and a programme of vocal music, under the conductorship of Mr. Alfred Smythson, was also provided. An interesting feature of the programme for the entertainment of the visitors was an exhibition of photographic views of the great Nile dam by Sir Benjamin Baker.

Royal Meteorological Society.—The monthly meeting of the Royal Meteorological Society was held on the 15th inst., when Mr. W. Marriott gave an account of the bequest to the society by the late Mr. G. J. Symons, F.R.S., who was the founder of the British rainfall organisation and a most distinguished meteorologist. By his will Mr. Symons bequeathed to the society his cross of the Legion of Honour, the gold Albert medal awarded to him by the Society of Arts, the testimonial album presented to him in 1879 by the Fellows of this society and the sum of £200, as well as such of his books, pamphlets, maps, and photographs of which there was no copy in the society's library. Mr. Marriott stated that from Mr. Symons's valuable collection he had selected for the society over 5,000 books and pamphlets, and about 900 photographs. A large number of the books were old and rare works, 750 bearing dates previous to 1800, while eight were as early as the fifteenth century. By this noble bequest, it is claimed, the Royal Meteorological Society now possesses the most complete and extensive meteorological library in existence.

Water Power and Irrigation.—Irrigation combined with electric utilisation of water power is the latest problem to which American engineers have been devoting their attention, with the result, we are told, that the water in falling from the high levels of the mountains to fulfil its work of irrigation on the plains has been made to pass through turbine wheels and thus generate power. The *Electrical Review* of New York, editorially commenting on the question, says that California, for example, has districts where such a system of utilising the mountain torrents for both purposes seems to promise an actual production of wealth greater than could be measured by all the gold ever dug out of the soil of that State. It is inevitable that manufacturing industries of great importance will sooner or later spring up around the water powers of that region, while the water itself having done its work in turning the dynamo, will furnish food for the great influx of population that such manufacturing would entail, as well as being applied to irrigation purposes. Up to very recently, the potential energy of the water applied solely to this latter need in America has been absolutely wasted.

Mercardier Telegraphy.—We gather from a note in one of our daily contemporaries that a new system of telegraphy is being experimented with at the Post Office. From the details given of the new system, it would seem that it is the one described by Mr. Gavey in his paper before the Institution in November last as devised by Mr. E. Mercardier. By this multiple telegraph system it is claimed that 24 messages can be sent simultaneously over one circuit, 12 in each direction. The device is based on the harmonic system. A number of vibrating reeds are used, each differing from the rest by a certain defined period of vibration. These, when used to send signals to the line, cause a complicated system of vibrations to be set up in the currents transmitted. The line current is then analysed at the receiving end of the line by the series of receiving reeds or telephones only responding to the notes to which they have been tuned. With the Mercardier system Morse characters alone can be transmitted up to the present. It is stated that the inventor has been so successful with the tuning of the various parts, that satisfactory results have been obtained on a circuit between Paris and Bordeaux. A complete metallic surface is, however, required for satisfactory working.

Light Railways.—A parliamentary paper has just been issued embodying the proceedings of the Board of Trade under the Light Railways Act and of the Light Railway Commissioners up to Dec. 31, 1900. We gather from the report submitted by the late Sir Courtenay Boyle on behalf of the Board of Trade, that on Dec. 31, 1899, there were 18 orders before the Board for consideration. Out of these 13 were confirmed during the year under review, while the remaining five were held over for various reasons, one of them having since been confirmed. Again, out of 40 fresh orders submitted by the Light Railway Commissioners, 16 were confirmed by the Board of Trade. The remaining orders, 24 in number, were still under consideration on Dec. 31 last, but of these 10 have since been confirmed. The report also refers to six orders in respect of which the Treasury have conditionally agreed to make advances. The report of the Light Railway Commissioners states that 56 applications for orders to authorise light railways were made in the year 1896-97, 65 in the year 1897-98, 94 in the year 1898-99, 67 in the year 1899-1900, and 27 in the month of November, 1900. In respect of 133 applications the Commissioners have now submitted 126 orders to the Board of Trade for confirmation.

Electromagnetism as a Therapeutic.—We notice in the *Electrical Review* of New York the description of an apparatus devised by a Mr. John Barry, of that city, which is said to have given relief in all cases of rheumatism and certain kindred diseases. The device in question consists of a large hollow solenoid which is enclosed in a metallic cover, the length of which can be varied by removing segments at will. The length of the apparatus is then so varied as to just cover any limb which has to be treated. Alternating currents are then put through

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the winding of the solenoid of such a strength as to cause a considerable alternating magnetic field in the space occupied by the limb under treatment. We should like to have seen some information as to the actual strength of field obtained, because obviously this field has to be set up in a material whose permeability is practically unity. According to the explanation of the inventor, the action is to cause alternating local currents which do not have any electrolytic effects, but which stimulate the blood and improve the circulation. We can quite realise that some such effects would take place, and it is only a matter of experiment as to how far they are successful in overcoming disease. Careful measurements by a qualified electrical engineer under the supervision of a medical man would be of great value in ascertaining exactly what effects do take place.

Sychronising Alternating-Current Machines.—When synchronising an alternator to bring it into parallel with other alternators working on load, it is exceedingly important that the connection should be made absolutely at the right instant in order to avoid throwing additional load on the machines already working on the circuit, which may be heavily loaded. In fact, in certain of the London stations, when dealing with a sudden fog, there is no time frequently for new machines to be synchronised before they are switched in. In such cases damage is sometimes done by the haphazard way in which the new machine is thrown into circuit. As an indicating apparatus as to what is the right period to switch in, a voltmeter is more reliable than the usually employed incandescent lamp, because the eye is not sufficiently sensitive to variations in voltage when looking at a lamp the brilliancy of which is varied rather rapidly. Even with a voltmeter there is a need for an apparatus which would automatically close the switch at the right instant. The nearest approach to this we know of is a device working in the exactly opposite direction, in that it cuts the incoming alternator off again if the current exceeds a predetermined limit immediately after the main switch has been closed. We believe that Mr. Andrews, of Hastings, was the first to introduce these maximum and non-return current cut-outs for alternators in this country, but there are now other types being introduced which have the same object.

A Frequency Changer.—With the use of abnormally low frequencies for three-phase transmission work, the need arises for a frequency changer in order that the electric lighting done from the power mains may be of a satisfactory nature. Opinions differ as to the lowest frequency which can be used both for lighting and power, but there is often an advantage in power work in employing a frequency below that at which satisfactory results can be obtained with arc or incandescent lamps. We have recently seen in the columns of the *American Electrician* the description of a rotary frequency changer manufactured by the Stanley Electric Manufacturing Company, of Pittsfield, Mass. This consists practically of an inductor alternator having a single exciting coil, which is fixed in between the two cores which carry the armature coils. The winding on one of these cores acts as a generator circuit, receiving a current at a frequency of 25. The winding of the other armature core is so arranged as to give a frequency of 50 complete periods per second. In order that this may be done, the laminated projections on the rotor which come opposite the first or generator armature core are of twice the size and only half the number of those opposite the motor core. It will be seen from the above description that the machine has several advantages as a frequency changer, in that one exciting coil suffices for what is practically a double machine. Naturally, however, the change in frequency is invariable. We understand that the machine is run up to speed by a small induction motor.

Frequency Converters.—We notice in the *Electrical World* a description by Mr. A. S. McAllister of a frequency converter, in which the frequency of the secondary current can be made practically anything by means of slight alterations in the original design. The principle on which the author proposes to work is that of using an ordinary induction motor as a frequency changer. It is known, for instance, that if the rotor of an induction motor is fixed, it has the current induced in it, the frequency of which is equal to that of the current supplied to the stator. Again, if the induction motor is allowed to run up the speed, the frequency in the rotor becomes less and less. If, now, the secondary is driven by independent means at any fixed speed, the frequency obtained in it by the combination of its speed and of the speed of the revolving field can be made anything at pleasure. The author suggests for the driving a synchronous motor, so that a constant frequency would be obtained in this secondary. By means of analysis he then shows that the actual dimensions of the machines will be considerably less than if the whole of the current required was actually converted. In fact, the power which has to be supplied by the frequency converter, bears to the total output the ratio of the primary frequency to that of the secondary. The rest of the power is then supplied by the synchronous motor. For instance, if a lighting load of 60 kw. has to be taken from a power circuit the frequency of which is only 25, and assuming that the frequency of the lighting circuit has to be 60, then the capacity of the frequency converter will have to be 25 kw., and that of the synchronous motor 35 kw. This idea of Mr. McAllister seems to have in it the elements of success.

Tramway Comparisons.—In its issue for May the *Street Railway Journal* has an editorial note comparing the figures obtained from the tramways in Great Britain and Ireland for the year ended June 30, 1900, with those of various street railways in operation in America. Taking the gross receipts from operation, these in the case of Great Britain and Ireland amount to £5,282,240, and it is shown that the gross receipts of two companies in one city in America, the Metropolitan Street Railway Company of New York and the Brooklyn Rapid Transit Company, nearly equal our results, the total being £5,205,128. Again, the gross receipts of the Massachusetts companies amounted to £4,277,528, and it is pointed out that these companies, with lower gross receipts, paid just about twice as much in taxes as the English companies, and that the roads in Greater New York paid about 2½ times as much in taxes. Of course, this is easily explained away by the fact that the taxes paid by the street railways in the States are very much greater than in the United Kingdom, so that a comparison of this sort conveys no reliable information of value at all when making a comparison. We are rather amused to find that at the end of this article the total payments on account of injuries and damages payable by the companies are given in comparison. If this is to be taken as a reliable basis of comparison as to the relative importance of the street railway or tramway systems on either side of the Atlantic, we in this country certainly take a back place. For instance, while Massachusetts has been held liable for £118,501 in respect of these matters, we in this country have only paid £38,538 during the same period. We agree that gross receipts, and to some extent taxes, may be taken as a fair basis of comparison, but it is absurd to suggest that the compensatory liabilities in respect of accidents, etc., have any bearing whatever on the relative positions of the tramway industry in the two

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countries. It would appear to us that the low figure laid to our account as compared with the States is rather a matter for congratulation than otherwise.

Electrically-Controlled Bulkhead Doors.—Mr. George W. Walsh has an article in the *American Electrician* on this subject which embodies several interesting points. The repeated failures of bulkhead doors to close promptly enough to save the ship have caused dissatisfaction and anxiety in many quarters. Both the hydraulic and pneumatic methods of controlling these doors have proved at least uncertain enough to involve an element of danger. Electricity, on the other hand, is peculiarly well adapted to the performance of this work on a steamer. One great thing in its favour, the author points out, is that a sudden and great power can be exerted at a critical moment, exceeding often by far the normal rated power of the apparatus. Owing to the fact that electricity is used so generally on shipboard now for a great variety of purposes, a new auxiliary source of power does not have to be installed to control the bulkhead doors in an emergency. For nearly a year now there have been in operation electrically-controlled bulkhead doors on the United States cruiser "Atlanta." The apparatus used was devised by Naval Constructor Francis T. Bowles, of the Brooklyn Navy Yard, and a model of it was placed on view in the war material building at the Paris Exhibition. According to Mr. Walsh, this apparatus has proved so successful that the Navy Department of the United States has decided to equip all future warships with the electrical mechanism, while many of the warships now in service will gradually be changed also in this respect. The "St. Paul" and other ocean merchant steamers have also adopted the electric bulkhead door. Among the many unique features of the apparatus, it is so wired that the officer in charge can operate it from the bridge, and by pushing a button he can tell at any moment the condition of the door. A small lamp near the button indicates whether or not the door is in good working order, the current being automatically cut off when the door is closed, and so darkening the lamp. One great advantage of the invention is that one or a dozen doors may be closed simultaneously or in rapid succession. In cases of emergency there is provision made for local control of the apparatus between decks in addition to the control from the bridge.

The Newport Tramways.—We have received a copy of the *South Wales Argus* for May 15, in which there is an amusing *résumé* by the editor of the debates in the Newport Town Council over the acceptances of the contracts for the tramway power station. According to the editor's account, the fight was a three-cornered one. The first party advocated that the power station, which is to be equipped under the supervision of Mr. Horace F. Parshall, should be used to supply not only the tramways, but also a certain amount of power for other purposes—perhaps some lighting, from what we can gather. The next party advocated the use of electric tramways, but were not in favour of municipal control. The third party strongly supported the present electricity works, and advocated that the supply for the tramways should be taken from plant erected either in the station or in extensions of it. It will be remembered that the lighting station, which was one of the first equipped by Mr. Robert Hammond as consulting engineer, supplies on the single-phase alternating-current system, whereas the tramways require continuous current, and the same is advocated for the supply of motors, and also for lighting in the central portions of the town. The end of the debate seems to have been exciting, as personal remarks were made by various members of the Town Council. We think that the Council were not well advised, however, when they called in the resident engineer of their electric lighting works and asked him to give his opinion as to the position of the tramway works. It is not right to expect two electrical engineers to argue out differences of opinion for the edification of any town council. The more dignified course, having called in outside advice, is to adhere to the advice given, which has practically been done in this instance, except that a needless amount of heat was generated by the discussions of details in public. It was incidentally mentioned at the meeting in question that Mr. Robert Hammond had resigned his position as consulting engineer to the Council on electric lighting matters. The most amusing part of our contemporary's report is the editorial comparison of the eloquence of the two experts who have advised the Council on their electrical undertakings.

London County Council Tramways.—The agenda of the London County Council for this week contains a report of the Highways Committee, which is dated May 16, concerning the proposed reconstruction for electric traction of the considerable further portion of the London County Council tramways. The details as to which of the lines are next to be started will be found in a note elsewhere in this issue, and these lengths involve the equivalent of some 13½ miles of single track. With respect to the equipment of these lines, the Highways Committee suggest an entirely different procedure to that adopted for the first three sections of the tramways now under reconstruction. Acting on the advice of their chief engineer, the committee propose to take full advantage of the experience of the various firms of contractors who are used to executing such work. The specifications on which tenders are to be invited are therefore to be drawn up in such a way as not to bind the parties tendering to any details of construction. For instance, instead of a particular design of yoke and insulator being selected on which all parties have to tender, the actual design will be left to those who offer to supply and equip the same. If it is the desire of the committee to proceed quickly, we think that their procedure is one which will have advantages. But the question arises as to how far it is advisable in the long run to let piecemeal the contracts for the equipment of small lengths of a large system of tramways. For instance, as things now stand with the London County Council, the first eight miles or so of tramway will be equipped with a conduit designed by Prof. A. B. W. Kennedy, and with the one kind of insulator. The next lengths, according to the agenda now before us, are likely to be equipped by A. B. and Co., with another type of conduit and insulator. There are certain dimensions, of course, which have to be the same in each. Again, when the third section of the line is equipped most likely another firm will have the contract. We should then get some 20 miles of track in various parts of South London, all contiguous, and each equipped with a different system. Of course, the difference would mainly lie in the means for supporting the insulated conductors, and the County Council would get valuable experience. It is questionable, however, how far this valuable experience—which would be of the nature of a good knowledge of how not to do things—would make up for the trouble arising out of the want of uniformity.

Two versus Four-Motor Cars.—At the meeting of the New England Railway Club at the end of February last, two papers were read on the advantages of cars equipped with two motors as compared with those of cars having four motors—*i.e.*, one on each axle. The first of these two papers was by Mr. W. Pestell, the electrical engineer

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of the Lynn and Boston Railroad Company. The motors with which he experimented were, as a rule, of the G. E.-58 type. In each case the motors on the four-motor trucks were of exactly the same size as the two motors used for the same cars, so that there was a considerable excess of motor weight to be carried in the case of the four-motor equipments. To really make the experiments of value, the gross output of the motors should have been the same in each case—*i.e.*, the size of the motors in the four-motor equipment should have been half that of the two motors used in the other case. From actual trials and practice the author found that, as a rule, the four-motor cars consumed about 25 per cent. more energy than those equipped with only two motors. He obtained rather higher speeds, as is shown by the curves given in the report of the paper in the *Street Railway Journal*. We gather, however, that as the cars equipped with four motors were worked in the ordinary service, the increase of speed could not be great, as otherwise the cars would have got out of their schedule time, and would have had to wait behind at frequent intervals. The author's experiments on the heating of the motors was naturally greatly in favour of the four-motor equipments, his conclusion being that as regards the deterioration of the windings, the four-motor equipment had the advantage over the two-motor equipment in the ratio of 6 to 1. On the other hand, he thought that the extra wear, or, rather, the more wearing parts of the four-motor equipment, would be against them. Mr. C. B. Bigelow, the inspecting engineer of the Boston Elevated Railway Company, also read a paper on the same subject. In this case, again, we gather that the gross power of the four motors was considerably more than that of the two motors. In fact, the weight of the whole car with the equipment of four motors was 18 per cent. greater than in the other case. He found, however, as would be expected, that he would get much quicker acceleration with a four-motor equipment. In fact, a speed of 15 miles per hour was reached in only 68 per cent. of the time required by the two-motor cars, but 64 per cent. more current was used to give the same speed. In view, however, of the reduction of time, it only made an increase of about 12 per cent. of energy. From what we can gather from reading through these papers, and the discussions which follow the experiments made, were not really such as to bring out the relative advantages of the two methods. Although both the authors reported against the four-motor equipment, it does not follow that on lines such as the Metropolitan District Railway, where all the energy is used in accelerating the cars, that the gain from the four-motor equipment may not be very considerable. If, however, one tries to run cars equipped with four motors in the same schedule as those with two motors, no advantage would result.

Electricity in West Ham.—If not in its locality, West Ham at least compares most favourably with any of the other metropolitan boroughs in regard to its electrical undertaking. Already the Corporation electricity station has been found to be inadequate to the demand, and a scheme of large extensions and additions, both in connection with the lighting department and the projected electric tramways, is well advanced. Looking back on the past three years one is struck by the rapidity which has marked the progress of the electric light in the borough. Last year, for instance, the maximum demand at any hour was 578 kw., at the present time it is 1,000 kw., which shows a growth of close on 100 per cent. Consumers are now being connected at the rate of 12 per month, the charge per unit being 3·90d., which is the lowest of all the metropolitan boroughs having their own electric light undertaking, with the exception of Shoreditch. Among the various improvements introduced within the last year or so are the abolition of meter rents, the introduction of the system of allowing discounts, and the inauguration of the system of free wiring. The latest problem which is having the careful consideration of the Electricity Committee is as to supplying electric power for motive purposes during the daytime; and as the best means of demonstrating the many and various applications of electricity in this connection, the Corporation have organised an "electrical exhibition," which was opened to the public in the town hall on Monday last by the Mayor of West Ham. Having regard to the local nature of the exhibition, we were agreeably surprised to find so many well-known electrical firms represented; but this only goes to show the deep interest and sympathy with the Corporation in their latest effort to convince the ordinary householder of the great advantages which electricity has over all other motive powers. As showing the representative character of the exhibition, we may mention a few of the exhibitors. Thus Messrs. S. Z. de Ferranti show switchboard gear, rheostats, direct-current meters, etc.; while no less than seven different firms have electric motors, direct and alternating, driving various machines on view. These are Messrs. Geipel and Lange, the Langdon-Davies Electric Motor Company, the British Thomson-Houston Company, the General Electric Company, Messrs. Verity's, Messrs. Witting Bros., and the Vulcan Electric Company. The last-mentioned firm particularly demonstrates how suitably electric motors may be employed for various domestic purposes. We noticed, for example, electrically-driven sewing, mangling, washing, and knife-cleaning machines in operation, while an electrically-heated flat-iron also appeared to perform its work with due effect. Among the numerous other exhibitors we may mention Messrs. Jackson Bros., showing cooking apparatus, electric fans, telephones, etc.; the British Insulated Wire Company, cables; the Hart Accumulator Company, storage batteries; the Electric Lighting Boards Company, electric signboards for advertisement purposes, etc.; and the Renewable Lamp Company, showing glass-blowing for incandescent electric lamps. The stall of the General Electric Company is particularly attractive. Here may be seen the application of electricity for such things as kettles, cigar-lighters, and similar articles; while Messrs. Young and Marten have given special attention to electric cooking and heating apparatus of all kinds. An interesting feature of the opening day was the "setting" of an exhibition edition of one of the local papers on the spot by means of an electrically-driven Linotype machine. The town hall, which has been appropriated for the purpose, is artistically decorated with festoon cables and ornamental signboards, which lend a most brilliant effect to the surroundings. Mr. James K. Bock, the borough electrical engineer, whom we heartily congratulate on the organisation of the exhibition, is issuing a little pamphlet giving a brief *résumé* of the history of electricity, as well as a few of the methods by which electricity is produced and utilised for modern commercial purposes. In this we notice a good view of the engine-room at the West Ham electricity station, showing the 350-h.p. generators, before the addition of the two recent sets of 2,000 h.p. each. Altogether there is now some 6,000 h.p. of plant at the central station. Another view of a part of the transformer chamber at one of the electricity sub stations is equally interesting. It was the original intention of the committee to close the exhibition to-morrow (Saturday), but owing to the success which has so far attended the movement, it has been decided to extend the time for another week.

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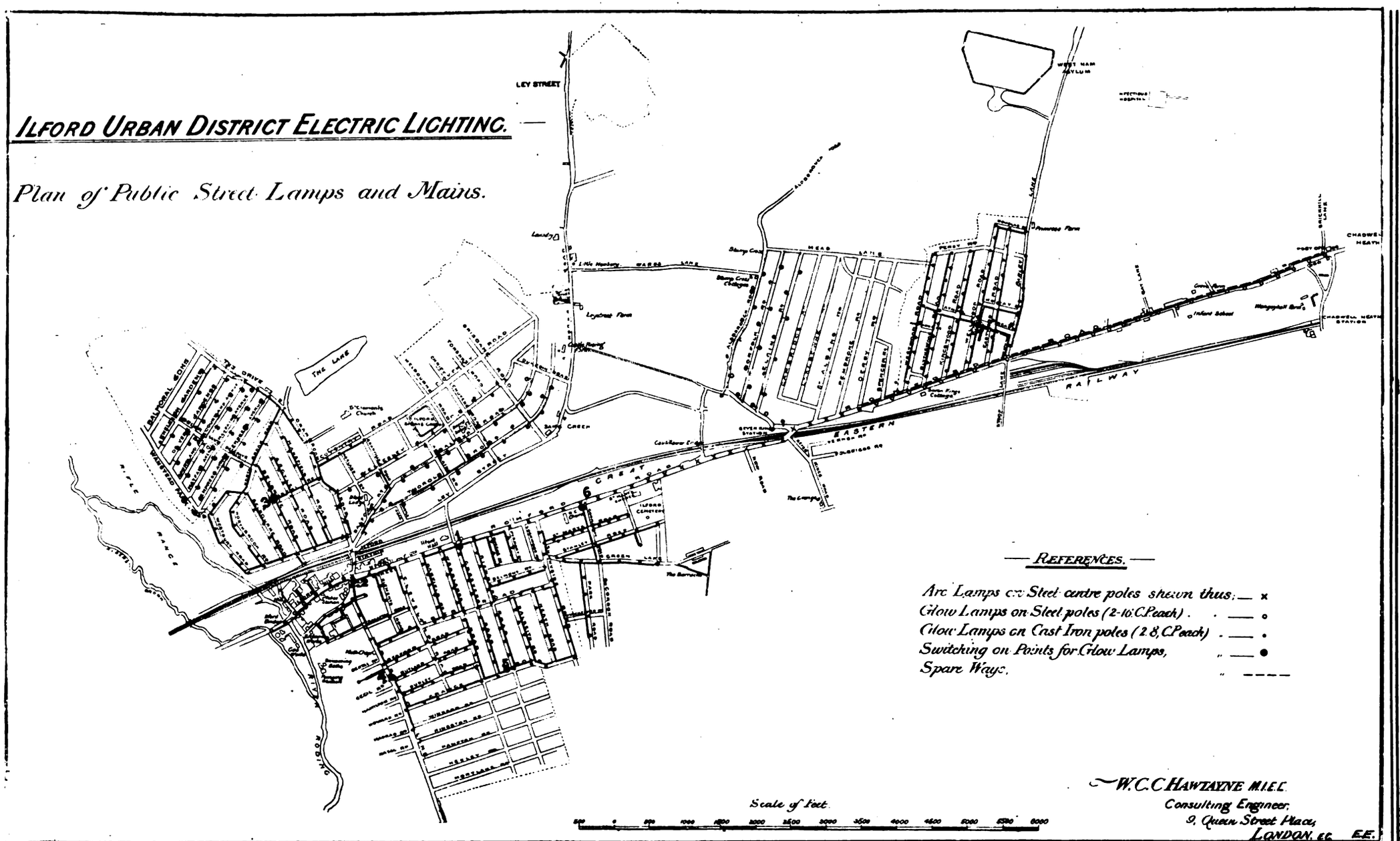

Fig. 1.—The above Map of Street Lighting also shows the extent of area served for Private Lighting, as distributing mains are laid wherever public lighting is provided. The black square marked C. S. is the Central Station Site.

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ILFORD ELECTRICITY WORKS.

Mr. Arthur H. Shaw, A.M.I.E.E., was born at Clapham, S.W., in 1867. He entered the employ of the Manchester Edison-Swan Company at Manchester as pupil, etc., in 1883, and in 1887 entered the works of Messrs. Fowler and Lancaster, in Birmingham, leaving them in 1889 to take the position of electrician to the Marquis of Salisbury at Hatfield. In order to gain further experience, especially in regard to electric traction, Mr. Shaw proceeded to the States in 1890, and entered the works of the Thomson-Houston Electric Company at Lynn, passing through

MR. A. SHAW, ELECTRICAL ENGINEER TO THE ILFORD URBAN DISTRICT COUNCIL.

the shops and "expert course" both in lighting and traction. In 1893 he went to Jamaica for the Thomson-Houston International Company to take charge in their interests of the Jamaica Electric Lighting and Power Company, Limited. Ten months later he was transferred as manager and engineer to the British Guiana Electric Light and Power Company, Limited. After 18 months in Demarara he returned to England in 1895, and joined the Otis Elevator Company as electrical engineer, but left them in 1896 to take the post of chief assistant to Mr. W. C. C. Hawtayne, consulting engineer. In 1898 he was appointed resident engineer to the Harrow Electric Light and Power Company, Limited, and was promoted to his present position in February, 1901.

that one-half of the streets now electrically lighted are not indicated on the Ordnance map, or at the most are shown by a few dotted lines indicating probable street extensions. In view of the rapid rate at which Ilford has grown and is growing, we hardly like to make any statement as to the population within the boundaries controlled by the Urban District Council. According, however, to the preliminary report of the census authorities, the population on March 31 was 41,229. The industries of Ilford are summed up in the statement that building residential houses finds employment for the bulk of the labour actually engaged in the district. The very large majority, however, of the inhabitants come up to town each day, an excellent service of trains being provided by the Great Eastern Railway.

It was in 1897 when the energetic councillors of Ilford first bethought themselves of electric lighting their district. Mr. W. C C. Hawtayne was called in to advise the Council, and his report was adopted in November of that year. A provisional order was applied for and obtained in 1898, and in October of that year Mr. Hawtayne received instructions to at once prepare plans and specifications for some 17 miles of electrical tramways. Powers for the construction of these have been obtained, and due provision was made for the same when drawing up the plans for the electric lighting station. There is a striking difference between the action of the Ilford Council in these matters and that of other town councils who have obtained provisional orders and held them for years without taking action. In Ilford, the decision of the Council to go in for lighting and traction has in each case preceded the granting of parliamentary powers. An advantage from the businesslike decision shown is that Mr. Hawtayne has been able to organise the work so that it can be carried out economically with the least inconvenience to the people. For example, when the lighting feeders and distributing mains from the power-house to the various parts of the district were being laid down, it was known exactly where the feeders for the tramway system would afterwards be required. Earthenware ducts were accordingly laid down, into which the tramway feeders will be drawn very shortly. By means of this there will be no need to break up the streets a second time,

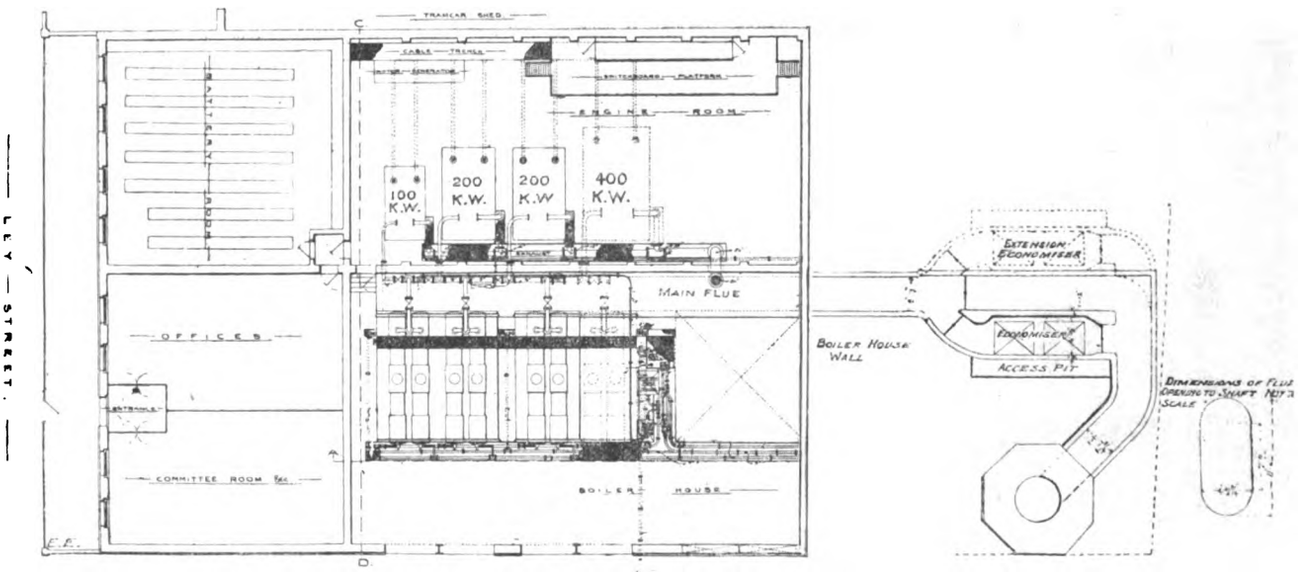

FIG. 2.—Plan of the Ilford Electricity Works.

Anyone who knew Ilford some 10 years ago would be utterly bewildered if he were to revisit it to-day. He would find green fields replaced by countless streets of houses, and also that most extensive building operations were being carried on in all directions. As an example of the progress made, one has only to compare the map which we give herewith of the streets which are now electrically lighted with the latest Ordnance map. The date of this Ordnance map is only 1897, and yet we should say roughly

as has had to be done at nearly every town we know of when making provision for electric traction.

In 1897 a site for the works was secured in Ley-street, which is, as shown on the map (Fig. 1), in a central position. The area of the site obtained is quite sufficient to meet the needs of the district as far as power works are concerned, and there is also room on it for the construction of carsheds in connection with the electric tramways. The designs for the buildings were got out by Mr. H. Shaw, the surveyor

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to the Ilford District Council, who also superintended the erection of these buildings. A general arrangement drawing (Fig. 2) shows the positions of the various parts of these works, while Fig. 2 is a cross-section through the same. In the plan the chimney shaft is shown, owing to the exigencies of our space, somewhat nearer to the boiler-house than is actually the case. The arrangement of the economisers

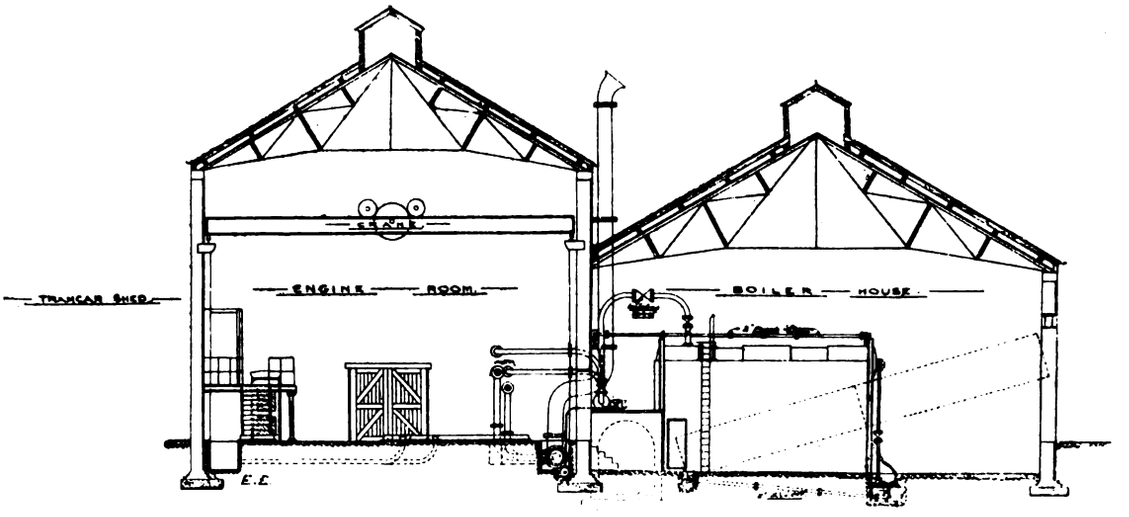

FIG. 3.—Section of the Ilford Electricity Works.

is also shown in the plan. It will be seen that when the extensions are completed there will be two of these useful adjuncts, and they will be so arranged that either half can be shut down for cleaning. Again, if need be, they can both be closed down, and the whole of the gases passed into the chimney by means of the by-pass between the two economisers. As will be seen from the photographs, the interior of the boiler-house and engine-house is lined

arranged in two batteries of two and one boiler respectively. Each boiler is composed of 12 sections, each section comprising nine tubes in height, the tubes being 4in. in diameter and 16ft. long, expanded at the ends into staggered headers. The headers are provided with handholes placed opposite the end of each tube to permit cleaning and removal and renewal of a tube, the handholes being provided with caps fastened with bolt, clamp, and cap nut. The several sections are connected at each end to two steam and water drums 36in. in diameter and 24ft. 4in. long, and at one end with a mud-drum for collecting the deposit. The boilers are constructed for a daily working pressure of 200lb. per square inch. Each boiler is fitted with steam superheater. There is also a Green's economiser of 196 pipes in the main flue, fitted with

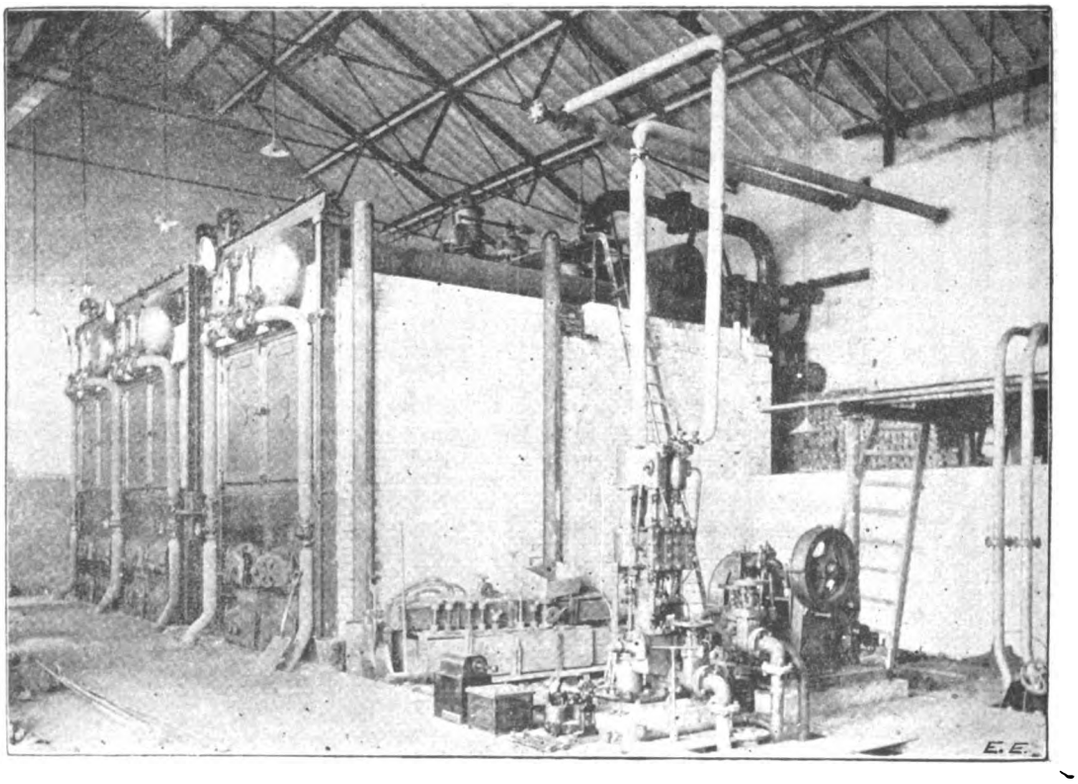

FIG. 4.—View of the Ilford Boiler-House.

with glazed bricks. The walls of the buildings are also of bricks, as is the chimney shaft, which is 185ft. high. The internal diameter of this shaft at the top is 8ft. Before leaving the buildings to pass on to the engineering plant, we must congratulate their designer on their businesslike appearance, and on the ample space which he has allowed in each department.

The boilers are of the Babcock-Wilcox type, three being at present installed, each with a heating surface of 2,197ft.

scrapers, etc. A gallery and ladder are fitted across the tops of the boilers for facilitating access to the fittings. Beyond the three boilers now fixed, which can be seen in Fig. 4, there is a space for one more boiler of the same size before coming to the feed pumps and gear connected therewith. There are two of these pumps, the first being of the compound duplex steam type. The other is of the treble barrel plunger type, 3½in. by 6in., driven by an electric motor made by J. H. Holmes and Co. Messrs.

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Babcock and Wilcox have also supplied and erected all the mild-steel steam-piping, fitted with wrought flanges, together with the necessary valves, which are so arranged that the breakdown of any portion of the steam-main will not interfere with the working of more than one engine or boiler at any time. The pipes are supported by hangers, and provision is made for expansion and contraction, the pipes being lagged with non-conducting composition. A steam-trap is also provided. The complete system of cast-

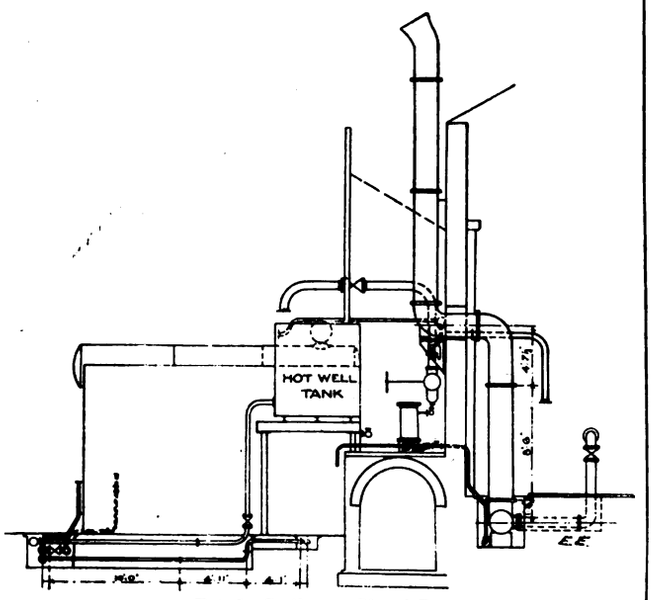

FIG. 5.—Section on Line A B.

iron exhaust pipes and valves fitted to each engine has also been erected by the firm, as well as the wrought-iron feed pipes, which are arranged in duplicate, so that either pump can feed into either main. In addition there is a separate injector to each boiler, arranged so that any injector can feed any boiler. A storage tank, capable of holding 2,000 gallons of water, erected on girders is provided in order that the water flows naturally to the pumps and injectors. A complete system of drain pipes has been erected. The general arrangements of these pipes are shown in Figs. 5, 6, and 7.

The generating plant in the engine-room consists of three engines at present, while a fourth engine is now on order and will soon be delivered. Each of these consists of a General Electric direct-current dynamo, coupled to an engine made by Willans and Robinson, of Rugby. The engines manufactured by this firm are so well known

they are designed to give 220 kw. without overheating. With ordinary conditions for lighting they run as shunt-wound dynamos, whereas when supplying the traction load they have a series coil assisting in the excitation, so that they are somewhat over-compounded. For instance, when working on the traction load, the voltage on open circuit would be 500 and at full load 550. Through the courtesy of Messrs. Willans and Robinson, we are able to reproduce in Figs. 11 and 12 the results obtained with the 200-kw. machines on trial. It will be seen that at 460 volts the steam required per kilowatt-hour was slightly below 34lb. The smaller set gave even better results, the consumption being as low as 32·39lb. per kilowatt-hour. These engines are at the present time working non-condensing, but if the supply of water from the artesian well now being sunk is found to be ample, it is likely that condensing gear will be added at an early date.

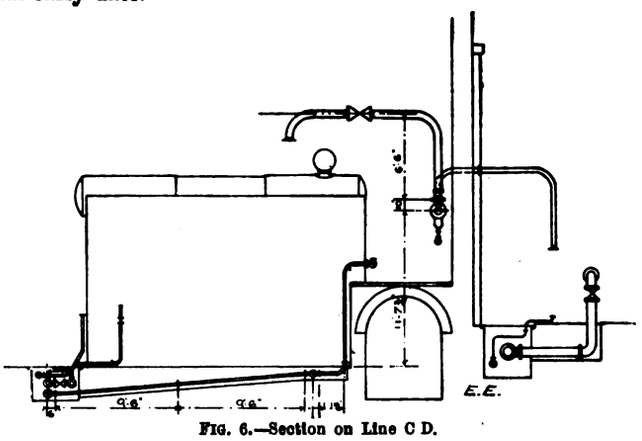

FIG. 6.—Section on Line C D.

Before proceeding to describe the switchboard, a few words as to the balancing boosting set may be of some interest. This consists of four independent dynamos coupled together with their axes in line. The two inner machines are balancers, and each armature has a capacity of 95 amperes, 220 to 250 volts. The two outer machines are boosters, and have each an output of 120 volts, 175 amperes. The combination runs at a speed of 850 revolutions per minute. The machines are of the firm's light four-pole type, and of their usual design, with circular pole-pieces and cast-steel magnet system. The windings are embedded in slots on the armature.

The main switchboard is arranged for three-wire lighting, and has been supplied and equipped by Messrs. Kelvin and James White, Limited, of Glasgow and London. The diagram of connection used on this board is shown in Fig. 13. The switchboard is mounted upon a platform near

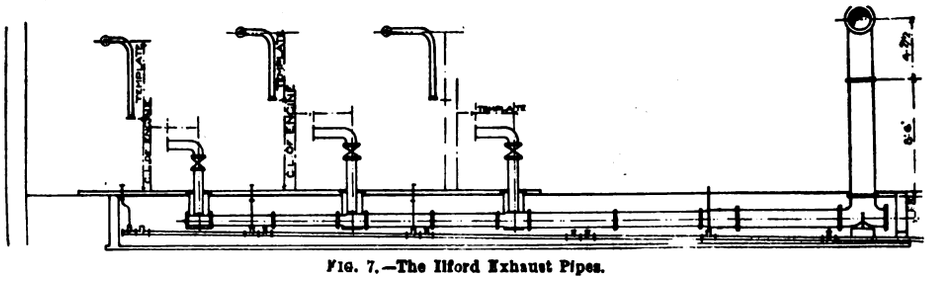

FIG. 7.—The Ilford Exhaust Pipes.

that no special description is required of the same. We give, however, in Figs. 8 and 9 a plan and elevation of one of the 200-kw. sets, of which two have now been provided. It will be seen from this drawing that two of the engines are of the three-crank type, and that there is provision on them so that the governors are able to alter the cut-off quickly in case the load is varied between wide limits in a short space of time, as is frequently the case in traction working. The smaller engine, which is seen to the left of the engine-room in the photograph from which Fig. 10 is prepared, is a 100-kw. These dynamos of the General Electric Company's make are practically similar to those supplied by the same firm for the Wigan electricity works, which were described by us in full in our issue of Feb. 1. While the normal output of the larger machines is of 200 kw.,

what will be the centre of the engine-room when the works are completed—*i.e.*, when the wall, which is shown in Fig. 2, is extended out to the line at which the flues curve out into the economisers. The switchboard (Fig. 14) consists of polished marble slabs mounted on a steel framework, with an ornamental metal top, having an electrically-driven clock of this firm's make fitted at the centre. The total length of the switchboard is 19ft. 6in., and it is divided into 10 separate panels. The four panels at the left contain all the instruments and switch gear for the negative side of the dynamos and feeders. The four panels at the right contain all the instruments and switch gear for the positive side of the dynamos and feeders, and the two panels at the centre contain all the instruments and switch gear for the batteries, boosters, balancers, and middle wire. The switchboard as at present

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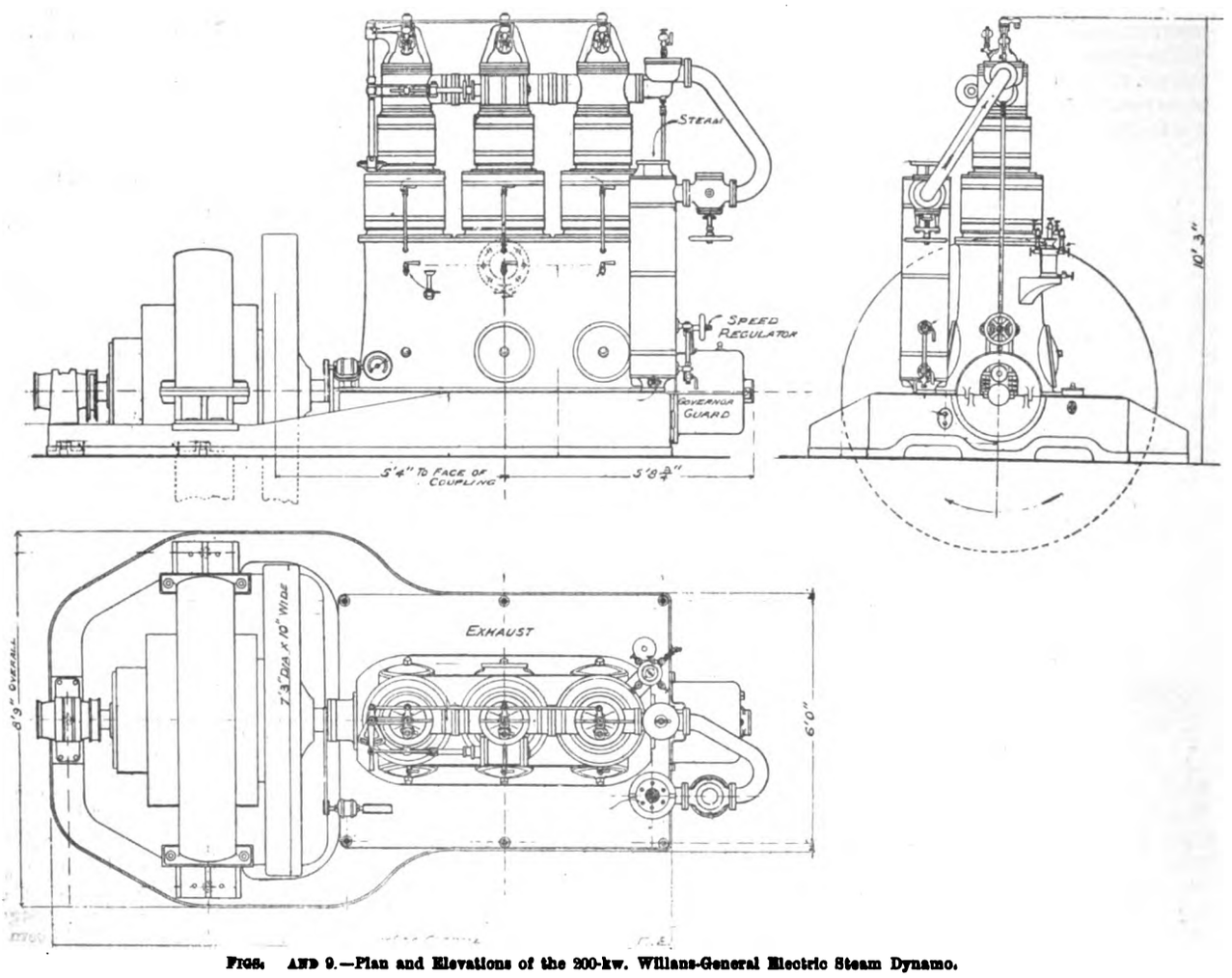
arranged is capable of dealing with three dynamos and 11 three-wire feeders, as well as two boosters, two balancers, two batteries, etc. Space, however, is provided by which instruments and switch gear for three other dynamos and one feeder can be added at a later date. All the instruments mounted on the board are of the Kelvin type, and include ampere gauges of the sector and edge-wise pattern, "S.R." (siphon recorder) voltmeters, recording voltmeters, and earth-current recording ammeter. The top panel on the positive and negative side contains all the switch gear and instruments for the feeders, as well as the plugging bars for the dynamos, boosters, and feeders. The two lower panels on the positive and negative side contain all the instruments and switch gear for the three dynamos,



FIGS. AND 9.—Plan and Elevations of the 200-kw. Willans-General Electric Steam Dynamo.

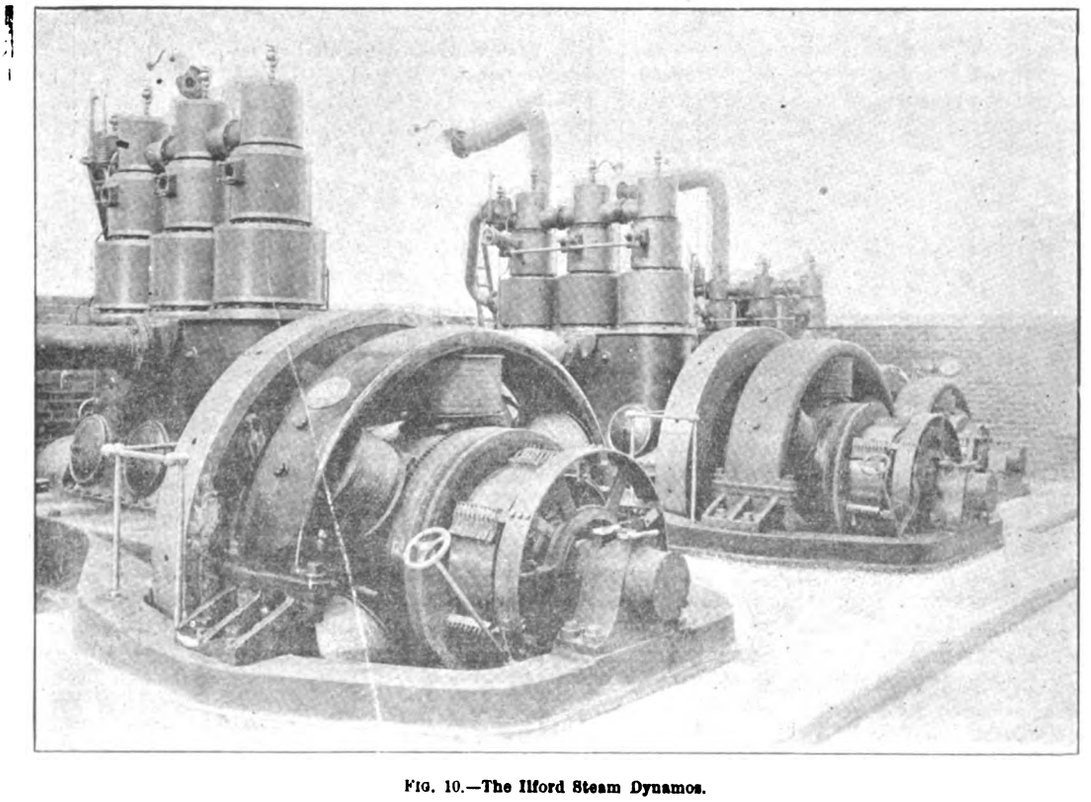


FIG. 10.—The Ilford Steam Dynamos.

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the two other panels at the bottom being left spare for the addition of switch gear and instruments necessary for three extra dynamos to be added at a later date. The two large dynamos are provided with double-pole throw-over switches

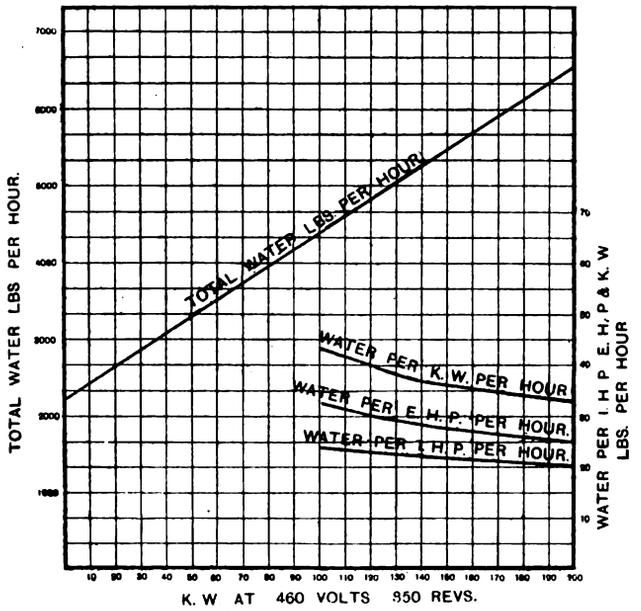
TOTAL WATER LBS PER HOUR.
WATER PER I.H.P. E.H.P. & K.W. LBS. PER HOUR
TOTAL WATER LBS. PER HOUR
WATER PER K.W. PER HOUR
WATER PER E.H.P. PER HOUR.
WATER PER I.H.P. PER HOUR.
K.W AT 460 VOLTS 950 REVS.

FIG. 11.—Non-Condensing Steam-Consumption Curves for the 200-kw. Steam Dynamo.

in order that they can be thrown over either to traction or lighting. These throw-over switches are neatly arranged with a catch, so that when the circuit is being broken from the one set of contacts the catch prevents an accidental throw-over into the lower set of traction contacts unless such a connection is required. The automatic cut-outs fitted in the dynamo and feeder circuits are of Ferguson and White's patent type, and are arranged to work either as a maximum-current cut-out or a reverse-current cut-out. During working it is set as the former, and when it is desired to shut down a machine it is changed to act as a minimum cut-out. This change is made simply by turning over a small key

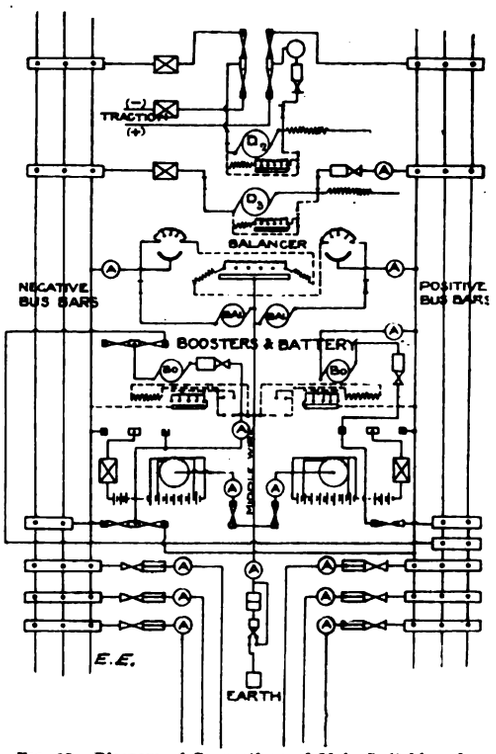

FIG. 13.—Diagram of Connections of Main Switchboard.

from the position marked "maximum" to that marked "minimum." By the adoption of this type of cut-out it is impossible to hold the switch closed should an excessive current be passing, and the same handle is arranged so that it can be used as an ordinary switch. Carbon breaks and asbestos screens are provided for taking and effectively wiping out any spark that may occur. The fuses on the dynamo and feeder circuits are of the plug type, and are thoroughly protected by means of porcelain covers. On the centre panel and at the top are mounted the ampere gauges for

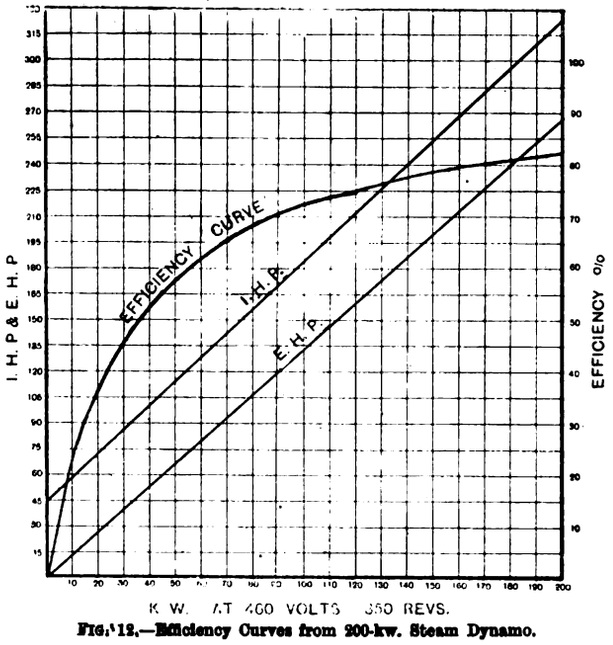

FIG. 12.—Efficiency Curves from 200-kw. Steam Dynamo.

the balancers, batteries, and middle wire, as well as the two recording voltmeters. Immediately below the ampere gauges are fitted the voltmeters for the batteries and bus

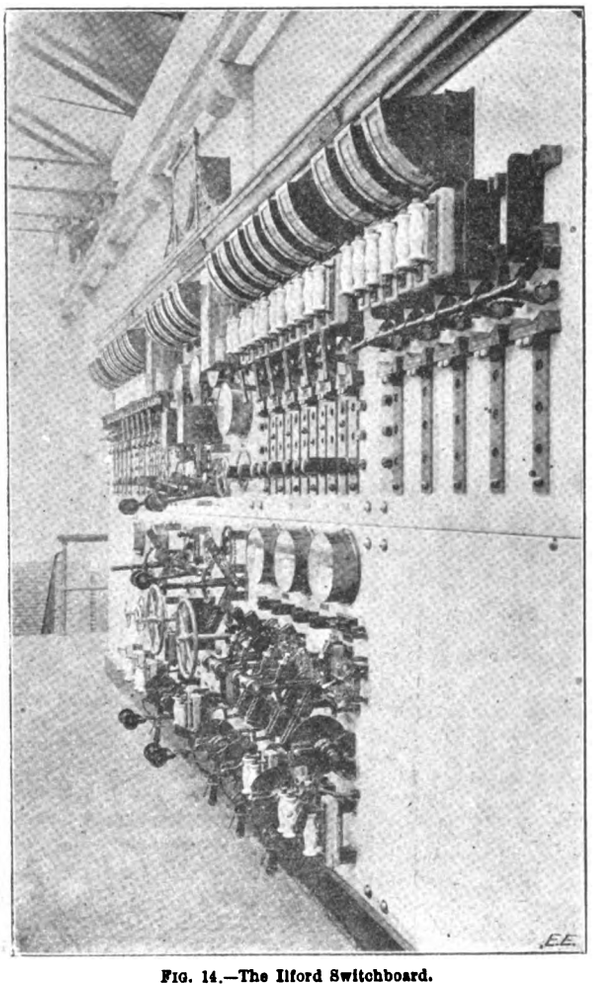

FIG. 14.—The Ilford Switchboard.

bars, as well as the two Kelvin electrostatic multicellular voltmeters for the feeders. On this panel also are mounted the booster ampere gauges, as well as the single-pole emergency switch for the batteries. On the lower centre panel is mounted the switch gear for the balancers and boosters, as well as the handwheels for the battery-regu-

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lating switches. The battery-regulating switches themselves, however, are mounted on a separate marble slab (Fig. 15) which is let into the battery-room wall, the connections to the cells being run directly from the back of this board. The switches themselves are actuated from the main board by means of shafting geared to the handwheels

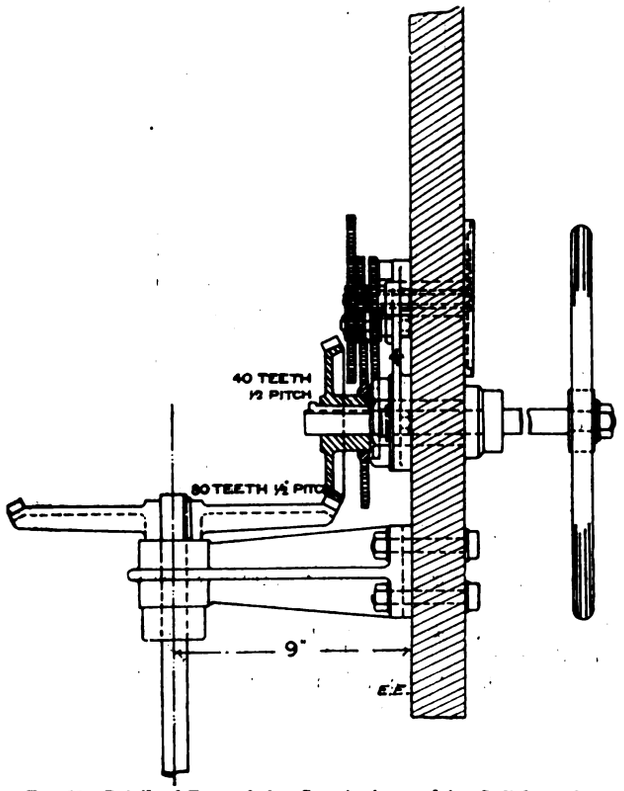

FIG. 15.—Details of Transmission Gear to Accumulator Switches. One revolution of the hand wheel shifts the contacts one cell.

(Fig. 15), and as arranged at this station has a very neat and compact appearance.

In order that the attendant working the switchboard may know when working these handwheels that he is not leaving the accumulator switch in the wrong position, a system of electric bells has been provided, which will ring when the switch is in an intermediate position between the two contacts. Another interesting feature is the use of arrows on the handwheel in order to indicate approximately the right position in which the wheel should be left. The space between the two points of these arrows is practically equal to the distance through which the wheel has to be used to overcome back-lash when reversing the direction of the rotation. Arrangements are also provided on the lower centre panel by which the boosters, ordinarily used for charging the batteries, can be connected to vertical bars on the positive and negative side and can thus be used to raise the voltage of any set of feeders. The Kelvin earth-current recorder and short-circuiting switch, for use with the earth circuit, are also mounted on the centre panel. On the wall below the platform are fitted the two Aron battery meters, as well as the three Thomson dynamo watt-hour

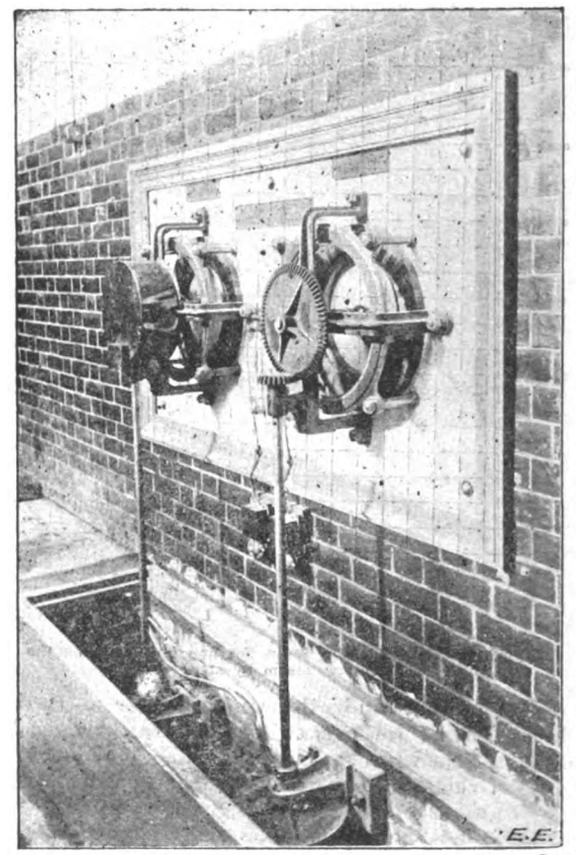

FIG. 16.—View of the Accumulator Regulators and Transmission Gear for working the same from the Switchboard.

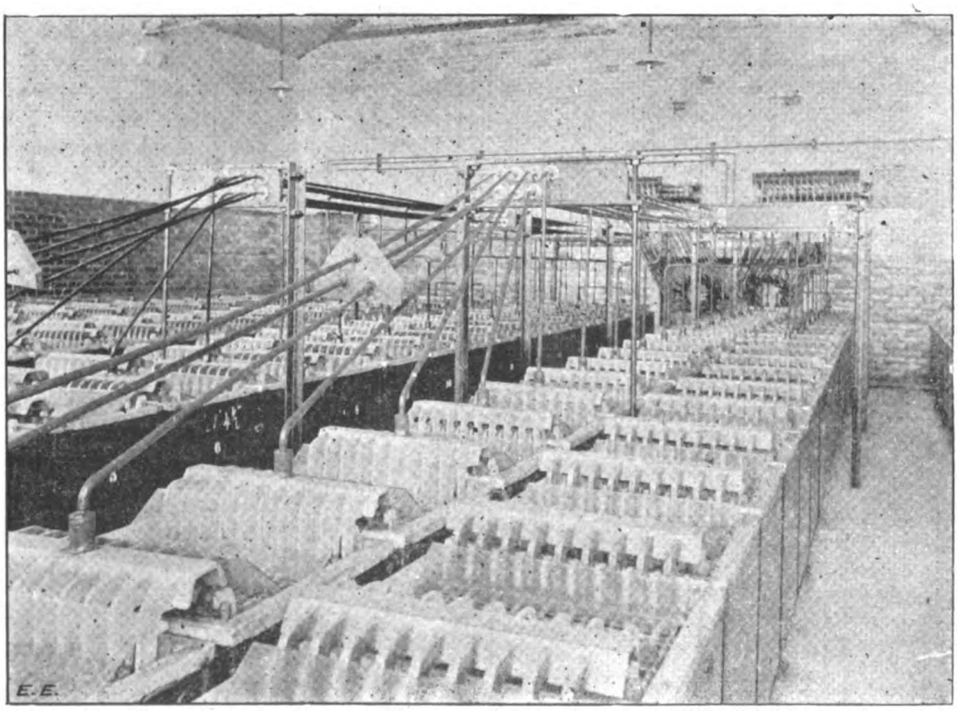

FIG. 17.—View of the Accumulator Connections.

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meters. The whole of the work on this switchboard has been carried out by Messrs. Kelvin and James White, Limited, and the same firm have also been responsible for the connecting up of the machines and accumulators

amperes for three hours, at 460 volts. The containing boxes are of wood, lead lined, each cell consisting of 19 plates supported on glass slabs and separated by glass tubes. The cells are erected on single-tier stands,

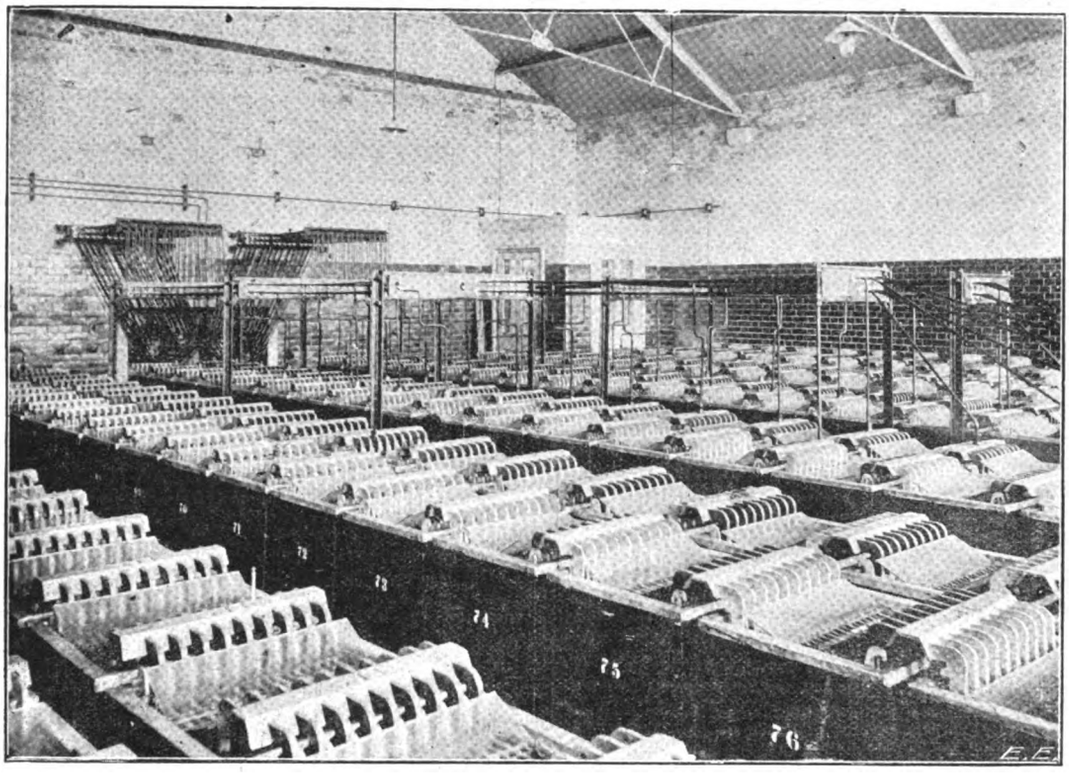

FIG. 18.—General View of the Ilford Accumulator-Room, with E.P.S. Accumulators.

to their respective switches. The connections in the accumulator-room are carried out by means of copper rods, which are painted to protect them from acid fumes. In Fig. 17 we give a view of these connections, which have been equipped in a most workmanlike way.

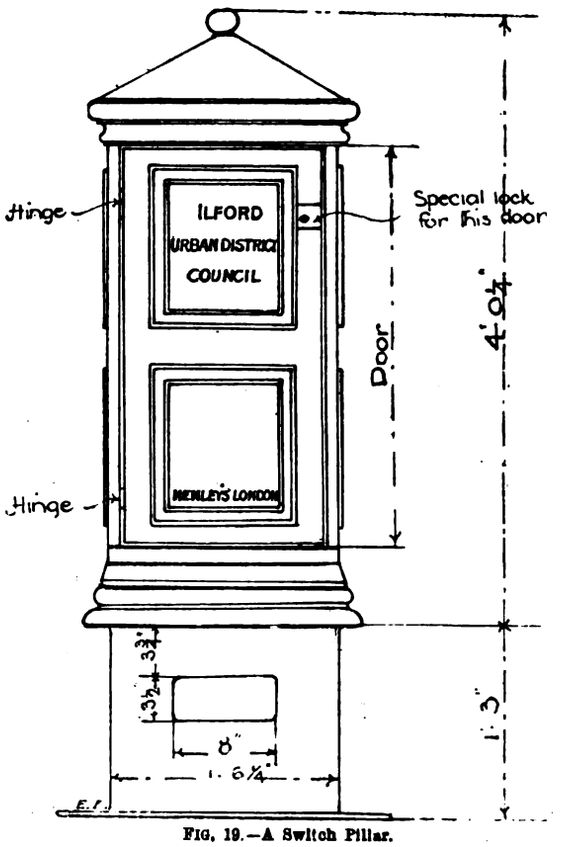

FIG. 19.—A Switch Pillar.

The accumulators (Fig. 18) were supplied by the Electrical Power Storage Company, and are of the K.L.P. type. There are 270 of these cells provided, each of which is capable of discharging at 400 amperes for one hour, or 200

and the weight of each cell complete with acid is approximately 170lb. As will be gathered from the illustration (Fig. 18), the accumulator-room is a spacious one; in fact, we know of no accumulator-room in the kingdom the arrangement of which we prefer to those we have seen at Ilford. The only objection in the same is that the regulating cells are not connected on the earth side of the batteries, so that there is practically 500 volts between the cells on the opposite sides of the centre of the alley.

The supply of electricity throughout Ilford has to be given over an area approximately three miles long and two miles broad. This is done on the low-tension three-wire system at 460 volts between the outers. Nine feeders in all are included in the first scheme, and these consist of either triple-concentric or concentric mains, which are armoured and laid direct in the ground. The three-core pilot cables laid to the end of each feeder are also armoured. The distributing mains, on the other hand, consist of three single cables, which are only lead-covered, and are laid in wooden troughs on the solid filling-in system. The sections of these are respectively ·12, ·06, and ·12 square inch. In the usual way this distributing system would be connected throughout, but disconnecting boxes are placed at the end of each street, by means of which the mains can be divided up when required. Instead of using street feeder boxes, the whole of the feeders are led to feeder pillars, which are much more accessible than street boxes. One of these feeder pillars is shown in Fig. 19, while Figs. 20 and 21 show the apparatus contained in this pillar. The street-lighting—of which a large amount is being done, there being at the present time 306 incandescent lamps and 33 arc lamps in use—is all carried out by means of independent cables from the feeder pillars. The arc lamps are run five in series off one side of the three-wire system. The whole of the cables, amounting to more than 60 miles in length, were manufactured and laid by the W. T. Henley's Telegraph Works Company, Limited. The same firm have also laid about seven miles of stoneware ducts and drawing-in boxes, which are to be used for extensions and for the tramway feeders.

The street-lighting has been let in two contracts. The first of these was for the arc lighting in the main road, and was awarded to Messrs. Verity's, Limited. This firm have

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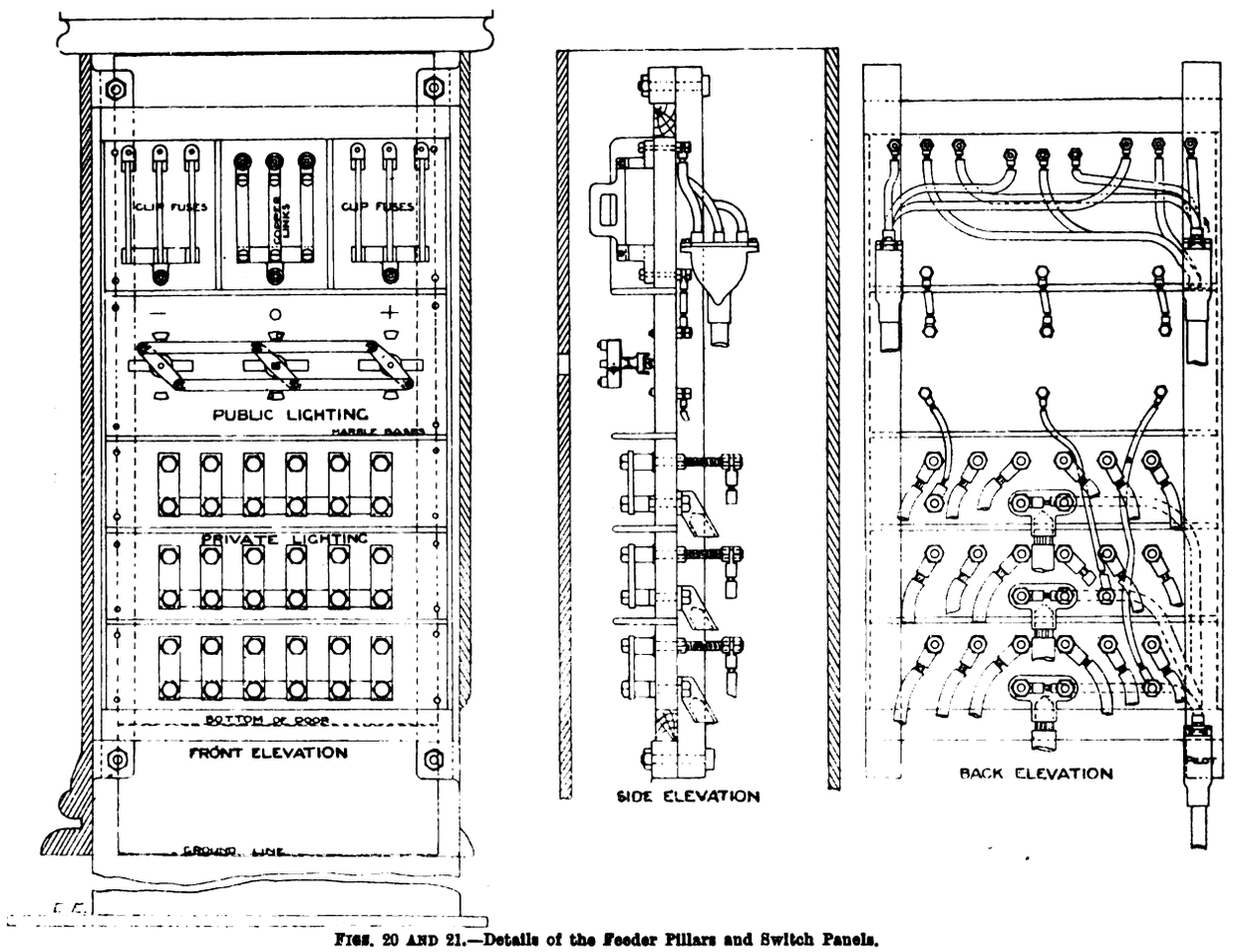
supplied the 33 double-carbon arc lamps of 10-ampere capacity, referred to above. Each lamp is adjusted to burn in series with four others across the 230-volt mains, and is under a guarantee to keep within 3 per cent. of 45 volts at its terminals. They are erected under a specially-designed hood and carrier on the tops of the traction poles (Fig. 22), each of which is also provided with two ornamental bracket-arms carrying incandescent lamps. The poles themselves are of steel, the bases being of massive design in cast iron. The switch gear, automatic cut-out, resistances, etc. (Figs. 23 and 24), are all carried in the bases of the poles, and are of a specially compact and suitable design. In addition to the above arc lamps and posts, there are a further 40 traction pillars only already erected and used to carry incandescent lamps. Provision is made on these for the addition of arc lamps themselves, with heads corresponding to the others when required. The whole of this contract was placed with Verity's, Limited, the carrying out of which has been supervised by Mr. C. S. Northcote, M.I.E.E., their newly-appointed manager.



FIGS. 20 AND 21.—Details of the Feeder Pillars and Switch Panels.

The incandescent street-lighting has been done by the Improved Electric Glow Lamp Company, who have supplied the new posts required to support the lamps. This was necessitated because the gas company refused to sell the gaslight standards. In certain of the newer districts, however, these standards are already the property of the Council, so that only new lanterns will be required. In fact, the opposition of the gas company has gone so far that they not only refuse to sell or to remove their lamp-posts, but have also continued to light the same free of cost. In certain instances they have even gone so far as to instal two of the latest type of incandescent gas burners in order to show what they can do in the matter of street-lighting. In view of the fact that there is often barely more than a foot between the two lanterns, the absurdity of the present condition of street-lighting in Ilford will be appreciated. To revert to the electric lamp-pillars supplied by the Improved Glow Lamp Company, they are fitted with copper lanterns glazed on four sides, each fitted with two, three, or four-light fittings and improved reflector incandescent lamps. These lamps consume 60 watts per lamp, and are stated by the company to give 80 c.p. per lamp in the desired direction. The fittings consist of a special compact double, triple, or quadruple lampholder, in which the lamps are placed at an angle of 20deg from the horizontal, double lampholders being fitted in lanterns placed on either side of the street the same distance apart as the old gas lanterns, triple lampholders (two lamps in line and one at right angles) at the corners of branch streets, and quadruple lampholders at cross streets. The light given out by the filaments of each lamp is collected by the silvered top surface of these now well-known lamps and distributed over a given area below the horizontal in such a manner that the light from each individual lamp crosses that from the next in line with it about 8ft. above the ground, thus producing an even lighting area of high candle-power, covering the whole of the space, road, and pavement between neighbouring lamp-posts. From recent tests the company claim that two 60-watt Improved Electric Glow lamps placed 100ft. apart will illuminate an area of 1,000 square feet with a mean candle-power of 60. Each lamp-post is provided with a D.P. damper pattern cut-out specially mounted and covered in, and fixed in the base of the post. All the posts are wired in groups and controlled from section pillars in the usual manner, alternate lamps being on different circuits.

The scale of charges for private lighting at Ilford can, at the option of the consumers, be either a flat rate of 5d. per unit or a sliding scale rate on the Wright maximum-demand system. If this latter scale is selected, the consumer will pay 8d. per unit for the first hour's average consumption per day of his maximum demand, and 2d. for all above this. In order to encourage the supply of electricity to consumers, the Ilford Urban District Council have arranged to wire consumers' houses on the deferred payment system The one advantage of this which it appears to us is likely to be most appreciated in Ilford is that any consumer can get his house wired by the contractor who has all the free wiring work to do, and can then pay cash down for the same. Such a large number of the inhabitants own their own houses that they are quite prepared to expend the necessary money in the first instance, but they will gain a great advantage from the low rate at which the Council

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will do the work, and from the fact that the same is done under the supervision of the Council's engineers. The station has been giving a supply for certain hours in the day for some weeks, but the formal opening of the station is to take place on Saturday next. The Council then propose to throw the station open for the ratepayers to inspect. There is also under consideration a proposal that the station shall be open for an hour on a certain day of each week, in order that the inhabitants of Ilford may go

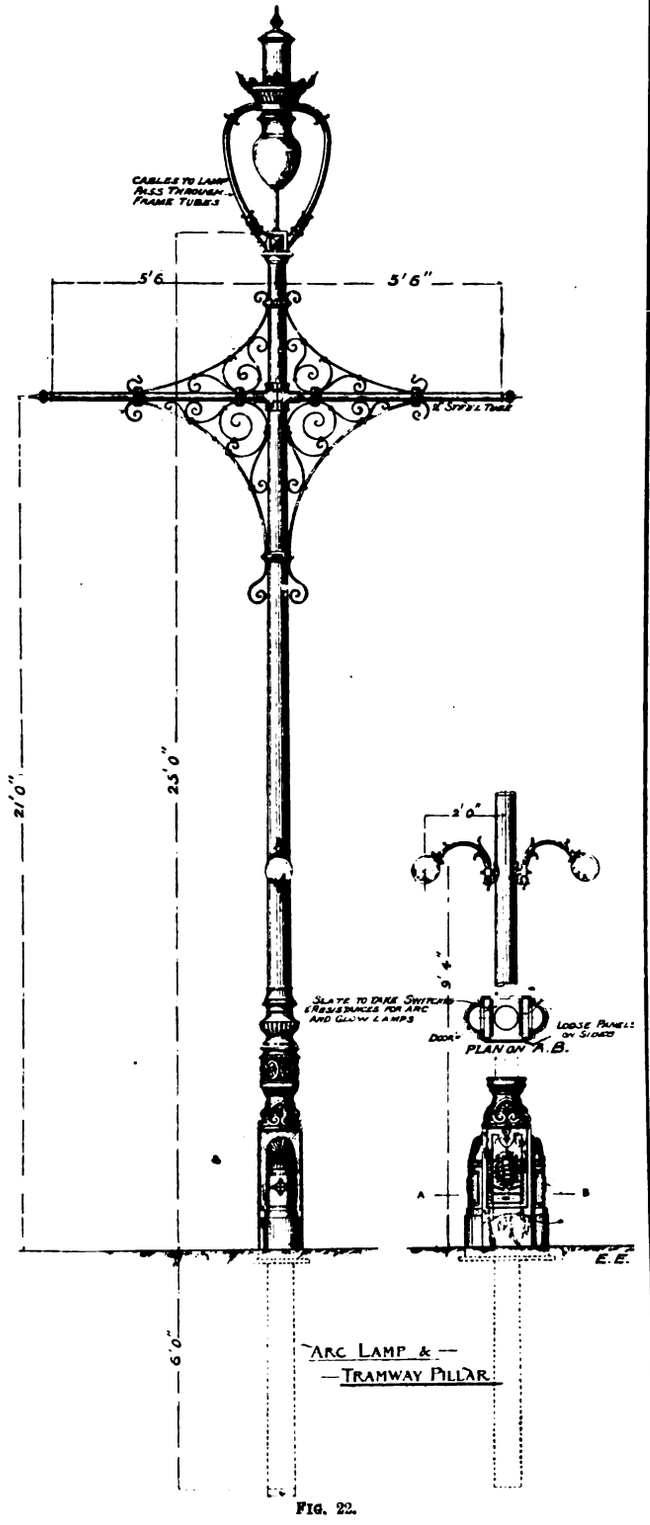
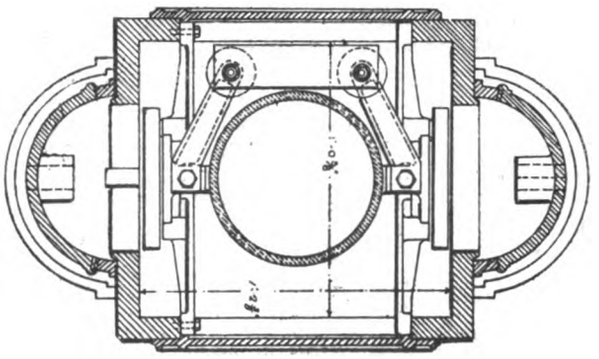
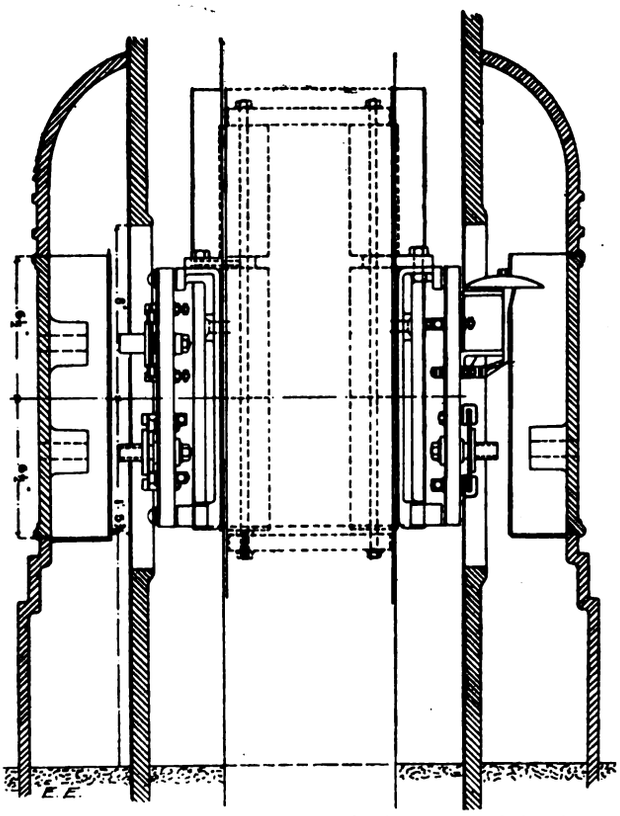


FIG. 22.

and admire the good works which they have secured under the able advice of Mr. W. C. C. Hawtayne and their surveyor, Mr. H. Shaw. Mr. A. Shaw, the borough electrical engineer, has been responsible for the carrying out of the work, and is to be congratulated on the prompt way in which he is having the various plant completely equipped for work.

Mr. Hawtayne is now urging forward the electric tramway work, and several of the specifications are ready for issue. These electric tramways when completed will form a through connection to Barking, and thence to West Ham, also through Ilford to East Ham and to Barkingside, and in the East along the High-road to Romford-road to





FIGS. 23 AND 24.—Base of Traction Pole, showing Arc Lamp Switch Gear.

Chadwell Heath. The track along the Romford-road and the High-street will be double throughout, with trolley wires supported from centre poles. In the other streets

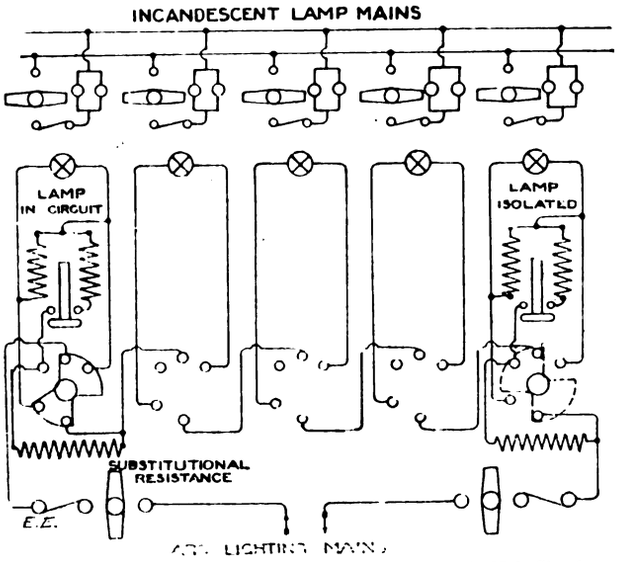


FIG 25.—Connections to Arc and Incandescent Lamps in Main Streets.

the line will chiefly be single track with side-pole supports, with turnouts or short lengths of double track as indicated above. The tramway leading to Barkingside passes along

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Ley-street, past the generating station. Two overhead trolley wires will be provided throughout to do away with the necessity of employing frogs for turnouts, and the line will be constructed in sections not exceeding ½ mile in length. Guard wires and all usual accessories will be provided. The rails will be of the girder pattern, 100lb. in weight, electrically bonded and supported on 6in. of concrete, with stone setts between rails and tracks and 18in. outside of tracks. The overhead trolley wires will be supplied at 500 volts from the generating station through feeders laid partly solid and partly drawn into conduits. The usual feeder pillars will be provided, together with telephone equipments and switching gear for isolating the half-mile sections. There will be 12 double-deck motorcars, to seat about 43 passengers, each provided with two 25-h.p. motors, and all usual controlling gear, emergency switches, etc. The cars will be lighted electrically. The car-sheds will be erected on land adjoining the power station and additional generating plant will be provided at the works, also designed, as is the present plant, to be suitable for either traction or lighting purposes as required. A number of steel poles along the High-street and Romford-road have already been erected, and these poles will serve both the purpose for supporting the trolley wires and for public street-lighting by means of arc and incandescent lamps. Intermediate poles will very shortly be erected when the permanent way is started. The total length of the tramway route now being equipped is 6m. 3f. 3·25ch., made up of 2m. 3f. 6·8ch. of single track and 3m. 7f. 6·45ch. of double track.

OBITUARY.

Sir Courtenay Boyle.

The sudden death of Sir Courtenay Boyle, permanent secretary to the Board of Trade, through heart failure, will be sincerely regretted by electricians who recognise his remarkable ability for the position he so ably filled. Born in Jamaica in 1845, the eldest son of Cavendish Spencer Boyle, grandson of the seventh Earl of Cork, Sir Courtenay Boyle was educated at Charterhouse, and subsequently at Christ Church, Oxford. From 1868-73 he was private secretary to the Viceroy of Ireland, and again from 1882 85; from 1873-85 he also occupied the position of Local Government Board inspector; from 1886-93, assistant secretary to the Board of Trade; and in 1893 he attained the office of permanent secretary to the Board of Trade. Created a C.B. in 1885, he was made Knight Commander of the Bath in 1892. On railway matters he was, of course, a recognised authority, while one of his favourite themes on which he was never weary of dilating was the need of better commercial training for the youth of England if the nation was to keep its place in the struggle for existence. Sir Courtenay, in his position as permanent secretary to the Board of Trade, has been identified and chiefly responsible for much of the important work which has been accomplished by the department in recent times. Probably his greatest and most arduous task was that which he performed as joint commissioner with Lord Balfour in revising the rates, tolls, and charges of the railway companies in the United Kingdom. A mere recapitulation of the Acts the adoption of which Sir Courtenay Boyle recommended to Parliament would occupy more space than we have at our disposal. We may mention, however, that in 1888 he had much to do with the Railway and Canal Traffic Act, and a year later with the Regulation of the Traffic Act. The latter was a very important statute, empowering the Board of Trade to call upon railway companies to fit their passenger trains with continuous brakes, as well as to interlock their points and signals. The year 1894 witnessed the passing of another Railway and Canal Act, designed to check the raising of the rates which Lord Balfour and Sir Courtenay Boyle had previously fixed. About this period, too, the latter turned his attention to the consolidation of the statutes relating to merchant shipping. In 1890-1 Sir Courtenay served with Lord Rayleigh and Lord Kelvin on the Electrical Standards Committee, and in July, 1898, he was an active member of the committee which, under the chairmanship of Lord Rayleigh, considered the desirability of forming a national physical laboratory. Eighteen months ago Sir Courtenay was called upon to preside over the inter-departmental committee on the expediency of establishing electrical communications between light-houses and the shore, and this committee has not yet finished its labours. One of his last public acts in London was to give evidence before the Parliamentary Committee on Metropolitan Underground Railways. From the inception of the new National Physical Laboratory the late secretary to the Board of Trade took the greatest interest in the progress of the institution, and entertained high hopes of the position it was destined to occupy in English science. In the vexed question of a suitable site for the laboratory he acted with much tact and discernment, and took a prominent part in the long and delicate negotiations with the tramway companies and the Kew and Royal Society authorities, which finally led to the adoption of Bushey House, Hampton Court, as a site, and the settlement of the terms of compensation for the removal of the magnetic apparatus from the Old Deer Park institution, under Dr. Chree. As far, however, as electrical engineers are concerned, Sir Courtenay Boyle will be remembered more for the good work which he done in connection with electric lighting and electric traction regulations. Whenever the industry had so advanced as to require new regulations or the abolition of old ones, the late Permanent Secretary made a practice of holding a conference with electrical engineers representing various interests, and at these conferences the whole matter of the proposed change was thrashed out. Sir Courtenay Boyle's tact in presiding over these conferences was evidenced by the fact that they were always conducted in a businesslike way, all sides having a hearing, and we do not remember any case in which his decision was afterwards cavilled at by any of the parties represented. His last work in this direction was the amendment of the rule which originally gave the consumer power to prevent a complete change over to the higher voltage of an electric lighting undertaking. The decision in this instance was only given a week or two ago. Notwithstanding the great amount of work associated with the post of permanent secretary to the Board of Trade, Sir Courtenay Boyle maintained his general love of sport throughout. In his young days Sir Courtenay made a name for himself both at Charterhouse and Oxford as an excellent cricketer.

Mr. E. W. Parsone.

We regret to record the death, in his fifty-third year, of Mr. E. W. Parsoné, who for the last 30 years has been intimately connected with the submarine telegraph industry. Mr. Parsoné, on leaving the University College School, entered the service of the Great Western Railway Company, and in 1870 joined the staff of the late Sir Charles Bright, and was employed in the laying of the cables of the West India and Panama Telegraph Company. He eventually was engaged on the staff of the India Rubber, Gutta Percha, and Telegraph Works Company, and after being employed in the laying of cables along the French coast and between Marseilles and Algeria, and between Marseilles and Barcelona, he proceeded to the West Coast of South America, and became manager of the first series of submarine cables laid in these waters between Callao, in Peru, and Valparaiso, in Chili. He served with conspicuous ability in this post during the trying times of the war between these two countries, and made many friends among the native and foreign merchants, which friendships have endured until death has carried him away. In the cable steamer "Retriever," Mr. Parsoné surveyed the route for the laying of the cables which connect Salina Cruz in Mexico with Callao in Peru, and are the property of the Central and South American Telegraph Company. Returning to England in 1884, Mr. Parsoné was appointed manager of the West African Telegraph Company, and organised the service on the string of cables connecting the Cape de Verd Islands and the principal settlements on the West Coast of Africa. While on the

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Congo River he visited Shark Point, and reported to the Royal Geographical Society the locality of one of Diego Cam's beacons, the existence of which was suspected but was unknown to modern geographers. After remaining a few years on the West Coast of Africa, Mr. Parsoné came home and shortly afterwards proceeded to Brazil in connection with the South American Cable Company, of which he was manager and secretary at his death. The deceased had qualifications in connection with submarine telegraphs which are rare among the younger men now that the growth of this great necessity to modern life has called for subdivision of work and specialisation. He knew the business in its electrical, mechanical, and commercial bearings, and was consequently never at a loss in whatever circumstances he found himself. From the personal point of view, his friends have lost a cheery companion full of humour and of goodwill towards his fellow-man. The French Government had conferred on him the decoration of Officier de l'Instruction Publique, and the Government of Portugal had granted a Knight Commandership of the Order of Christ. Mr. Parsoné joined the Institution of Electrical Engineers in 1874, and for the last 20 years has been a full member. He was also a Fellow of the Royal Geographical Societies of London and Lisbon.

Mr. A. H. Roe.

We much regret to have to announce the death of Mr. A. H. Roe, whose appointment as borough electrical engineer of Bury St. Edmunds was chronicled at the beginning of last year. The son of the late Mr. G. Roe, of Bournemouth, the deceased engineer served his apprenticeship in works at Acton. He then entered the service of the P. and O. Steam Navigation Company as a sea-going electrical engineer, and in this way made several voyages to India, China, and Japan. Mr. Roe had completed the electrical equipment of the hospital ship "Coromandel," the vessel which took out Prince Henry of Battenberg on his ill-fated expedition to Ashanti, when he obtained the post of assistant engineer to the Bradford Corporation. He remained there some three years, during which time the electric lighting undertaking made great headway, the system of supply being changed over to the three-wire, a new generating station erected and equipped, electric traction introduced, and many other improvements effected. Mr. Roe may, therefore, be said to have carried exceptional experience with him to Bury St. Edmunds, where, as borough electrical engineer during the past 17 months, he supervised the erection of electrical plant, and most successfully inaugurated the lighting of part of the town by electricity in spite of his failing health. While obtaining a good number of electric light consumers, by his excellent organisation the cost of running the station was kept at a low figure. When the late engineer was appointed there was a very strong opposition to electricity in the town, but, in the words of one of the Gas Committee, Mr. Roe proved so tactful and courteous that since then there has been no opposition to speak of. In evidence of this, we may state that the Corporation have recently applied for a loan of £1,200 for extensions. His early demise at the age of 29 years will be deeply regretted by all those who ever came in contact with him, and is a distinct loss to the profession in which he so ably worked.

FORTHCOMING EVENTS.

FRIDAY, MAY 24.

Royal Institution.—At 9 p.m., Dr. R. T. Glazebrook on "The Aims of the National Physical Laboratory."

TUESDAY, MAY 28.

National Electrical Contractors' Association.—At 2 p.m., meeting at 46, Queen Victoria-street, E.C., for the purpose of forming the above association.

Electro-Harmonic Society.—At 4.30 p.m., annual general meeting at the Institution of Electrical Engineers, 28, Victoria-street, S.W.

THURSDAY, MAY 30.

Institution of Electrical Engineers.—At 8 p.m., annual general meeting at the Society of Arts, John-street, Adelphi, W.C.

Royal Institution.—At 3 p.m., Prof. Dewar on "The Chemistry of Carbons" (Lecture II.)

FRIDAY, MAY 31.

Physical Society. — At 5 p.m., ordinary meeting. Papers: "On a Model which imitates the Behaviour of Dielectrics," by Prof. Fleming, F.R.S., and Mr. A. W. Ashton, B.Sc.; "On the Resistance of Dielectrics and the Effect of an Alternating E.M.F. on the Insulating Properties of Indiarubber," by Mr. Ashton; and "Note on the Electrification of Dielectrics by Mechanical Means," by Mr. Ashton.

The annual dinner of King's College, London, will be held at the Trocadero Restaurant on Monday, June 24, Mr. Justice Byrne in the chair.

ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

Regimental Orders.

1. **Non-Commissioned Officers' Instruction.** — Wednesdays, 6.30 p.m.

2. **Recruit Drills.**—Tuesdays and Thursdays, 6.30 and 7.30 p.m.

3. **Oil-Engine Instruction.**—July 4 to 13 and July 11 to 20 camps, Monday, 6.30 p.m.; June 6 to 15 and June 13 to 22, Tuesdays and Thursdays, 6.30 p.m.; July 18 to 27 and Aug. 8 to 17, Wednesday, 6 30 p.m.; Aug. 15 to 24, Fridays, 6.30 p.m.; Royal College of Science and School of Mines party on Tuesday, 4.30 p.m.; Central Technical College party on Tuesday, 5.30 p.m.

4. **Uniforms.**—Issued on Tuesday and Thursday, at 7.30 p.m.

5. **Equipment.**—Issued on Tuesday and Thursday, at 6.30 p.m.

6. **Training, 1901.**—It is requested that all non-commissioned officers and men who can change the date of their training to the weeks commencing July 13 to 20, or July 20 to 27, or who can stay both weeks, should notify the Acting Sergt.-Major at once.

7. **Formal Opening of Headquarters.**—Saturday, June 1, 4 p.m. Tickets of admission, including tea, members of corps, 1s. There are a limited number for friends at 5s. each. Application to be made to the Acting Sergt.-Major.

8. **Cycling Club.**—General meeting at headquarters on Tuesday, May 28, 8.30 p.m.

9. **Woolwich Detachment.**—Drills, recruit and company, every Friday, 8 p.m.

(Signed) R. S. ERSKINE, Major, O.C.E.E. (R.E.) Vols.
C. T. RUSE, Acting Sergt.-Major.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Electrical Productions, Limited.—Capital, £3,000. Object: to carry on the business of manufacturers of and dealers in wires, cables and lines of all kinds, electricians, mechanical, gas, and general engineers, etc.

Desolle Electroplating Company, Limited.—Capital. £70,000. Object: to acquire certain patents of M. E. L. Desolle, of Fontenay Bois, France, chemical engineer, relating to electroplating, and to carry on the businesses of mechanical, electrical, sanitary, and general engineers, etc.

Chadwick, Son, and Clarke, Limited. — Capital, £3,000. Object: to acquire the business carried on at the Princes Bridge Ironworks, Salford, Lancashire, as John Chadwick, Son, and Clarke, to adopt an agreement with James A. T. Clarke, and to carry on the business of engineers, electricians, providers of electric light and power, etc.

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SCRAP.

A nice short word of five letters, conveying a suggestion that may be beneficial or result in the loss—to someone else, of course—to the extent of thousands of pounds. The little investigation that we have been able to make into the habits and idiosyncrasies of those who call, not "Wolf, wolf," but "Scrap, scrap," tends to make us believe they are about the last people in the world to follow their own advice. The wholesale suggestion to scrap comes from sellers, who naturally do not care a fig for the financial position of the buyers provided they get the money due for sales. Then when advice is not thought to be weighty enough, it is interlarded with tales of what the Americans do. It is always America! There, we are informed, the financial princes and parvenues alike scrap directly someone puts something better on the market. They are a happy-go-lucky race, according to the views of the wiseacres, and money is no object. Neither is it with certain ladies who buy dresses and forget to pay for them. But, joking aside, is there not a time to scrap, and a time not to scrap? Some of us may recollect the introduction of three-cylinder locomotives. According to those who favoured this type, they were far and away better than what had gone before, and if the favourers of indiscriminate scrapping are to be believed, all the old engines ought straightway to have gone to the scrap heap. Yet Mr. Webb, the able locomotive engineer to the London and North-Western Railway, did not scrap his other engines, nor did any other locomotive engineer do so. Perhaps it will now be urged that time has proved the three-cylinder not to be so immeasurably superior to its predecessor as its early advocates supposed it to be. Time may say the same with regard to some of the electrical apparatus which it is said ought to replace that consigned to the scrap heap. Sellers have to sell, and their words are not always words of wisdom, but rather of the character of pushing advertisements. Their blandishments are calculated to catch the unwary, and success means profit. Is it possible to say when it pays to scrap and when it pays to retain apparatus? We imagine the whole problem is one of simple arithmetic. Assume that a purchaser buys the best piece of apparatus known at the time of purchase. Assume, also, that he is a business man, and calculates that his profit by the use of this particular piece of apparatus will be sufficient to enable him to live in competition with his neighbours. Of course, he allows each year enough for depreciation, so that when the apparatus in the ordinary course of nature ceases to exist, its capital charge in the books also ceases to exist. Say depreciation is 10 per cent., giving the apparatus a ten years' life. One thing we should like to mention as an aside. It is that a business man cannot always depreciate up to the standard prescribed by "abstract" argument. There is never an absolute certainty of making a profit sufficient to do all that the abstract argument says ought to be done. If the profit is insufficient, what then? Two courses are open: one is to worry along over a longer life, the other is to

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make a dead loss. Either way is bad. In the former case possibly the old apparatus has to compete against newer development; in the latter case another business man, firm, or company goes to Carey-street. Just as there are two courses open in the case assumed, so there are two conditions to be considered when the question of scrapping arises. First, has the man, firm, or company, the capital at call to replace the scrap? If the capital is not there, scrapping is impossible. Secondly, will the new apparatus enable the user to obtain the extra profit required by the extra capital expended; for the new machinery stands capitalised in the books, not at the amount of its cost, but at that amount plus the capital at which the machinery scrapped stood in the books. It is very easy to say "scrap," but sovereigns do not grow like mushrooms, and scrapping costs money. No doubt it is hard for a man to invest his whole capital in a business only to find the tools and machinery installed getting obsolete before they have earned enough to enable him to replace them. There is, of course, another way of looking at this thing. There always is; and no doubt some people will argue that when scrapping is necessary capital should be forthcoming. This would mean a reserve of capital, which is not economic so far as a business man is concerned; hence we conclude that indiscriminate scrapping is neither possible nor economical.

REVIEWS.

Conduit Wiring and Erection. By L. M. WATERHOUSE. S. Rentell and Co., Limited, 2, Exeter-street. Price 2s.

The two great faults we have to find with this book are, first of all, the incompleteness of its title and, next, its price. It should be called the "Simplex System of Conduit Wiring," and it should be given away free by the makers of these conduits. In the first page of the book the author adds after the title, "Conduit Wiring and Erection," the following words: "With special reference to the Simplex system of steel conduits." We have looked through the 80 odd pages of this book in a casual way without seeing any reference whatever to any other kind of conduits. The illustrations also, when not actually taken from the catalogue of the company supplying these conduits, are made from photographs of installations carried out on the Simplex system. Again, excepting on those pages which deal with the gauges and capacities of copper conductors, we do not think there is a single page in which the Simplex system of conduits is not either directly mentioned or referred to. While we agree that the author has given a limited amount of independent advice as to the running of conduits for electric light wires, we do not think there is any excuse for asking an electrical engineer to pay 2s. for a book which is really an advertisement of one class of conduit only. We do not mean by this that the Simplex conduit system is not a valuable one to electrical contractors, but rather that any praise bestowed on it by Mr. L. M. Waterhouse would be much more valuable if at the same time he placed before his readers the advantages and disadvantages of the rival systems of conduits which are in the market.

POWER BILLS.

The Shannon Water and Electric Power Bill.

This Bill has passed the Select Committee of the House of Commons presided over by Mr. Arthur Elliott with but slight opposition. In the West of Ireland there is no coal supply, and the proposition under this Bill is to utilise the waters of the River Shannon to generate the electrical energy. For this purpose the promoters intend to construct a canal, with an intake from the Shannon at a point a few miles from Limerick, 2½ miles in length, to Cloonlara, where the power-house will be situate, the fall at this point being 40ft. At first it is proposed to equip this station to produce 5,000 h.p., which eventually could be extended to 8,000 h.p. After passing the power-house, the water, according to the present proposals, will be reconveyed to the Shannon by means a tail-race two miles in length. Under this scheme only four miles of the river will be interfered with, and on such occasions as it will be found impossible to take water from the river, an auxiliary steam apparatus, which it is proposed to set up, will enable the company to fulfil their obligations to their customers. The area proposed to be supplied extends 30 miles from the power-house, and the price to be charged for electric power will vary from a maximum of 5d. to a minimum of 2d. per unit. It is proposed to supply the Corporation of Limerick, however, at the fixed price of 2d. per unit. The proposed capital of the company is £360,000, with borrowing powers of £180,000. The estimates prepared show the cost of the works to be £265,000, and the working plant £75,000, making a total of £240,000. The Bill also asked for general powers to supply electricity not only for motive purposes, but for general lighting. To this the late Sir Courtenay Boyle, on behalf of the Board of Trade, took exception before the Select Committee. He pointed out that the proposals were contrary to adopted policy, and that lighting powers should only be allowed for special districts and not wholesale. The promoters then asked to be put in a position to grant powers to other persons. That, again, was *ultra vires*. Further, there was no provision in the Bill to supply on reasonable demand, as in the Bills of last year, and there was no sliding scale proposed. If the water power were abandoned, there was nothing in the Bill to show that the other powers of the promoters ceased. In deciding that the preamble of the Bill was proved, the chairman directed clauses to be brought up to satisfy the wishes of the Board of Trade. During the course of the enquiry a suggestion was made on behalf of the Treasury that payment should be made for the water abstracted from the Shannon, but with this the committee expressed itself not in favour. Mr. Fraser, C.E., is the engineer to the scheme.

The Cleveland and Durham Power Bill.

In further reference to the above Bill, we neglected in our last issue to mention the name of Mr. A. A. Campbell Swinton, of 66, Victoria-street, S.W., as engineer to the scheme, in conjunction with those of Messrs. Bramwell and Harris, of Great George-street.

THE COMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

The Cable Works of the Allgemeine Elektricitats-Gesellschaft.

One of the most attractive visits which will be paid by the Institution of Electrical Engineers will be that to the cable works of the Allgemeine Elektricitäts-Gesellschaft. These fine works are pleasantly situated on the banks of the Spree at Oberschöneweide, a village about 10 miles to the east of Berlin; and by the courtesy of the directors of the company a boat will be placed at the disposal of the party, so that the journey may be made by water, which, should the weather be favourable, will be a much more agreeable method of travelling than by rail. If further example were needed to illustrate the rapid growth of the electrical industry on the Continent, it could not be better found than in the new cable works of the Allgemeine Elektricitäts-Gesellschaft, the equipment and organisation of which are model in every respect, and cannot fail to leave an impression upon the visitor. The

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annual output of copper in the form of cables has increased between the years 1890-1900 from 112 tons to 9,000 tons.

Up to the end of the year 1897 the manufacture of cables and insulating material was carried out in the Ackerstrasse, in the building known at present as the apparatus factory. The accommodation being insufficient to meet with the demand, however, the directors acquired a site at Oberschöneweide, where the building of the new factory

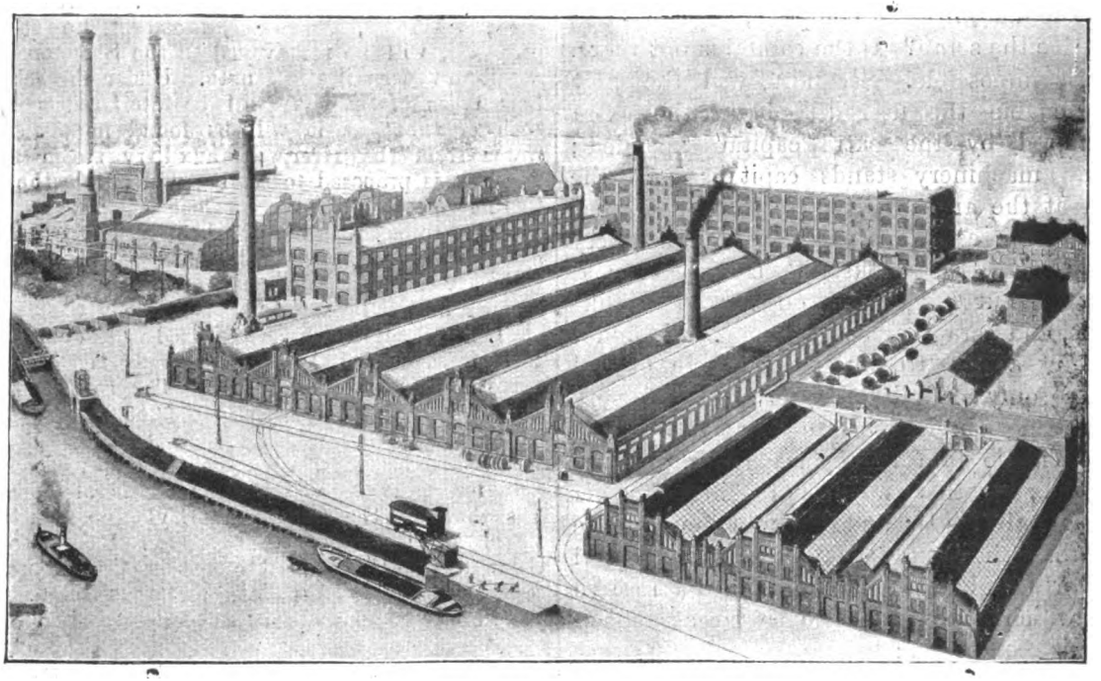

FIG. 1.—The Cable Works of the Allgemeine Elektricitäts-Gesellschaft, Oberschoneweide.

was commenced in 1896. The site chosen had the special advantage that, being alongside the river, it was possible to bring all raw materials by water to the works, the river being navigable right away to Hamburg. A railway siding and branch line were constructed to connect the works with the neighbouring railway, and specially-built wagons provided for the carriage of heavy drums of cable. A complete system of lines extends throughout the works and goods yard, and several electric locomotives and cranes are in use for dealing with the outgoing and incoming materials. The works were completed towards the close of the year 1897, and the whole of the cable machinery was removed from the Ackerstrasse, and the factory put into operation in the short time of 14 days. The buildings are illustrated in Fig. 1. To facilitate communication with the passenger station at Neider Schöneweide, which is on the opposite bank of the river, the Allgemeine Elektricitäts-Gesellschaft, in conjunction with another firm, built the handsome bridge which now spans the Spree. It is constructed of wrought iron throughout in three spans, the centre one being 90 yards long, and the two outers 50 yards. The bridge is open to general traffic, which has, of course, greatly increased owing to the new dwellings which have sprung up since the cable works were started.

The ground occupied by the cable works amounts to 100,000 square yards. The different manufactures are carried on in five separate buildings, and include the copper and metal-working, cable, wire, indiarubber, and micanite departments, as well as a large cable machinery repairing shop, foundry, and woodworking shop for the manufacture of cable drums, etc.

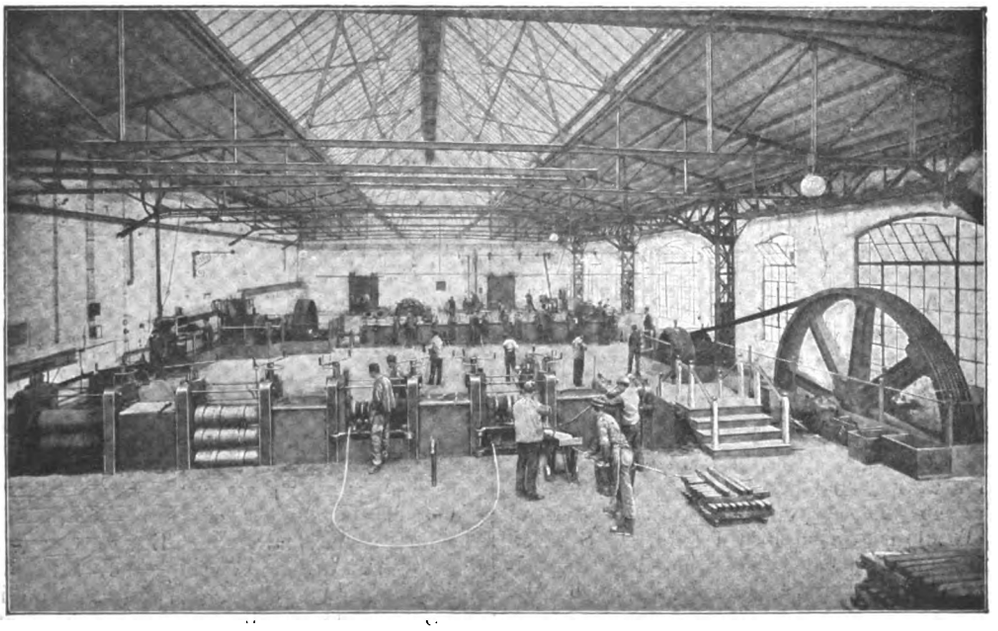

FIG. 2.—Copper Rolling Mills, Oberschoneweide.

The machines and tools in all departments are driven by separate three-phase electric motors, of which there are nearly 600 in use. The total power consumed amounts to 3,000 h.p., which is obtained from the neighbouring central station of the Berliner Elektricitäts Werke at a tension of 6,000 volts. The absence of a power station is a noteworthy feature in these works. The underground three-phase mains are brought into a gallery at the end of the wire-drawing department, where the whole of the apparatus

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for controlling the driving of the factory is placed, including the step-down transformers and the motor-generators which convert the three-phase current into continuous current for the working of the cranes.

The copper and metal-working department is devoted to the rolling, drawing, and annealing of the various wires, bars, etc. The heated bars coming from the ovens are 1m. long and about 9cm. square. Fig. 2 shows the rolling

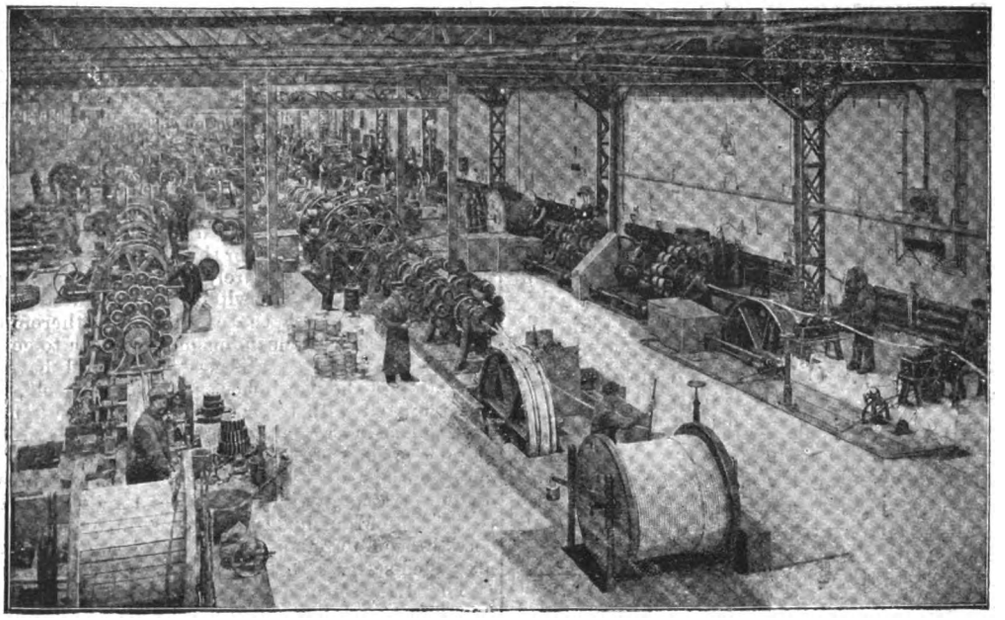

Fig. 3.—High-Tension Cable Department, Oberschoneweide.

machines, the three being driven by a 600-h.p. three-phase motor. The bars are passed rapidly backwards and forwards through the rolls, and in three minutes their diameter is reduced to 6mm. and their length increased to 260m. This wire is then passed through drawing machines of the Allgemeine Electricitäts-Gesellschaft's special design, and its section reduced to any desired value. The diameter of the smallest wire drawn by these machines is about 2mm.; the finer wires are drawn in a special department. They are made by passing the wire through diamond dies drilled to the necessary diameter. In this manner uniformity in the section of even the smallest wire is ensured. On one of these drawing machines several diamond dies of different sizes are put one above the other, so that wires on the same machine diminish their diameter by passing through the dies in succession. The smallest diameter drawn is 0·05 mm. Not only round wires but bars of various sections are drawn in this department, such as commutator segments, 'bus bars for switchboards, and overhead trolley wires. Electrolytic copper of the highest conductivity is generally used. The large increase in the cost of copper, however, has caused aluminium to be used as a substitute for many purposes. Aluminium has not so high a specific conductivity as copper, but weight for weight it has about double the conductivity. The Allgemeine Elektricitäts-Gesellschaft are now manufacturing large quantities of aluminium wire.

Every variety of cable and wires can be turned out to suit both English and foreign specifications, so complete is the equipment with which the company are in possession. A special feature is made of lead-sheathed cables for lighting and power-transmission purposes which are suitable for working tensions up to more than 20,000 volts. These high

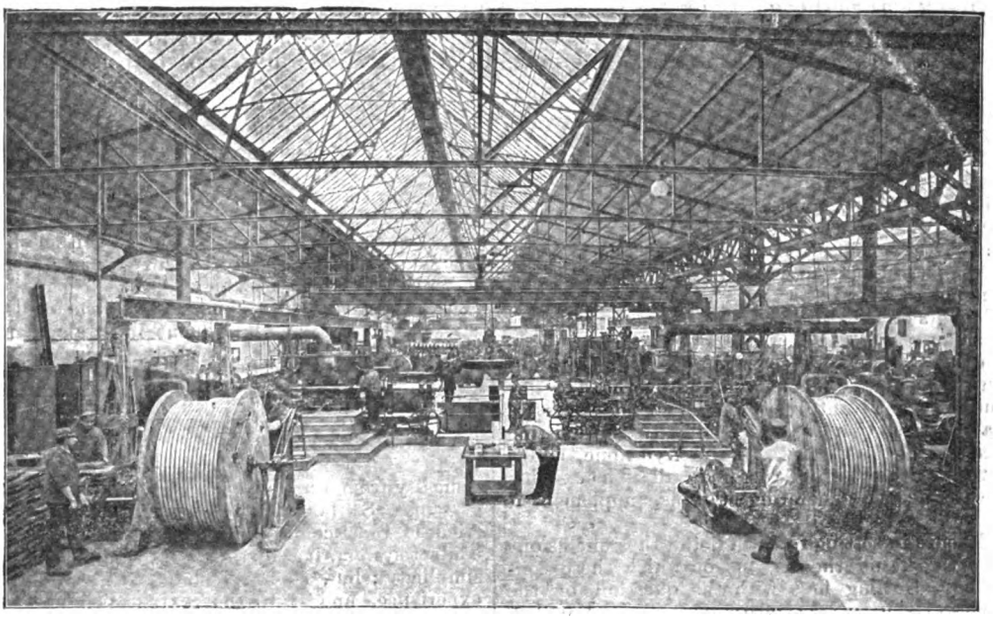

Fig. 4.—Lead-Sheathing Department, Oberschoneweide.

tension cables (Fig. 3) are subjected to a trial test of 40,000 volts. The insulation used for ordinary lead-covered cables consists of, first, a layer of jute, from which, when completed, the moisture is extracted by vacuum drying presses. The vacuum drying method is specially interesting, being a great advance on the old-fashioned methods of baking. The cables are coiled up into baskets, each drying oven having room for four of these. The ovens are heated with steam-coils, and the air carefully exhausted from them

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after the cables are placed within. The vacuum gauge on the outside of the ovens affords a ready indication as to when the jute covering is thoroughly dry. After drying the cable is passed through a bath of resinous insulating compound, and from thence into the lead presses, where it receives a seamless sheathing. This lead covering is put on by hydraulic pressure. The cable after leaving the insulating compound is drawn through the interior of a patrix or conical-shaped ring, which is surrounded by a matrix resting against the end of the lead chamber. The half-melted lead is forced down through the space between the matrix and patrix, and forms a seamless sheath over the cable as it is drawn through the press. By adjusting the distance between these two dies, the thickness of the sheathing can be varied. These presses (Fig. 4) have been found to give great satisfaction, the sheathing process being continuous as long as the press is fed with lead, and thus cables of any length can be given a jointless cover. Cables manufactured in this way are ready for use without any additional treatment, but frequently receive a further protection against external abrasion. They are first covered with a layer of jute, impregnated and dusted with French chalk, and armoured by a double layer of hoop iron or iron wire, and finally asphalted as a protection against moisture. Cables for working tensions of from 5,000 to 10,000 volts are insulated first with a layer of impregnated jute, then with a mantle of rubber and a taping of paper, after which comes the lead sheathing. Cables for still higher tensions receive, instead of the jute, a sheathing of rubber, and over this a specially-prepared insulating material of such a nature that a piece 1mm. thick will withstand a pressure of 50,000 volts without injury. Cables insulated with this material can be used with security for working pressures of 25,000 volts. Lead-covered cables can be made with a single core or with two or three cores, twisted or concentric.

(To be continued.)

ELECTRIC TRAMWAYS FOR LEICESTER.

The following is the full text of the report of Mr. E. Manville, M.I.C.E., on the proposed electric tramways for Leicester. This report has been adopted, and Mr. Manville appointed consulting electrical engineer for the work. The expert's review of the advantages of the various systems will be of great interest to electrical engineers. The report is addressed to James Bell, Esq., the town clerk of Leicester, and reads as follows:

In accordance with the instructions contained in your letters of Feb. 21 and 25 and March 8, I have very carefully considered the several questions which have been laid before me, with the object of reporting thereon; and have conferred with your Tramways Committee, with the individual members of your Corporation who have given special consideration to the matters, with your gas and electric light engineer (Mr. Colson), and with your borough engineer (Mr. Mawbey).

The principal points on which I have now the honour to report to you may be summarised as follows: (1) the relative advantages, in the case of Leicester, of the underground conduit systems, the surface-contact systems, and the overhead trolley systems; (2) the relative advantages of an independent central power station, a power station in connection with the existing Corporation gas and electric light works at Aylestone, and a combination of the various dust destructor installations existing in the borough with electric generating stations, supplemented by coal-fired boilers.

I have now pleasure in setting forth in detail the conclusions at which I have arrived, and the reasons on which these conclusions are based. Dealing first with the question of the relative advantages of the surface-contact systems, the underground conduit systems, and the overhead trolley systems, I have considered the matter under the two heads of safety and reliability in working and capital cost.

Surface-Contact Systems.

Your committee especially brought to my notice four surface-contact systems. I have supplemented my own knowledge by consultation with those specially interested in each such system. The systems were as follows: (1) the Lane electromagnetic; (2) the British Schuckert; (3) the Union Electricitäts-Gesellschaft; (4) the Dolter.

Both the systems of the British Schuckert Company and of the Union Electricitäts-Gesellschaft consist essentially of contact plates located at somewhat frequent intervals in the centre of each track, but having no electrical or magnetic apparatus attached thereto, the actuating apparatus being in groups situated in chambers formed beneath the sidewalk at infrequent intervals. The chief advantage claimed for these systems is that the apparatus putting the contact plates in circuit with the conductors carrying the electric current are not situated beneath the road surface, but in positions in which they can be easily inspected and properly maintained, and are, therefore, less liable to derangement than other systems involving the switches or controlling apparatus being placed in the roadway beneath the individual contact plates. Both these systems are at work to a limited extent on the Continent of Europe, but, in common with the other surface-contact systems, have never been tried on a practical scale in this country, and must therefore, to some extent, be regarded as still in the experimental stage.

The Dolter system consists of a surface-contact plate or block—as in the above two cases—installed at moderately frequently intervals along the track, each surface-contact plate having beneath it a magnetic switch, which places the same in circuit with the insulated electrical conductor carrying the current. The advantage claimed for this system is that the switch beneath the road surface is purely magnetic, and magnetism in the magnet portion of the switch being induced by the collecting bar carried beneath the car, involving therefore no windings round the subterranean magnetic switch to get out of order; and from a model of this system which I have inspected, the operation of these switches seems to be reliable, and the system, as compared with other surface-contact systems, undoubtedly has the advantage of extreme simplicity, and less liability to derangement, than others in which wire-wound switches form an essential part. This system is at present in use to a limited extent on a tramway in Paris, and I am informed that the consent of the Municipality has been obtained to its extension in substitution for another system at present in use on a more extended scale.

The Lane electromagnetic surface-contact system presents many features of originality. It consists essentially of a gas-tight metallic conduit, in which is contained a flexible magnetic conductor, resting upon porcelain insulated bridges, placed at frequent intervals within this conduit. On the top of the conduit, and brought up to a level with the road surface, are the regular surface-contact plates employed in all these systems, so arranged in this case that when the magnetic conductor is brought towards the top of the conduit, it places itself in contact with the surface-contact plates above. The car carries a short collector, which is made permanently magnetic—as in the case of the Dolter system—by magnetising coils, energised by the current derived from the conductor or from a separate small battery of accumulators carried upon the car. As the car travels over the surface of the contact plates, they are successively magnetised by the collecting bar, and pull up the magnetic conductor into contact with them, the collector being so arranged that, as it passes on, the poles of the surface-contact plates are reversed as the collector leaves them, thus not only releasing the magnetic conductor, but repelling it, thereby ensuring disconnection of the circuit when the car has passed. To ensure the magnetic conductor and the projection of the contact plate with which it makes contact remaining unoxidised at the breaking of the circuit, when sparking might occur, the whole of the conduit is denuded of oxygen, and filled with some gas, in the presence of which neither the magnetic conductor nor the contact plates will oxidise; and in the case of a street tramway it is proposed that coal gas should be used for the purpose. This system involves the contact plates being placed at much more frequent intervals than is common to the other systems of surface contact—viz., at intervals of about 8in.—as compared with a distance of about 10ft. in the case of most other systems. This, in itself, presents some advantage, as the length of the collector is consequently shorter, and less mechanical difficulty arises in connection with the irregularity of the surface of the paving—an element of considerable difficulty from a maintenance point of view with most contact systems. So far as I am aware, this system has never been tried in practice in this country or elsewhere. As a surface-contact system, it is distinctly attractive, in view of its extreme simplicity; but, so far, it has not stood the test of practical experience, and is to that extent behind the other systems mentioned.

In addition to these four systems specifically mentioned by members of your Council, there are many other surface-contact systems, some of which have been tried in practice. One which was inspected by the sub-committee of your Tramways Committee is the Diatto system, which is now being used on a somewhat extensive scale in Paris, and from what I can gather as to the practical results of this system, these are not altogether encouraging for its adoption in this country. It must be recollected that there is probably no climate so trying to the use of a surface-contact system as that prevailing in this country owing to its extreme humidity, and even if any of these systems worked successfully in other climates it does not by any means

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follow that such a system would give satisfaction in this country on that account.

Beyond the difficulties that might be apprehended owing to the prevailing humidity in this country, there are further risks connected with the possibilities of a surface-contact plate being left in circuit with the live conductor after the car has passed from over it. Your Council will readily appreciate that all moving switches, however simple they may be in their construction, are liable to failure in action on some occasions. If this failure prevented the contact plate being put into circuit with the live conductor no serious consequences would follow, and but little inconvenience would be experienced in the supply of current to the car; but, on the other hand, if the failure involved the contact plate remaining in circuit with the live conductor after the car had passed, very serious consequences would be likely to follow. It is, for instance, certain that horses or cattle of any description treading upon the surface-contact plate would be seriously hurt, and probably killed, and so far as human beings are concerned, although the consequences are likely to be less fatal, the shocks received by them might be of a serious description, especially in the case of aged persons or those who have a weak constitution; and it is a matter of common knowledge that a good many accidents of the character of those referred to above have occurred in Paris in connection with one of the systems which have been there installed.

In connection with the working of this particular system of surface contacts an interesting report has been issued upon the subject by the Paris Municipal Council, the French Ministry of Public Works, and other public bodies in Paris concerned in the safety of the streets, and published in *L'Industrie Electrique*, from which I gather that, as a result of a letter received from the Prefect of Police, showing that during the period extending from June 15, 1900, to Feb. 20 last no less than 120 accidents had taken place, of which 58, or practically half, occurred in January last—that is to say, during the snowy period—the French Minister of Public Works instructed the Comite d'Exploitation Technique des Chemins de Fer (Committee on the Technical Working of Railways) to enquire into the inconveniences and dangers which may appertain to the Diatto system. This committee reported that the accidents that had taken place were due to: (1) Insufficient drainage of the surface contacts and conduits, causing shunt currents. (2) To the action of the special contacts fixed fore and aft to the motor tramcars at the moment these contacts pass over the surface contacts. (3) In order to give stability to the latter, they have been supported by two metallic cross-pieces joining the tram-rails, an arrangement which is very bad from the point of view of the insulation of the surface contacts, and one which has been attended, when the tramlines have been sprinkled with salt after a fall of snow, with most unfortunate results. (4) The sparking which occurs each time the working of the surface contact is not perfectly regular gives rise to a formation of a conducting deposit of carbon, due to the combustion of the material of which the surface-contact box is made. (5) Finally, the committee reported that to the bad insulation of the cables, apart from the insufficient drainage of the conduits, many of the accidents are to be attributed. This insufficient insulation, while dangerous to public traffic, is not less so to pipes, buildings, and anything of metallic construction laying near to the tramway lines. Strict precautions are imposed in this regard on trolley tramway installations, and the committee consider that similar precautions should not be overlooked in the case of surface-contact lines, in which perfect insulation is much more difficult of attainment.

In December last the Prefecture of Police issued instructions to the tramway companies that all the surface contacts must be visited daily, and a report sent to the Prefecture within the next 24 hours on the results of the inspection, that the special contacts on the cars must be temporarily suppressed, and that at various points on the lines means of draining the conduits be laid down. An arrangement was also arrived at between the tramway companies and the Street Cleaning Committee of Paris, that the tramway lines should not be sprinkled with salt after a fall of snow. In their report, the committee, without expressing any opinion on the merits of the Diatto system, for or against, approve the action of the Prefecture of Police, and recommend (1) that the tramway companies be requested to establish sufficient space between the surface contacts and the cross-pieces above referred to; (2) to take steps, on the one hand, to suppress the formation of carbon deposits inside the surface contacts, and, on the other, to improve the defective insulation of the conduits; and (3) that the paving of the road around the surface contacts should always be kept in excellent condition. As a result of the report the Paris Municipal Council has passed a resolution calling upon the tramway companies to carry out the improvements outlined in the report above alluded to before Oct. 1 next.

There is no doubt that the surface-contact systems are very attractive, owing to their low cost of construction, as compared with an open-conduit system, and to the absence of a slot in the roadway, and, as compared with the overhead system, surface-contact systems are again attractive by reason of the entire absence of the standards and overhead gear inseparable from such a system, although, in regard to cost, the surface-contact system is somewhat more costly than the overhead system. I have given much consideration to the desirability of your adopting one or other of these systems; but I feel that, in the absence of practical experience of any of them in this country, it would be impossible for me to advise you to take upon yourselves the burden of an experimental demonstration which might end in the waste of public money, and would, in that case at all events, bring discredit upon your electrical tramway system at its inception, from which it might take a long time to recover, beyond which there is the more serious consideration of a possible result, involving, it might be, serious injury, or even fatal accidents, arising from failure of a part of any of the numerous circuit-making devices common to all such systems. At a later stage in this report I shall have some further remarks to make in relation to the possibility of installing a surface-contact system at some future period, but for the moment I would pass on from the consideration of this subject, and deal with the other methods of distribution of electrical energy to the cars.

Open-Conduit Systems.

Of open-conduit systems it may safely be said that they can all — in a well-drained town like Leicester — be depended upon, if properly designed, for reliable working, facility of maintenance, and immunity from danger; and the only objections which can be urged against them, as compared with the surface contact and overhead trolley systems, are the presence of a third rail—or pair of rails—breaking up the pavement, involving increased maintenance thereof, and the undoubtedly greater capital expenditure necessitated in the installation of such a system. I do not think it is necessary for me to enter at length into the consideration of the first objection, which is one which your Council themselves will be able to fully appreciate and duly recognise at its proper value; and with regard to the question of capital cost, I can more conveniently deal with this later on, in comparison with the cost of the overhead trolley system; and I am of opinion that if considerations of capital cost and somewhat higher maintenance in regard to the paving, together with the added obstruction of additional metals in the road surface, did not enter into your consideration, there can be little doubt that in the present state of experience, the conduit system would present advantages which would probably induce you to adopt it in preference to any system of surface contact.

Overhead Trolley Systems.

As your Council are well aware, the overhead trolley system is—as compared with other systems—almost universal. It has, as a rule, given almost unqualified satisfaction in use, and it is probably not too much to say that, although in a few cases accidents have occurred in the use of this system, these can be traced either to inefficient or faulty construction, which might have been avoided, or to gross carelessness, which cannot be wholly guarded against in any system of mechanical traction. It has sometimes been urged against the overhead trolley system that the use of the rails as the return circuit for the current might lead to the destruction of water and gas pipes and other metallic substances in the road, due to electrolytic action. It is hardly necessary, however, to point out that if the return system is properly designed, so that the differences of potential along the rails are kept well within the limit stipulated for by the Board of Trade, no results of this description need be feared; and in those cases in the United States where great destruction of pipes has taken place, this has invariably been due to an utter disregard of the above-mentioned conditions, which are essential to safe working in this respect. At one time the overhead trolley system did not find favour in this country for purely æsthetic considerations, with the result that more care has been taken to render the appearance of the overhead construction less obtrusive and objectionable than was formerly the case; and to-day, in this country, as your Council are aware, most of the principal cities having a regard for the appearance of their streets are adopting this method, not to mention Continental cities, where æsthetic considerations are generally considered even to a greater extent than in this country. This question of æsthetic consideration is one which is, perhaps, to some extent, outside the scope of an engineer's report; and when I have laid before you the financial conclusions at which I have arrived, it will be a matter for the consideration of your Council whether the æsthetic advantages of the conduit system compared with the overhead system are commensurate with the greatly-increased capital expenditure involved therein. The æsthetic question—apart from technical considerations—is one rather of individual opinion than of expert judgment; and your Council will doubtless, in dealing with this side of the question, give due consideration to the opinions formed and the views expressed by their sub-committee, who have made such an exhaustive examination of the various types of overhead construction installed in the numerous cities in this country and abroad, which

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they have specially visited for the purpose of forming a judgment; and I feel that it would be presumptuous on my part to express a merely individual opinion on this subject, which is entirely remote from any question of technical consideration; and I will therefore merely confine myself to saying that there are, in my judgment, no conditions in Leicester which make the introduction of the overhead trolley system less applicable than in the other important cities and towns of England which have already adopted it.

Before dealing with the question of the comparative cost of the overhead and conduit systems, I think it necessary to point out that there are special conditions in Leicester which make the introduction of a conduit system somewhat difficult—namely, the existence of at least three bridges carrying main roads over the railways and sidings of the Midland Railway Company, where the available depth from the surface of the road to the upper surface of the bridge construction is at present insufficient to admit of the construction of a conduit. I believe it would be possible in all these cases to so alter the form of the bridge decking as to enable a conduit to be constructed, and consequently the difficulty will probably be mainly represented by cost, provided either the consent of the railway company or compulsory powers can be obtained to enable such alterations to be carried out. Apart from this consideration, which is one which would require to be gone into in very considerable detail before absolutely deciding on a conduit system, should the Council otherwise favour this method of traction, I propose dealing now with the comparative cost of the overhead and conduit systems. In order to arrive at the expenditure your Council are likely to incur in the construction of either one of these systems, I have thought it desirable to base my estimates not only on the reconstruction of the existing tramways and the construction of those extensions already authorised by your Council, but I have included some further extensions which it appears are likely to be required in the immediate future, and the following is a schedule of the routes showing the approximate lengths thereof:

	m.	c
Existing lines—		
Belgrave road route	1	63
London-road route	2	2
Humberstone gate route	1	49
Aylestone route	1	75
Church-gate route	1	2
Total	8	31
Extensions of existing lines—		
Belgrave-road route	0	60
Loop line along Bedford street	0	42
London-road route	0	46
Humberstone gate route	0	38
Aylestone-road route	0	58
Bowling Green-street and Welford-place route	0	15
Church gate route	0	38
Total	3	57
Additional new lines—		
Narborough road route	1	54
Hinckley-road route	1	8
Fosse-road route	0	70
Great Central street route	0	26
Melton road route	1	10
St. Peter's-road, etc., route	1	52
Highfield-street line	0	18
Evington-road route	0	50
Melbourne-road, etc., route	0	62
Welford-road route	1	62
Clarendon Park-road route	0	57
Groby-road route	0	70
Cavendish road, etc., route	0	68
Belvoir-street route	0	13
Park-road (including Queen's-road) route	1	0
Evington-lane route	0	77
St. Saviour's road route	0	75
Upperton-road and Walnut-street route	0	61
Total	16	33

From the above table it will be seen that the total length of the whole of the tramways in contemplation amounts to about 28½ miles, of which 19½ miles are double line and nine miles single line, the figure for double line being, of course, inclusive of an allowance for passing places on the single-line routes, which I have had more or less to approximate, but which may be taken as sufficiently accurate for the purposes of this comparison.

I have gone very carefully into the estimates of cost of the construction of these tramways—both on the overhead and the conduit system—including the whole of the electrical equipment in the roadway. In dealing with the cost of the construction adapted for overhead construction, I have based my figures on the very best modern type of construction. As regards the conduit system, there is not so much data available as in regard to the overhead system. The experience in this country in regard to the conduit system is practically nil, and the figures available from the experience obtained either in America or on Continent are scarcely applicable in this country. In this connection I would point out that there appears to be a very great divergence of opinion amongst those engineers who have carried out conduit systems abroad as to the proper size of the conduit and in respect to the general details of the design. The figures available from foreign experience as to the cost of conduits are so excessive as almost entirely to preclude the consideration of the use of this system in this country, excepting in the largest cities, and there only where the traffic is so extensive as to practically make the question of first capital cost of but little moment. I am, however, myself disposed to think that a thoroughly reliable and efficient conduit system can be constructed at a much more moderate price than has heretofore been estimated on the basis of foreign experience, and I have thought it only right in comparing the two systems of overhead and conduit traction to thoroughly analyse the prices and quantities on which these foreign estimates are based, and to adapt and modify them by my experience of English prices and conditions; and I think that the figures which I have arrived at, while being sufficient, may at the same time be taken as the very lowest estimate of what a reliable and efficient conduit system could be constructed for in this country. I append to this report a cross-section showing the general type of conduit on which my estimates are based, and I would state that I have had occasion, in connection with cable and other conduits, to very carefully test and experiment on the necessary strength of yokes or castings for such purposes when subjected to the most extreme conditions of street traffic, such as those designed by my firm for Birmingham and Edinburgh, and I therefore speak with some confidence as to the suitability of the particular type of conduit on which my estimates are based. With these introductory remarks, I beg to submit the following figures at which I have arrived:

Conduit System.	£
Cost of constructing nine miles of single line of tramway complete, including conduit, together with the electrical equipment therein, and allowing for the points and crossings at junctions, but exclusive of feeders (or, say, £10,786 per mile)	97,077
Cost of constructing 19½ miles of double line of tramway complete, including conduit, together with the electrical equipment therein, and allowing for the points and crossings, and also a sufficient number of cross-over roads, but exclusive of feeders (or, say, £22 941 per mile)	447,342
	544,419
Add 10 per cent. for engineering and contingencies	54 442
	£598 861
Estimated cost of alterations to water-mains, sewers, manholes hydrants, bridges, etc. (but exclusive of alterations to the two Midland main-line bridges at London-road and Welford-road) as estimated by the borough and water engineers, say	46,064
	£644 925
Overhead Trolley System.	£
Cost of constructing nine miles of single line of tramway complete, including points and crossings, bonding, and overhead electrical trolley equipment, but exclusive of feeders (or, say, £6,079 per mile)	54,71
Cost of constructing 19½ miles of double line of tramway complete, including points and crossings, cross-over roads, bonding, and overhead electrical trolley equipment, but exclusive of feeders (or, say, £11,148 per mile)	217 385
	272,096
Add 10 per cent. for engineering and contingencies	27,210
	£299,306
Difference in cost on the complete system between overhead and conduit systems, exclusive of feeders	£345,619

These figures, as above stated, are exclusive of the cost of feeders, which, as shown hereafter, will cost considerably more in the case of the conduit system than in the case of the overhead trolley system, owing to the necessity in the former case of having an insulated return as against the uninsulated rail return in the overhead system, and involving in consequence an extra amount of feeders of larger section. I do not propose, however, at this stage to deal with this matter in detail, as the cost of feeders in both cases must, to some extent, be dependent on the situation of the generating station, and is dealt with under that heading.

(*To be continued.*)

APPOINTMENTS VACANT.

Switchboard Attendant for three-wire continuous-current supply. Details in our advertisement columns.

Agent, with some knowledge of electrical goods and small capital. Details in our advertisement columns.

Engineering Teacher, Merchant Venturers' Technical College Bristol, £170 to £200. Details in our advertisement columns.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

379. What is considered the best form of gearing on electrically-driven pumps for silent running and durability? Has chain gear met with any success?—J. R.

380. Give a sketch and discuss the merits and demerits of an earthing panel for the middle wire of a three-wire continuous system of distribution.—S. D. S.

ANSWERS.

Question No. 374.—I wish to have a motor driven by a dynamo at a short distance apart, but the motor to correspond in speed *exactly* to that of dynamo, however varied the speed of the dynamo may be. What peculiarities in design or other detail are necessary to ensure perfect synchronism, and would it be reliable?

Best Answer to No. 374 *(awarded* 10*s.)*.—In order to ensure perfect synchronism between the machines, an extra or synchronising connection must be made between the two armature windings. This is best effected by adding a slip-ring to the motor and another to the dynamo, each connected to a coil or commutator segment. An electrical connection between these two slip-rings after the motor has been speeded up will serve to lock the armatures in synchronism. For starting the motor it would be necessary to first cut out the starting resistance, R_1 (Fig. 1), and then

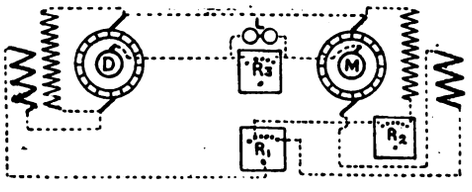

FIG. 1.

adjust the shunt regulating resistance, R_2, until the synchronising lamp or lamps, L, ceased to "beat," showing that the armatures were running at practically the same speed; finally, the resistance, R_3, would be cut out, and the "electrical coupling rod" established between the two armatures.

For the satisfactory working of such an arrangement the following considerations must be borne in mind when designing the machines and afterwards in running them: (1) the pole-faces and armature cores must be of similar type, although not necessarily of the same size; (2) the armatures must be wound to run normally at equal speeds; (3) both machines should have similar characteristic potential curves; (4) if the dynamo speed is likely to vary much, these characteristics should be as straight as possible—*i.e.*, the field magnets should be designed with a low induction or fairly large air-gaps used; (5) the dynamo should be compound-wound to neutralise the "drop" in the machine, and the motor should have a reversed compound winding to prevent the speed tending to fall with increase of load; (6) when the machines are in operation the rheostat, R_3, should occasionally be switched off and R_2 readjusted if found necessary (owing to differences of temperature in fields, etc.).

Unless the above precautions are observed, surgings will take place between the armature windings, with consequent sparking at the brushes, excessive heating, and unnecessary waste of power. An alternator and synchronous motor (with the same number of poles) would be rather preferable to the method just described, but such a combination is apparently not within the scope of the question.—DISPAR.

Answer to No. 374 *(awarded* 5*s.)*.—There are two methods of obtaining this object—one employing continuous and the other alternating currents. For the first method the dynamo and motor would both have to be separately excited from some perfectly constant source, such as a storage battery. The connections between dynamo and motor would be otherwise exactly as usual (see Fig. 1). Any speed variation on the dynamo will

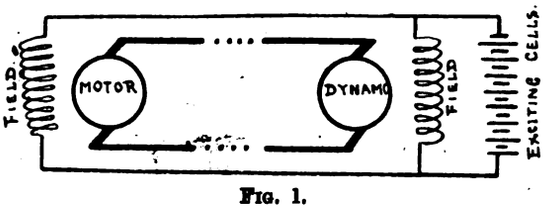

FIG. 1.

produce an exactly proportional variation in its internal armature voltage, and a very nearly proportional variation in its external terminal voltage, with the result that the corresponding motor voltages will also vary very nearly proportionately to the dynamo speed. The motor being separately excited, these voltage changes will cause its speed to very closely, though not quite exactly, follow the dynamo speed. If E and E_1 are the internal (armature) voltages of the dynamos at two speeds, R and R_1 respectively, and e e_1 are the volts lost in the resistances of dynamo armature, motor armature, and line in the two cases (if the torque required from the motor is constant at all speeds, the current will remain constant, and e will equal e_1), then the ratio of the two dynamo speeds, $\frac{R}{R_1}$, will equal $\frac{E}{E_1}$, whilst the ratio of the corresponding motor speeds will eqnal $\frac{E-e}{E_1-e_1}$, and this ratio may be made to differ as little as necessary from $\frac{E}{E_1}$ by making the armature and line resistances low enough (by using machines rather large for the work and a large section for the line wire) and so reducing e and e_1. It may be pointed out that, even if the torque and current are not constant, the effect of changes in armature reaction is negligible, for whilst an increase in current lowers the voltage given out by the dynamo at a given speed, it also weakens the motor field, and so enables the lower dynamo voltage to produce practically the same motor speed as if no armature reaction existed, the two effects nullifying one another.

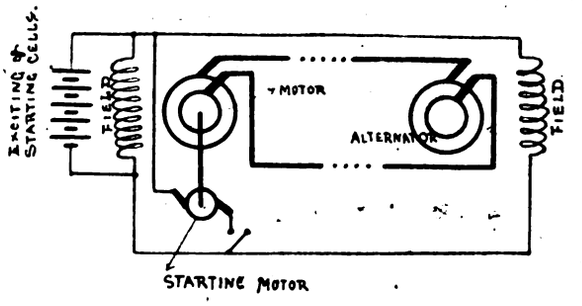

FIG. 2.

The second method, employing alternating currents (Fig. 2), involves the use of a synchronous motor. Such a motor will run at absolutely the same speed as the alternator supplying it, unless a sufficiently sudden change in load or current occur to actually throw it out of step. In the case under consideration it is not of much importance whether a single-phase or a polyphase current be employed. The machines must be separately excited from some continuous-current source, which may also conveniently be used for starting the motor by means of a small auxiliary continuous-current motor connected to the spindle (as

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shown in Fig. 2). It is, however, quite possible to start a synchronous motor, if of the polyphase type, at light load by means of the alternating current, by leaving the motor field unexcited and passing an alternating current (which may require to be two or three times the full-load current) through its armature. In the present case this self-starting would be especially easy, since the alternator has apparently no other work to do beyond driving the motor, and, therefore, the two machines could be connected together before starting the alternator. In this way the motor would start long before the alternator had attained full speed, and a much smaller starting current would be required. The question of the method of starting has a certain effect on the design, as a motor with large armature reaction and small air-gap would be preferable if the machine is to be self-starting. Beyond this, the only other point to be considered is the flywheel effect of the armatures. The alternator armature should have as *great* a flywheel effect as possible, so as to prevent *sudden* changes in speed, whilst the motor armature should have as *little* flywheel effect as possible, so as to be ready to follow the changes in periodicity sharply. In fact, if the speed variations are at all sudden, it will not be possible to utilise the alternate-current scheme. The permissible amount of sudden speed variation is increased the smaller the number of poles on the motor, so that a very low periodicity (20 to 25 ⁓) should be chosen if not otherwise determined.

To sum up, the alternating-current scheme gives more exact correspondence in speed between dynamo and motor, but it is not quite reliable, especially with sudden speed changes. The continuous-current scheme, on the other hand, is absolutely reliable, but the motor speed is not quite proportional to the dynamo speed.—Q.

Answer to No. 374 (*awarded* 5*s.*).—A series-wound dynamo will drive a series-wound motor (Fig. 1) at a speed corresponding to its own, and whether the load on the motor be large or small, the motor must run at the same speed as the generator, and will vary in speed as it varies. The solution of this problem, to obtain synchronism of the two machines, consists in the proper design of dynamo and motor, so that their characteristic curves fit each other.

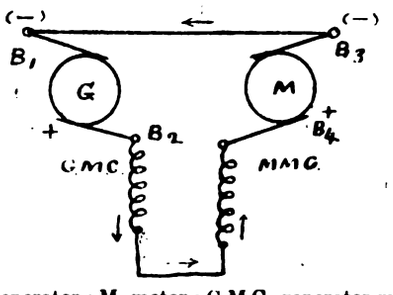

FIG. 1.—G, generator; M, motor; G M C, generator magnet coils; M M C, motor magnet coils; B_1 B_2 B_3 B_4, brushes.

Beyond this no other peculiarity in design or other detail is necessary to ensure constant speed of the motor at all loads, provided the generator be driven at a constant speed and the system becomes perfectly self-regulating. Kapp, in his book on "The Electric Transmission of Energy," shows, by means of a diagram (which I reproduce) how this is accomplished. Let, in Fig. 2, O E represent the ordinary characteristic of a series-wound dynamo, the curve being drawn for a constant speed of, say, 1,000 revolutions per minute. Let O *e* represent the characteristic of the motor also for, say, 1,000 revolutions per minute. The counter E M.F. developed in the armature of the motor at that speed is represented by the ordinates of the curve O *e*. Thus to a current O C will be opposed an E.M.F., C B; to a current O C_1 will be opposed an E.M.F., C_1 B_1, and so on. In the dynamo the E M.F. corresponding to the current O C is C D, and that corresponding to the current O C_1 is C_1 D_1. Draw O R so inclined to the horizontal that the tangent of the angle R O X represents to the scale of the diagram the numerical value of the sum of the resistances $(R+r+s)$ of dynamo, motor, and line, then the E.M.F. lost in overcoming these resistances is for the current O C evidently C A, for the current O C_1, C_1 A_1, and so on. The ordinates between the straight line, O R, and the characteristic curve, O E, represent, therefore, the counter E.M.F., which must be developed in the armature of the motor at various currents. If the current is O C, the counter E.M.F. is A D; if the current is O C_1, the counter E.M.F. is A_1 D_1, and so on. Now, the counter E.M.F. of the motor, if running at a constant speed of 1,000 revolutions per minute, is given by the curve O *e*, and it will be seen that if the ordinates of this curve are for every current equal to the ordinates contained between O R and O E, the motor suits perfectly the requirements of the generator, and it will run at a constant speed. The motor will run at that speed whether the current be O C_1 or O C, provided that C_1 A_1 = B_1 D_1, and C A = B D. Even if the characteristics do not fulfil the condition C A = B D over the entire range, by testing we will generally find two points, C_1 and C, tolerably far apart for which the condition is fulfilled, and between which the deviation of one curve from the form

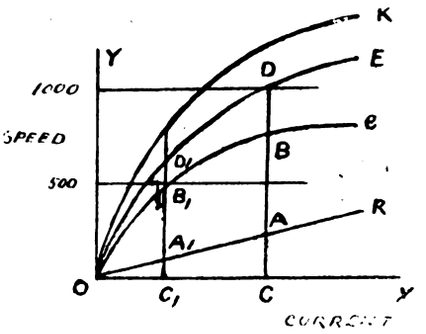

FIG. 2.

demanded by the other is very trifling. The system will become self-regulating between these limits. If it is necessary to run any two machines which happen to be at hand for constant-current transmission, and the dynamo and motor have not got their characteristics related in a fixed manner, we must make them agree by inserting a resistance in circuit (see Fig. 2). Let O *e* = the characteristic of the motor, and O K = that of the generator. In this case they do not agree, but by putting a resistance in circuit so that O K is brought down to the line O E, then the dynamo and motor will suit the requirements of the case, provided that the conditions already given are fulfilled. As there is some loss of energy by the introduction of the resistance, it is better to make the machines have as near as possible the required characteristics, and so have as little variation as possible in the way of a resistance to introduce. This system is perfectly reliable.—J. A.

Answer to No. 374 (*awarded* 5*s.*).—The requirements stated in this question are rather difficult to satisfy in the case of continuous-current machines. The simplest and most reliable way out of the difficulty would obviously be to employ a polyphase generator which would drive a synchronous polyphase motor; but the question, which specifies a continuous-current set, does not admit of this. A good way to solve a problem of this kind is to determine, first of all, what would be the *ideal* solution, and then, by careful designing, to endeavour to approximate as nearly as possible to it. Now, the ideal method in the present case would be to employ two magneto-electric machines—that is, machines having permanent magnets instead of the customary electromagnets. In this case the speed of the motor would vary directly as the back E M.F. of its armature. This would depend upon the E.M.F. of the dynamo, and the E.M.F. of the dynamo would, in turn, vary directly as its speeds. Thus the speed of the motor would to all intents and purposes correspond to that of the dynamo. The demagnetising effect of the armature current would not, as might be supposed, interfere with this result, for, whilst the demagnetising action of the generator armature would cause the voltage to fall slightly (and consequently tend to lower the speed of the motor), the demagnetising action of the motor's armature would tend to raise the speed of the motor, thus compensating for the lowering of the voltage. This method, however, is impracticable on account of the

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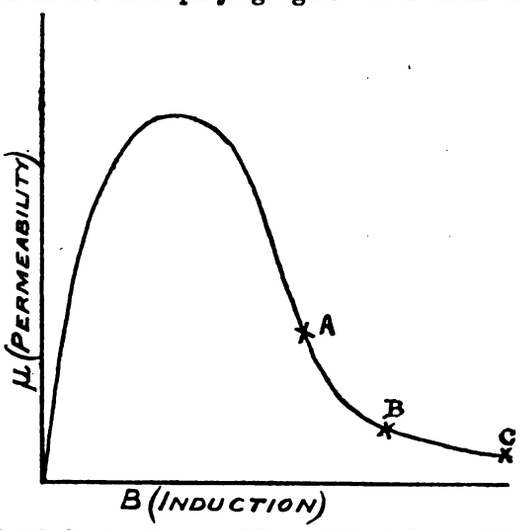
massive field magnets that would be required—it being impossible to get anything like the flux density in a permanent steel magnet that can be attained in an electro-magnet, and also because such a permanent magnet could not be relied upon to retain its magnetism properly.

The problem that confronts us is this: To design a machine in which, whether running as a dynamo or motor, the strength of the field shall remain practically constant with varying speeds and voltages, as would be the case with a magneto-electric machine. The reason of this will be apparent when we come to consider the working of series and shunt wound machines under the conditions stated in the question. Two series machines would give good results within certain limits, but at light loads (and consequently with lower flux densities in the magnets) the speeds of the two machines would probably not be in very close agreement unless the permeability curves of the iron or steel of the two magnets happened to correspond exactly, and this, unfortunately, cannot be relied upon for low inductions. Therefore, the induction in the magnets must remain fairly high for all voltages and speeds that will be required in practice. For this reason series-wound machines will not be suitable. In shunt-wound machines the induction in the magnets would remain more nearly constant for varying speeds than it would in the case of series-wound machines. And by slightly modifying the proportions of the shunt machine we can obtain practically what is required. Consider for a moment the permeability curve for iron or steel of average quality. The general contour of such a curve is shown in the accompanying figure. It is usual to work



Sketch showing Contour of Permeability in Iron and Steel.

somewhere on the curve between the points A and B. It will be noticed that between the points B and C the permeability remains practically constant with varying inductions. Let the magnet cores be made longer than usual, so as to carry a heavy shunt winding, and work at an induction between the points B and C on the curve. In cast steel this will be when B_{11} is about 135,000, and in cast iron when B_{11} is about 70,000. For the same reason the induction in the armature should also be fairly high. In machines designed on these lines the magnetic induction will remain very nearly constant within wide limits of speed variations; and what variation there is in the magnetic induction will take place simultaneously in both machines, as different samples of iron or steel (by the same maker) differ but very slightly in their magnetic qualities at the higher flux densities. The armatures should be long and of correspondingly small diameter, so that the motor may have a small moment of inertia in order that it may respond quickly to variations in the supply voltage. It goes without saying that the armature resistance should be kept as low as possible, as the loss of volts in the armatures at full load will cause the speed of the motor to fall below that of the generator. A shunt machine embodying the above modifications of design will approximate very nearly to the simple magneto machine; and two such machines will, I believe, satisfactorily fulfil the requirements as stated in the question.

In the above, it is not assumed that, as the two machines are required to be only a *short* distance apart, the drop in the leads will be negligible. Of course, if they were placed any considerable distance apart, the loss of volts in the leads at full load would complicate matters and render the motor less susceptible to variations in the speed of the dynamo.—F. W. D.

LEGAL INTELLIGENCE.

ELECTRICAL ENGINEERING COLLEGE.

The case of G. W. de Tunzelmann came before Mr. Registrar Giffard last Friday. The bankrupt stated that he was proprietor of the Electrical and General Engineering College and Experimental Works at Penywern-road, Earl's Court, from 1893 to 1899, when he sold the business to a limited company then formed to acquire it. The company, which had a nominal capital of £15,000, of which about £1,500 was subscribed, recently went into voluntary liquidation. The bankrupt further stated that in March, 1897, he promoted a company, having a nominal capital of £40,000, of which about £3,500 was subscribed, for the purpose of acquiring from him two patents for electric welding apparatus. He had since acted as director and also as consulting engineer for the company, and attributed his insolvency mainly to losses and expenses incurred in connection with the electric welding company, and by the transfer of the electrical college and works to a company. The examination was concluded, the statement of affairs disclosing an unsecured indebtedness of £9,197, and no available assets.

NATIONAL TELEPHONE COMPANY v. HUTTON.

Test Case.

Mr. A. T. Hutton, veterinary surgeon, Barnstaple, was on Monday sued at Barnstaple County Court by the National Telephone Company for £6. 10s., one year's rent for a telephone. It was a test case. Mr. R. Hendy appeared for plaintiffs, Mr. A. F. Seldon for the defendant. Defendant took the telephone on a yearly tenancy from Dec. 22, 1899. Only one year's rent had been paid, the wire being recently disconnected.

Mr. Drummond, district manager for the company, in cross-examination, said he understood Mr. Hutton considered he ought to have communication with Ilfracombe, Combemartin, Lynton, and elsewhere. He admitted a letter from Mr. Hutton, saying he had not the advantages which it was represented he would have. The establishment of the trunk system rested, he observed, with the Postmaster-General. The company only had the right of user, and in consideration of such trunk line not being established, subscribers were allowed an annual rebate of £1. 10s. Mr. Seldon further cross-examined with a view of showing that there had been several complaints about the trunk line not being established, while some time ago an indignation meeting was held at Barnstaple with regard to the matter.

Mr. Cox, district canvasser, denied the suggestion that he had given promises when obtaining orders a couple of years ago that the trunk system should be established forthwith.

Mr. Seldon declared that he had given such a promise to himself and others, and it was on this misrepresentation that orders had been obtained.

His Honour Judge Beresford said defendant could not get over the agreement, and judgment was for the amount claimed, but without costs.—*Western Morning News.*

CARRALL v. NEW BRITISH INCANDESCENT ELECTRIC LAMP COMPANY.

In the Chancery Division, Mr. Justice Byrne had before him on Wednesday in this debenture holder's action a motion for judgment, which came on in default of appearance by the company. The company was formed in 1898 with a capital of £30,000, and it issued debentures for £7,950, of which the plaintiff was the holder of £2,000. The debentures were a charge on all the property of the company, and the plaintiff's moneys had become payable. It was stated that a distress for rent had been put in, and that an order for the appointment of a receiver had been made by Mr. Justice Buckley.

Mr. Justice Byrne made an order in the common form.—*Financial Times.*

H. G. MASSINGHAM, EXETER.

The first meeting of creditors of Henry George Massingham, of 15, Southernhay West, Exeter, managing director of the West of England Boot and Shoe Supply Company, Limited, and lately carrying on business at 23, Victoria-parade, Torquay, as an electrical engineer, was held on Thursday week at the Castle of Exeter, before the official receiver (Mr. T. Andrew). The debtor's statement of affairs showed gross liabilities to the amount of £7,827. 8s. 10d., which are expected to rank at £2,689. 13s. 4d. His assets amount to £311. 11s. 5d., leaving a deficiency of £2,378. 1s. 11d. The causes of failure alleged by the debtor were losses in connection with electric light undertakings, moneys paid for and liabilities incurred on behalf of the West of England Boot and Shoe Supply Company, Limited. After the production of the

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official receiver's statement, the public examination was adjourned until June 20.

CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED, v. FITCH.

A consent order was made this week in the Chancery Court by Mr. Justice Cozens-Hardy for an injunction in this action to restrain the use of a secondary battery in an electric launch on the Thames in breach of the Rhodin patents, of which the plaintiff company have the English rights. The kind of battery is known as the "R plate battery." The defendant had bought the storage battery in ignorance of its being an infringement, or that it was not made by the British proprietors. Mr. Stewart Smith was for the plaintiff company, and Mr. Fitch for the defendant.

COMPANIES' MEETINGS AND REPORTS.

CALLENDER'S CABLE AND CONSTRUCTION.

The annual general meeting of the shareholders of this Company was held at Hamilton House, Victoria-embankment, under the presidency of Mr. Henry Drake.

The Chairman moved the adoption of the report (already published in this journal), and in doing so expressed the hope that the balance-sheet would be regarded by the shareholders as satisfactory. The Company had had a very successful year, and the figures showed a very healthy state of things, considering the much larger business done by the Company. The preference share capital had been doubled, and now stood at £200,000. It might appear, perhaps, to some of the shareholders that the amount carried to reserve (£23 616) was large, but, in view of the extensive business which the Company were doing, he thought that they would agree that the directors ought to be careful. It must also be remembered that as time went on competition became very keen, and the tendency was to make prices closer. The prospects of the Company for the present year were excellent.

Major W. M. Mackenzie seconded the motion, which was adopted unanimously.

A resolution for the payment of the usual dividend on the ordinary shares of 10 per cent. and bonus of 5 per cent., making 15 per cent. in all for the year, having been passed, the proceedings closed.

NEW GENERAL TRACTION.

The annual meeting of the proprietors of this Company was held at the Cannon street Hotel on Tuesday.

Captain Francis Pavy, who presided, stated that the directors had not embarked in any doubtful projects, but had confined the Company's operations within a small compass. They had not sought to get the public to join them in working out large and uncertain schemes, nor had they placed the Company in jeopardy by issuing any large amount of capital bearing a high rate of interest—in fact, they had worked more as a limited partnership than anything else. This was the fifth year of the Company's existence, but only last year was any payment made to the directors, and the present was the first time that any distribution had been proposed on the ordinary shares. He thought that this was evidence of a careful and conservative policy. They had very able experts in the business and they had examined numerous schemes which had been submitted to them, but in the past year they only came across one or two that appeared worth following up. On these they had spent both time and money, and they were considering new business now but in taking new business they must have a chance to live. After paying a dividend of 4 per cent. on the ordinary shares, amounting to £4,800, £41.135 remained to be carried forward, and adding to that sum the general reserve and the reserve against goodwill, they had over £90,000 to their credit undivided. This was on the principle of taking at their par value the shares and the securities which were received in payment for work carried out by the Company. They were only interested in a few undertakings—the Douglas tramways, the Norwich tramways, the Coventry tramways, and tramways at Philadelphia—of the prospects of all of which he spoke hopefully. The directors had not wished to issue further 6 per cent. preference shares, and they had themselves found the money that was required for completing works in hand. This accounted for the large item of "loans secured," £157 000. Their undertakings would now be completed within the next few months, and they had come to the conclusion that it would be best to issue immediately £200,000 of 5 per cent. debentures. In conclusion he moved the adoption of the report and accounts.

The Hon. A. G. Brand, M.P., seconded the motion, which was adopted.

CHISLEHURST ELECTRIC SUPPLY.

Directors: A. Travers Hawes; Edmund Charrington; James Ford; Francis E. Gripper. Secretary and manager: F. S. Hanning, Electricity Works, Chislehurst.

In their report for the year ended Dec. 31, 1900, the directors state that the supply of current during the year has been maintained steadily and uniformly, and has given satisfaction to the consumers. The number of new lamps added has not proved as large as was anticipated, the number having risen from 4,017 8 c.p. at the end of 1899 to 4,987 at the end of 1900. There are already signs of better progress in the present year, and several new installations are being completed. Extensions of mains are also in progress in several directions. After paying the debenture interest and meeting the loss on wiring work which was caused owing to the small amount of business done, there remains £102. 2s. 3½d., which the directors propose to carry forward. Debentures to the extent of £5,000 have been issued to Messrs. Edmundsons' Electricity Corporation during the year on account of the amount due to them under their contract work. Mr. Charrington, one of the directors retires by rotation, and, being eligible, offers himself for re-election.

Dr. Revenue Account.	£	s.	d.
Generation of electricity	762	17	8
Distribution of electricity	95	5	6
Rates and taxes	16	16	10
Insurance	33	15	0
Law and expenses	32	7	0
Management expenses	81	12	7
Total expenditure	1,022	14	7
Balance to net revenue	403	4	0
	£1,425	18	7

Cr.	£	s.	d.
Sale of current at 8d. per B.T.U.	1,388	6	1
Rentals of meters, etc.	37	0	0
Charging accumulators	0	12	6
	£1,425	18	7

General Balance Sheet.

Dr. Liabilities	£	s.	d.
Capital account—amount received	6 611	0	0
Sundry creditors	13 114	1	11
Balance at credit of net revenue account	102	2	3
	£19,827	4	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	18,423	4	10
Stores on hand	6	10	0
Wiring stock on hand	251	3	11
Preliminary expenses	81	19	1
Sundry debtors for current supplied	598	17	2
Sundry debtors for wiring accounts	290	8	9
Other debtors	69	8	6
Unfinished wiring work	33	15	2
Cash at bankers	71	16	9
	£19,827	4	2

Statement of Electricity Received, Sold, etc.

Quantity received in B.T. units		58 539
Quantity sold { By contract	1,402	43,823
Quantity sold { By meter	42,421	
Quantity used on works		5 475
Total quantity accounted for		49 298
Quantity not accounted for		9,241
Maximum supply demanded (kilowatts)		84

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Glasgow.—The Corporation invite tenders for the supply of electricity meters. Tenders by June 10. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for six specimen electric tramcars. Tenders by June 7. Details in our advertisement columns.

Islington.—The Lighting Committee invite tenders for free or assisted wiring. Tenders by June 11. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of branch rubber covered cables. Tenders by June 7. Details in advertisement columns.

Edinburgh.—The Corporation invite tenders for ash-conveying plant, Dewar place station. Tenders by June 15. Details in our advertisement columns.

Dundee.—The Town Council invite tenders for the overhead equipment of Seagate route. Tenders by June 5. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the wiring of the new Council offices. Tenders by June 5. Details in our advertisement columns.

Worksop.—The Urban District Council invite tenders for the supply of 150 electricity meters. Tenders by May 29. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply and delivery of additional steel poles, cast-iron bases, etc. (Contract No. 16), in connection with the electric tramways. Tenders by June 3. Details in our advertisement columns.

Uxbridge.—The Uxbridge and District Electric Supply Company invite tenders for erection of a generating station on land adjoining the Waterloo-road. Specifications, etc., can be obtained from the Secretary's Office, 1, Vine-street. Tenders by June 4.

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Sunderland.—The Corporation invite tenders for the supply of steel plate coal bunkers and overhead gantry. Tenders by May 31. Details in our advertisement columns.

West Stanley (Durham).—Tenders for electric lighting are invited on inspection for new Catholic church, West Stanley. Apply to Rev. J. Thompson. Tenders by June 1

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection of dry-back marine-type boilers. Tenders by June 8. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for the overhead equipment of about five miles of tramways and tramway poles. Tenders by June 7. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of special (permanent way) track work cross-over tracks, etc. Tenders by May 25. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of electrical fittings for the lighting of their Queen's-road car-shed. Tenders by June 4. Details in our advertisement columns.

London, E.C.—The East Indian Railway Company invite tenders for electric overhead travelling cranes, etc. Specification may be seen at the Company's Offices, Nicholas-lane, London, E.C. Tenders by June 12.

Dublin.—The Lighting Committee invite tenders for the supply and erection of motors and motor-generators, accumulators, meters, and works wiring. Tenders by June 3. Details in our advertisement columns.

Islington.—The Lighting Committee invite tenders for the painting of the arc lamp columns and crutches of which 398 are in use in the borough. Tenders by June 11. Details in our advertisement columns.

Dublin.—The Lighting Committee invite tenders for the supply and erection of main switchboards, sub-station switchboards, transformers, arc lamps, and arc lamp pillars. Tenders by June 3. Details in our advertisement columns.

Exeter.—The Town Council invite tenders for erection of the buildings of their new electricity generating station. Specifications, etc., may be obtained from Mr. Donald Cameron, city engineer and surveyor. Tenders by June 14.

Salisbury.—The Urban Sanitary Authority invite tenders for erection of a chimney shaft, 120ft. high and 5ft. internal diameter. Specifications, etc., may be obtained from Mr. Alfred C. Bothams, A.M.I.C.E., Municipal Offices, Salisbury. Tenders by May 25.

Aldershot.—The Urban District Council invite tenders for erection of buildings and shaft in connection with their electric lighting station. Specifications, etc., may be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., surveyor. Tenders by June 4.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the first portion of the Colinton Mains Fever Hospital, the number of lighting points being about 1,550. Tenders by June 12. Details in our advertisement columns.

Exeter.—The Council invite tenders for boiler-house equipment, pipes, etc., engine-room equipment, switchboards, connecting cables, coal bunkers and conveyors, and feed and condensing water tanks. Tenders by June 14. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for steel steam piping, valves, and accessories, at the electric lighting station, Dudhope crescent-road. Specification, etc., may be obtained from Mr. Walter H. Tibbenson, city electrical engineer, Dudhope-crescent-road. Tenders by May 30.

Doncaster.—The Corporation invite tenders for steel grooved girder tramway rails for eight miles of tramways in the borough of Doncaster and adjoining neighbourhood. Particulars may be obtained at the office of the borough surveyor, Mr. W. H. R. Crabtree, M.I.C.E., 3, Priory-place, Doncaster. Tenders by June 3.

Taunton.—The Corporation invite tenders for the construction, supply, and erection of one 250-kw. steam alternator, one 15-kw. motor generator, switchboard extensions, one water-tube boiler, superheater, jet condenser, and air-pump, and sundry pipe extensions. Tenders by June 11. Details in our advertisement columns.

Burnley.—The Electricity Committee invite tenders for (A) five injectors, capable of dealing with 700 gallons per hour; (B) one feed pump, capable of dealing with 3,500 gallons per hour. Specifications, etc., may be obtained on application to Mr. Robt. Birkett, the borough electrical engineer, Aqueduct-street, Burnley. Tenders by June 10.

Madrid.—Tenders are invited by the Spanish Postal and Telegraph Department for the supply of 30,000 zinc cylinders for the service of the Government telegraph stations. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by June 1.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

London, S.W.—Tenders are invited for the supply of 13,400 tons of steel rails and 958 tons of fishplates for the Queensland Railways. Tenders will be received at the Queensland Government Office, 1, Victoria-street, London, S.W., until 2 p.m. on June 11, endorsed "Tender for Steel Rails and Fishplates," and accompanied by a preliminary deposit of 1 per cent. on the tender. Specifications, drawings, etc., may be obtained at the office of the Agent-General for Queensland.

Uganda.—The Crown Agents for the Colonies, acting on behalf of the Uganda Railway Committee, invite tenders for the supply of galvanised iron wire, specification and form of tender for which can be obtained on application to the Crown Agents, at whose office the drawing will be on view between the hours of 10 a.m. and 4 p.m. (Saturday, 10 to 2). Tenders to be delivered, addressed to the Crown Agents for the Colonies, Downing-street, S.W., and endorsed "Tender for Galvanised Iron Wire, Uganda Railway," not later than noon on June 11.

RESULTS OF TENDERS.

Burnley.—The Electricity Committee have accepted the tender of the Oldham Boiler Works Company, Limited, for two Lancashire boilers, 28ft. by 7ft., with fittings, at £700.

Wrexham.—The Town Council have accepted the tender of Whitaker Bros., Limited, Dudley and Wrexham, for supplying and fixing electric calls for the fire brigade, at £62. 10s.

Battersea.—The Electricity Committee recommend that four additional telescopic ladders for use in connection with electric arc lamps be procured of Heathman and Co., at £29. 2s. each.

Woolwich.—The Electricity Committee have accepted the tender of Smith and Sons, South Norwood, at £40 574, for the erection of buildings in connection with electricity works and dust destructor.

Cardiff.—The following tenders have been accepted: J. Williams and Co., Cardiff, refuge pillars; J. Preece, Bristol, brackets; Thornton and Co. and Bergheil and Young, feeder and section pillars; Bock and Marsh and F. Smith, trolley, span, and guard wires; R. W. Blackwell and Co. insulators and line suspensions.

Barrow-in-Furness.—The Corporation have accepted the following tenders: British Insulated Wire Company, Limited, Prescot, paper-insulated lead-covered concentric cables, at £2,742 (approximate); Doulton and Co., earthenware conduits and pipes, at £592 (approximate) and Albion Clay Company, Limited, London, at £178 (approximate); Mavor and Coulson, Limited, Glasgow, balancing transformer and switchboards, at £583 (approximate).

Kingston (Surrey).—The following tenders have been received for the erection of a chimney shaft at the electric works:

F. and F. H. Higgs	£2,900
R. H. B. Neal	2,430
D. Gibb and Co.	2,400
W. Neil and Co.	2,400
H. Windsor and Co.	2,250
Myles and Warner	2,194
Foster Bros.	2,174
J. Pollard	2,076
F. and E. Davey (accepted)	1,989
Alphons Custodis Chimney Construction Company	1,700

BUSINESS NOTES.

TRACTION.

Hindley.—The question of the purchase of the tramways is still under the consideration of the District Council.

New York.—The tramway strike at Albany, referred to in our last issue, has resulted in the company agreeing to the proposals of the strikers.

Private Bills.—In the House of Commons the Tottenham and Hampstead Junction Railway and the Bexley Tramways Bills have been read a third time.

Blackpool.—The new line of electric tramways to Marton is now in working order, and a public service of cars will be put on the road for Whitsuntide.

London United Tramways Bill.—The Hammersmith Borough Council and the Hampton District Council have both sealed petitions against this Bill.

Surrey.—The County Council have approved the form of their agreement with the London United Tramways Company, and the necessary steps are being taken to carry it out.

Helston.—The Rural District Council have given their consent to the application of the Lizard Light Railway Company to work their proposed line to the Lizard by electricity.

Ramsgate.—The electric tramcar service is now reported to be running with improved smoothness and punctuality, and with a happy immunity from the mishaps which caused some local excitement during the opening days.

Moss Side.—The agreement between the Urban District Council and the Manchester Corporation in regard to the construction of tramways in Moss Side has been completed, and the Corporation have promised to begin the work as soon as possible.

Birmingham.—Success is attending the running of the Bristol-road overhead tramway. On Saturday last £109 odd was taken in fares, and this was repeated on Sunday, when the cars travelled for the first time over the Selly Oak extension of the route.

Scarborough.—The Tramways Sub-Committee have resolved to recommend the Council to apply to Parliament for a Bill empowering them to construct electric tramways within the borough, and failing that, to apply for a provisional order to the same end.

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Blackburn.—A heavy loss is reported on the working of the Corporation tramways during the past year, this being attributed to the universal adoption of 1d. fares. The result is an increase of fares by ½d. on most of the sections, and the adoption of 1d. stages is recommended.

Devonport.—Although the whole of the track of the Devonport and District Tramways is practically completed, there are some finishing touches to be carried out, and it is certain that the system cannot be opened for public traffic in time for the Whitsuntide holidays.

Bolton.—The monthly report on the Corporation tramways for April shows receipts £6,440, as against £5,638 the previous month; total mileage, 139,233, as against 146,771; passengers carried, 1,279,969, as against 1,350,730; and receipts per car mile, 11·10, as against 9·20 the previous month.

Barnsley.—The provisional order granted by the Light Railway Commissioners for extensions of the Barnsley and district light railway came up for confirmation at the Board of Trade on Wednesday. There was no objection to the preamble, and the adjustment of clauses was proceeded with.

Middlesex.—In addition to the 15 miles of tramways which they have received permission to construct, the County Council now propose to build lines from Wood Green to Finsbury Park, from Waltham Cross to Finchley and Kilburn, from Acton to Willesden and Hounslow, and several others.

West Cumberland Tramways Bill.—All opposition to this Bill, with the exception of that of the Cleator Moor Urban District Council, has been disposed of, and the Light Railway Bill has been dropped. The tramways proposed are from Cleator Moor, through Whitehaven, Workington, Maryport, Allonby, and ending at Silloth.

Brighton.—The question of granting facilities to the Brighton and Rottingdean Seashore Electric Tramway Company and to Volk's Railway to join the two lines by way of Madeira-road was further discussed at the last Town Council meeting, and the Council resolved to adhere to their original decision in favour of the scheme.

Plymouth.—The question of applying in the next session of Parliament for powers to construct a double line of tramways from the existing lines at Mutley through Alexandra-road to Lipson Vale is being considered by the Tramways Committee. It is estimated that the capital cost of the proposed extension will be about £10,000.

The Manchester-Liverpool Monorail.—The Committee of the House of Lords presided over by Viscount Falkland have passed the Bill authorising the construction of the electric express railway between Liverpool and Manchester, subject to the insertion of a clause to the effect that the centre of gravity shall be below the top of the uppermost rail.

Halifax.—The Tramways Committee have decided to reward tram drivers who show themselves especially efficient by paying them an extra 1s. per week wages. Those who remain five years and upwards in the service of the Corporation are to receive similar recognition. The maximum wage thus far paid to tram drivers in Halifax has been 30s. per week.

Worcester.—The report of the directors of the Worcester Tramways, Limited, for 1900 states that the Worcester and district light railways order has been confirmed by the Board of Trade. The Worcester Tramways Bill has been remodelled, and is now unopposed. The Worcester (extension) light railways order is awaiting the confirmation of the Board of Trade.

Aberdeen.—The Town Council have decided to proceed with the reconstruction as a double line of the tramway in Great Western-road between Forbesfield-road and Ashley-road, and also between Great Western-place and Holburn-street; that the line shall be electrically equipped, and the work carried out by the British Insulated Wire Company at the scheduled prices for the present contract.

Leicester.—The report of Mr. E. Manville on the scheme of tramways for Leicester—the first portion of which is given elsewhere—was presented to the Council by the committee on Tuesday last. A difference of opinion occurred, but after considerable discussion—with the exception of the site of the power station—the report of the committee was adopted. Mr. Manville was appointed consulting engineer for the work.

Tyneside Tramways Bill.—In the House of Commons this Bill has been brought up from the Lords and referred to the Examiner of Standing Order proofs. The object of the Bill is to authorise the construction of tramways and a tramroad in the urban districts of Walker, Wallsend, Willington Quay, and Gosforth in the borough of Tynemouth, and in the parishes of Willington and Longbenton in the county of Northumberland.

Glasgow.—The Town Council have resolved: "That it be an instruction to the Tramways Committee to consider the question of possible demands on the police in the event of accidents to overhead wires on tramway routes, and the equipment of the police for the same, and to report." It was pointed out that equipments in the shape of indiarubber gloves and so forth had been provided in Liverpool, Huddersfield, and other places.

Wolverhampton.—After several delays the Corporation have now commenced the work of laying down their new scheme of tramways for the borough. The first section of the line to be dealt with will run from Tettenhall to Queen-square, *vid* Newhampton-road, and on Monday the chairman of the Tramways Committee, in the presence of a number of members of the Corporation, performed the ceremony of "breaking the ground."

Finchley.—Councillor Todd has been appointed chairman of the Tramways and Electric Lighting Committee of the Urban District Council. At the last meeting of the Council a letter was received from the North Finchley Tradesmen's Association urging the Council to secure the insertion of several clauses in the Finchley and Hendon Tramways Bill, the last of which is that "all telephone wires crossing trolley wires be effectively guarded."

Bradford Corporation Bill.—When this Bill came before the Select Committee of the House of Commons presided over by Mr. Heywood Johnstone on Monday, it was intimated that the opposition of the Shipley District Council was withdrawn to the tramway part of the Bill, it having been agreed to strike out Clause 11, relating to the leasing of tramlines. The Committee then proceeded to adjust clauses, and the Bill will be reported for third reading.

Liverpool.—The tramway receipts from both electric cars and horse vehicles for the fortnight ended May 11 amounted to £17,813. 13s., an increase of £3,204. 15s. 7d. for the same period last year. The miles covered number 402,596, an increase of 78 859. The number of passengers carried was 3,858,523, which showed an increase of 1,041,117 over the same fortnight last year. There are now 287 electric cars in use, and only seven horse vehicles remain on the road.

Gateshead Tramways Bill.—Lord Morley's Committee of the House of Lords which deals with unopposed Bills, had before it on Monday the Gateshead and District Tramways Bill, under which authority is given to raise £80,000 of additional capital with which to complete the system of tramways in Gateshead and district, and which received the sanction of Parliament a year or two since. The measure passed the committee, and will be reported without amendment to the House.

Cardiff.—A conference between several members of the Tramways Committee and representatives of the tramway company has been held on the question of the tramways. The proceedings, which were conducted *in camera*, are said to have been of an exceedingly friendly character, and there is every probability of an arrangement being arrived at if Mr. John Glenn, the engineer to the company, and the borough engineer, Mr. W. Harpur, can come to terms as to the value of the existing lines.

Paisley.—It is anticipated that the Glasgow Corporation will accept the running powers over Paisley and district tramways granted by Lord Camperdown's commission. It appears that a representative of the Corporation attended recently at the office of the Secretary for Scotland in Edinburgh when the clause was being adjusted giving Glasgow these running powers. In the event of that arrangement being carried out, Mr. Murphy has undertaken not to ask for running powers into Glasgow.

Canada's Electric Railways.—According to the latest official statistics issued, during the year ended Dec. 31, 1899, the 612 miles of electric railway track in the Dominion of Canada were so used that the total number of miles run by cars was 20,646,847. The number of passengers carried was 104,033,659. Compared with the previous year, the number of passengers carried increased nearly 9,500,000, and the number of miles run by over a million. The amount of paid-up capital invested in electric railways in Canada is over £4,340,000.

The Proposed Solent Tunnel.—We note that it is proposed to commence operations in September next in connection with the scheme to connect the Isle of Wight with the mainland by means of an electric railway under the Solent. The total length of the new line will be eight miles, but that of the tunnel proper will be no more than 2¼ miles. Of the estimated cost of £550,000, as much as £400,000 will be spent on boring under the Solent. When the project is completed, it is expected to make the journey from London to the Isle of Wight in the record time of 2½ hours.

Sheffield.—The Tramways Committee met on Wednesday to make enquiries regarding the difficulty that occurred the other day owing to the men's threat to strike at a moment's notice. A full enquiry was made into the proceedings of the men the night previous to the strike and on the day when the traffic was disorganised. A number of the men who are supposed to have been the ringleaders were brought before the committee to give an explanation of their conduct. The committee did not arrive at any decision, but we understand that some recommendations will be made to the Council at the next meeting on the subject.

Tube Vibration Claim.—Mr Watney sat at the Surveyors' Institution last week as sole arbitrator to consider a claim of £700 made by the vicar and churchwardens of Christ Church, New Bridge-street, against the Central London Railway for damage to the vicarage alleged to have been caused by the construction of the tube railway. The railway company declined to admit any liability for the damage done to the vicarage. Even supposing the cracks were due to the construction of the tube, the claim, it was submitted, was exorbitant, for the whole damage could be repaired for an amount not exceeding £35. The arbitrator reserved his award.

Wakefield.—The tramway syndicate are already taking steps with a view to extending the existing lines, feeling confident, it is said, that their application for a provisional order will be granted. Immediate application is to be made to the Light Railway Commissioners for sanction to the construction of branch lines connecting Lofthouse with Rothwell and so with Leeds, and also Horbury and Ossett with Bradford. Colonel von Donop, of the Board of Trade, has visited Wakefield for the purpose of officially inspecting the Kirkgate Bridge, which the opponents of the tramways scheme allege cannot be used for tramway traffic in its existing form.

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Newcastle.—The iron posts to carry the electric trolley wires in connection with the new tramways have now been erected on the North-road between the police station and the Blue House, and work is progressing favourably. The City Council have determined, in conjunction with the Walker Council, to oppose the Tyneside Tramways Bill in the House of Commons, in view of the alleged unsatisfactory nature of the decision of the Lords' Committee which found the preamble proved, subject to the undertaking that the promoters would come to Parliament next year to proceed, either by Bill or provisional order, to do in Walker whatever the Corporation of Newcastle had promised to do.

North Lancashire.—According to the local Press, efforts are being made by the large Midland syndicate to buy up the tramways in North Lancashire. The Lancashire and District Tramway Company have had an offer for their Morecambe line, and overtures have also been made for rights to construct electric tramways in the borough of Lancaster, where the Corporation have received sanction for a £70,000 scheme. The syndicate's offer to take over the Corporation's powers has been considered by the Tramways Committee, but it is concluded from what transpired at the meeting that it is very improbable that the Corporation, having made several attempts to municipalise their tramways, will now sell their rights.

Sunderland.—A foot passenger fell in front of an electric car on Saturday, and getting underneath the guard was pushed along some distance. His injuries were serious, his collar-bone being fractured, and several ribs broken, but he is expected to recover. Another extension of the Corporation electric tramways running between the terminus at Roker and Seaside-lane, was approved on Wednesday by Lieut.-Colonel von Donop, of the Board of Trade, and was thrown open to the public the same day. The new line runs along the coast in a northern direction for three-quarters of a mile. The Tramways Sub-Committee have decided to recommend the Corporation not to grant running powers over the borough lines to the British Electric Traction Company, who are about to lay lines between Houghton-le-Spring and other places and Sunderland. They are, however, prepared, we understand, to negotiate with the Electric Traction Company as to through rates for both parcels and passengers.

Clacton.—At a special meeting of the Urban District Council a letter was read from the British Electric Traction Company in reference to their proposal to obtain powers to construct tramways in the town and district. The lines the company would suggest would commence in Great Clacton and run down Pier-avenue to the front. Thence one line would run in a westerly direction to the goods jetty, and another to the north-east along the Parade and Clacton Cliff to Frinton and Walton-on-Naze. The system proposed is the electric overhead trolley. The letter also referred to the electric lighting order the Council have obtained, stating that the company would be prepared to discuss terms, either for the acquisition of such order and carrying out the same, or the taking of the power required for tramways from the Council should they desire to carry out the order themselves. The letter, together with the question of the electric lighting order, was referred to the Council in committee for consideration.

Yarmouth.—At the last Town Council's meeting the Tramways Committee recommended the Council to invite tenders for 14 double-decked cars, the estimated cost of each being £530. It was pointed out, however, that until the Council had decided whether it would work the trams or lease them it was futile to take this course. The matter was then referred back to the committee. The Board of Trade have approved the plans and drawings of the proposed method of construction. In reference to the Gorleston tramways, a letter was read from the British Electric Traction Company, who have become the proprietors of the undertaking, stating that they were desirous of carrying into effect the Yarmouth and Gorleston tramways provisional order of 1897, authorising the equipment of the line for electric traction, which they were empowered to effect with the consent of the Corporation, and which consent they then applied for, and also enquiring upon what terms the Corporation would be willing to supply the necessary energy.

Reading.—The Corporation having failed to come to an amicable settlement with the tramways company as to the price to be paid by the Corporation for the undertaking, Sir Frederick Bramwell, the referee appointed by the Board of Trade, has opened an enquiry into the matter. At the last meeting of the Town Council, Messrs. J. Bowen and I. E. Winslow, the engineers to the Corporation's scheme, reported as to an interview with Colonel von Donop, of the Board of Trade with regard to the proposed doubling of portions of the projected tramways, etc. The question of commencing the construction of the extensions authorised by the provisional order was entered upon, the position in which the Corporation stood being explained, together with the absolute importance of constructing the permanent way and electrical bonding under one contract. Colonel von Donop stated that, all things considered, perhaps the best way out of the difficulty would be to apply to the Board of Trade for a further extension of time. The engineers further state in this report that instead of proceeding with the drawings and specification for the extensions of 1899 only, they are dealing with the whole of the work, and in the course of two or three weeks they will be ready to be laid before the committee for the purpose of advertisement, and that they are convinced that this procedure will prove the more economical plan. The report was adopted, and a memorial to the Board of Trade for a further extension of time was approved.

London Underground Railways.—The Parliamentary Committee on London Underground Railways met again on Tuesday, but before proceeding to take further evidence the chairman (Lord Windsor) expressed on behalf of the committee their very deep regret at the sudden death of Sir Courtenay Boyle. The case of the North-East London Railway was then enquired into. Mr. Jenkin, C.E., stated that in the system proposed no part of the electric circuit was connected with the other. The whole circuit was insulated, and even if the insulation were to break down at one part of the system no danger could possibly occur. It was proposed to have on the North-East London line multiple motors along the train, which would obviate the necessity of a loop at the end of the system and save shunting. There would be ample time for a 2½-minute service. Mr. J. F. Gooday, general manager of the Great Eastern Railway, was examined in opposition to the scheme. The Great Eastern were providing for early morning service trains to carry 850 workmen by increasing the seating capacity of the carriages. They were not prepared immediately to carry out or to go to Parliament with a scheme, but submitted it to the committee in order to show that the question was being considered, and to ask the committee not to pass any scheme that would interfere with their use of the ground under their line. In view of the probable report of the Vibration Committee and the fact that the Central London Railway was not on the right lines, and the proposed North East London Company were not prepared to say what scheme they would adopt, the Great Eastern directors were not ready to recommend their shareholders to find the money for any particular scheme in this Parliament. It was recognised that increased accommodation was required, and the Great Eastern, having practically created the district, ought to provide for it. The scheme which had been considered by the directors, but not formally adopted, was for a line from Chapel End by Low Leyton, under the existing line up to Liverpool street, and then curved round so as to serve the Ilford district and Forest Gate. They would thus duplicate a great deal of their existing suburban lines by the proposed electric underground railway. The committee adjourned until to-day (Friday).

Leeds.—The accounts of the city tramways for the year ended March 25 last show a gross profit of £61,797, and after payment of interest (£16 662) and sinking fund charges (£14,076) there is a surplus of £31,058, as compared with a surplus in the previous year of £6,167. 8s. 6d. The running expenses include £7,038 for depreciation of rolling stock, and in addition to that sum, which has been written off, the Tramway Committee have decided to reserve out of the surplus a further sum of £10,000 to cover the loss sustained by the sale of two old engines at the generating station, which had been replaced by larger units. The surplus, therefore, is reduced to £21,058. 2s. 6d. During the year there has been a great extension in the electric car service, with corresponding advantage to the public and a largely increased income. The receipts from electric traction amount to £133,449, or more than double the income from that source last year, which was £63,436. Horse and steam cars are now being rapidly replaced by electric cars and as was to be expected, the receipts from both those classes of cars are far less than they were 12 months ago. The difference between the receipts and the running expenses for electric traction was £80,834. The total receipts are £183,199, as compared with £129,137 a year ago, an increase of £54,061. The expenditure has increased from £99,110 12 months ago to £121,402, and the sinking-fund charges from £11,809 to £14,075. With regard to car accommodation, the report states that to meet the increased traffic they are at present working the full stock of 130 electric cars. Twenty additional cars will be licensed this week, in readiness for the Whitsuntide holidays; and of the undelivered cars still on order 20 may be expected next month and the remaining 20 during the month of July. The power station is now sufficiently equipped to handle up to 180 cars, with the necessary stand-by of reserve power. The electrical equipment of the Cardigan-road and Victoria-road sections will be completed in about six weeks, and 10 or 12 cars will be needed for this service. Pending the electrical equipment of the Wortley, Armley, and Stanningley sections, now commencing, the management will during this summer have at disposal an ample supply of cars for an increased service to Roundhay. It is therefore decided that the Roundhay Park fare shall be reduced from 3d. to 2d.

London County Council Tramways. — On Tuesday the Highways Committee of the London County Council presented a report on the proposed reconstruction for electrical traction of a further portion of the Council's tramways. The Council has already determined to reconstruct the tramways, rather more than eight miles in length, between Westminster and Tooting, Kennington and Blackfriars, and St. George's-circus and Waterloo-road, and the committee recommended that the tramways to be next dealt with should be those between (1) the junction of Kennington-road with Westminster Bridge-road and St. George's-circus; (2) the Elephant and Castle, and along the New and Old Kent roads, New Cross-road, and Greenwich-road to the terminus at Trafalgar-road, Greenwich; and (3) the Elephant and Castle, *vid* Newington-causeway, to St. George's Church, Borough, and thence *vid* Dover-street to the junction of the New and Old Kent roads. The total length of these tramways is 6 miles 1,317 yards of double (or 13 miles 874 yards of single) track, which is rather less than the length of the Tooting and other lines, in connection therewith, above specified; but the committee were informed that the amount of the traffic per mile on both sections is about the same. The committee have consulted the chief engineer with regard to the steps to be taken with a view to the reconstruction of these other sections of lines being carried out without any unnecessary delay, and, upon his advice, they suggested that, in order that full advantage might be taken of the experience of the various firms of contractors who execute such work, the specifications on which

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tenders were to be invited should be drawn up in such a manner as to allow the parties tendering to include their own details of conduit construction. The interests of the Council would be fully safeguarded by the general conditions which were usually attached to the Council's contracts and the issue of a detailed specification with quantities of the track rails the conductors, and the road-work; but instead of a particular design of yoke and insulator being specified and tenders according to that design only being asked for, parties tendering would be at liberty, if the Council adopted the committee's suggestion, to submit their own designs. The committee were informed that this practice was usual with regard to other kinds of work; indeed, it was adopted by the Council with regard to the tenders recently invited for the supply of the boilers and stokers required for the electricity generating station to be erected at the Camberwell tramways depôt, in which instance working drawings were not issued, but the results desired were clearly specified, and the parties who tendered submitted their own details. Of course, whatever system of electrical traction the Council might eventually decide to adopt for the two sections of its tramways specified above, would, under the London County Tramways Electrical (Powers) Act, 1900, require the approval of the Board of Trade, and the road authorities concerned are entitled to be heard by the Board thereon. The following recommendation was approved: "That the Highways Committee be authorised to prepare specifications and to invite tenders by public advertisement for the reconstruction for electrical traction of those portions of the Council's tramways between (*a*) the junction of Kennington-road with Westminster Bridge-road and St. George's circus; (*b*) the Elephant and Castle, along New and Old Kent roads, New Cross-road, and Greenwich-road, to the terminus at Trafalgar-road, Greenwich; and (*c*) the Elephant and Castle, *vid* Newington-causeway to St. George's Church, Borough, and thence *vid* Dover-street to the junction of New and Old Kent roads; and that the parties tendering be allowed to submit their own designs of the yoke and insulator which they propose to supply." The Select Committee of the House of Commons presided over by Mr. Seale Hayne has decided that the preamble of the London County Council Tramways Bill is proved, but rejected tramway No. 6 (the extension along the Farringdon-road) and the portion of No. 16 between Westminster Bridge road and Waterloo road—that is, the York-road portion of the Westminster and Borough High-street tramway.

LIGHTING AND GENERAL.

Whitehaven.—The Town Council propose to raise the price of current.

Share Market.—Electric shares have kept pretty steady during the week.

Southend.—The Corporation have received sanction to raise a loan for the electric lighting of the town.

Berwick.—Messrs. Edmundsons, Limited, are negotiating for the purchase of the old shipyard for an electric lighting station.

Hornsey.—The Council have received sanction for the inclusion of Clerkenwell Detached in the area to be lighted by electricity.

Gillingham.—The District Council have decided to purchase the undertaking of the electric light works in accordance with the recent agreement.

Haywards Heath.—The Urban District Council are asking the Postmaster General when they might expect telephonic facilities at Haywards Heath.

Quarry Bank.—Messrs. Sidaway, Dunn, Shaw, Tandy, Goodwin, and Turner have been appointed a committee to investigate the question of public lighting.

Swansea.—A committee has been appointed by the County Council to report on the advisability of procuring a license for the municipalisation of telephones.

Rattray.—We understand that at a recent private meeting the Provost broached the subject of the electric lighting of the burgh, but nothing definite was arrived at.

Electric Lighting Orders.—Electric lighting orders have been granted by the Board of Trade to Beverley, Honley, Ripon, Todmorden, Workington, Birstall, and Skipton.

Great Harwood and Rishton.—The District Council consider the charge of 7d. per unit inserted in the Rishton, Great Harwood, and Clayton le Moors electric lighting scheme is much too high.

Western Telegraph Co.—The directors have declared an interim dividend of 3s. per share or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31, payable on June 24.

Bury St. Edmund's.—Mr. L. Paton Greig has been appointed borough electrical engineer in succession to the late Mr. Roe, Mr. Greig having acted as chief assistant since and before the works were started.

Hastings.—Three electric arc lamps are to be erected in Norman-road, in substitution for the gas lamps, at £34. 10s. per lamp. The estimated annual cost of maintaining the lamps is £14. 8s. 2d. per lamp.

Hackney.—The Borough Council are prepared to supply electricity to the Stoke Newington Borough Council on the east side of High-street, Stoke Newington, provided all necessary powers and consents can be obtained.

Cricket.—The annual match, staff *v.* works of Glovers, Limited, was played on the 18th inst. at Trafford Park, and resulted in a victory for the works by 52 runs to 17. A. Horton took seven wickets for two runs for the winners.

Beverley.—The Town Council have asked Messrs. Gibbings and Baker to report what portion of the works should be proceeded with forthwith, and generally as to the best method of carrying out the works authorised by the order.

Kensington.—Electric arc lamps are to be used for lighting the principal thoroughfares in the borough—viz., Kensington High-street, Kensington-road, Brompton road, Holland Park-avenue, and High-street, Notting Hill. The cost of the installation will be £3,900.

Alloa.—Mr. Hogarth (of Messrs. Buchan and Hogarth, electrical engineers, Edinburgh) has reported on the various contracts and tenders in connection with the electric lighting scheme now in course of promotion by the Town Council. He estimates the cost at £8,500

London Gazette.—The estate of W. Haines, 261, Bury New-road, Whitefield, Lancashire, has been released from trusteeship.—A final meeting of the United Telephone Company, Limited (in liquidation) is announced to be held at 5, Moorgate-street, E.C., on June 26 at 2 p.m.

West India and Panama Telegraph Co.—The accounts for the six months ended Dec. 31 last show a credit balance of £3,337, to which has to be added £2,379, being interest on investments and £955 brought forward, making a total of £6 670, which it is proposed to carry forward.

Dumfries.—The Electric Light Committee of the Town Council, in view of the difficulties disclosed by Mr. Ritchie's report, have resolved to recommend the Council not to entertain the idea of a water installation, and an engineer is to be appointed to carry through a steam installation.

Southwark.—The City of London Electric Lighting Company, Limited, have notified their intention to apply to the Board of Trade for a provisional order to empower them to supply electric energy for all purposes throughout the whole area of the metropolitan borough of Southwark.

Guildford.—We understand that there will be no difficulty between the Council and the Guildford Electricity Supply Company with regard to their application to lay mains in certain of the roads in which paving works are proposed to be carried out before such works are commenced.

Cable Communications.—At Wednesday's meeting of the Cable Communications Committee at St. Stephen's House there were present Lord Balfour (chairman), the Marquis of Londonderry, the Earl of Hardwicke, the Earl of Onslow, Major-General Sir J. C. Ardagh, Rear-Admiral R. N. Custance, and Mr. J. H. Lindsay (assistant secretary). Mr. Robert Kaye Gray, of the India Rubber Gutta Percha, and Telegraph Works Company, gave evidence.

London County Council.—The London County Council on Tuesday decided to ask the Board of Trade to promote a Bill providing for the inspection of the lists of share and debenture holders in companies supplying gas, electricity, water, or hydraulic power, or owning docks or wharves, or undertaking tramway, telephone, or other public services in London, an aggressive move to which the investors in these companies will find it easy to reply, apart from the fact that the Government will probably not take the slightest notice of it. The Council have decided to increase the rate of wages for wiremen in the Council's list from 8½d. to 9½d. per hour, and also to lend the Hampstead Borough Council £17,225 for electric lighting purposes.

Stock Exchange.—The Stock Exchange Committee have appointed May 30 special settling day for the General Electric Company (1900), Limited, 18,000 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 7,001 to 25,000, and £150,000 4 per cent first mortgage debenture stock, and have also ordered the said securities to be quoted in the official list. The committee have been asked to appoint a special settling day in the British Electric Traction Company's further issue of 30,000 6 per cent. cumulative preference shares of £10 each, £6 paid, Nos. 160,001 to 190,000; and the West London and Provincial Electric Supply Company's 9 391 ordinary shares of £1 each, fully paid, Nos. 7 501 to 11,425, 12 926 to 15,025, and 16,026 to 19 391, and 33 814 6 per cent. cumulative preference shares of £1 each, fully paid. The committee have also been asked to allow Edmundson's Electricity Corporation's 6 637 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 6,637, to be quoted in the official list.

Grimsby.—The Corporation on Monday adopted a report of Mr. Vignoles, the electrical engineer, stating that in March there were 2 011 lamps connected with the system, which had since increased to 3,000; others now being wired would bring up the number to 3,407. Since then he had heard of a prospective 700 or 800 more lamps. They had power now for 12,000 lamps. The number of houses using the lights was 55 in March and 68 in May. Consumers taking the light numbered seven in February, 40 on March 31, and 54 on May 2. The total units sold for the six weeks ending March 31 was 3 058; and in the four and a half weeks ending May 2 8,432 units, 5,422 of which was for public street lighting. The income for the first period was £92, and for the second £142; whilst the expenditure in the first period was £120, or a loss of £28, and for the second period £116, or a profit of £26. It was agreed to extend the main in Hainton-avenue at a cost of £66, also to grant Mr. Vignoles £50 in consideration of his services to the Corporation and for extra work done before his appointment as borough electrical engineer. A detailed report of the work referred to was presented, stating that the net amount the Corporation were in pocket through this was £115.

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Battersea.—The Baths and Wash-houses Committee propose to purchase electric light fittings, etc., for the new baths and wash-houses, in accordance with the estimate of the electrical engineer—viz., £250—which includes fixing.

Chester.—The Lighting Committee have been authorised to lay distributing mains for incandescent public and private lighting in Queen's-avenue and Lee street, at £50; and for the public lighting of St. John's Churchyard, at £25; also to purchase 1,000 yards of distributing main, at £250.

Cheshunt.—The Urban District Council have decided to postpone further consideration of the provisional order under the Electric Lighting Act, and they will in the meantime make enquiries from other local authorities who have obtained orders, with a view to ascertaining what course they contemplate to adopt.

Admiralty Contract.—The Admiralty are proceeding with the fitting of wireless telegraphy to the ships of the British navy. We are informed that they have adopted the "Apps-Newton" coils as the standard pattern, and have placed a large order with Messrs. Newton and Co., of 3, Fleet street, for coils and transmitters.

Worcester.—Colonel A. G. Durnford has held an enquiry into an application of the City Council for permission to borrow £4,950 for purposes of electric lighting. Mr. C. J. Sutherland, electrical engineer, said this extension would cost £4,450, and the other £500 were required for the instalment of 60 incandescent electric lamps in place of gas lamps.

Sutton Coldfield.—At a special meeting of the Town Council last week, convened for the purpose of receiving a report from the Electric Lighting Committee, and for appointing a resident electric engineer, Mr. Trevor Duesbury (chief assistant engineer at the city of Gloucester electricity works) was unanimously elected to the post. There were 104 applicants.

Islington.—The Guardians have appointed a special committee to consider the advisability of wiring for lighting by electricity the St. John's-road and Cornwallis-road Workhouses. The committee is composed of Messrs. Bryen Fricker, Lambert, Mills, Tomkins, Walkley, and Williams. The Borough Council are about to expend £10,530 on the extension of electric mains.

Dollar.—At the last meeting of the Town Council a communication was read from the Board of Trade enclosing provisional order in favour of Messrs. Crompton and Co as to the electric lighting of Dollar, and asking for the remarks of the Council thereon. The order has now been adjusted, and it was thought that any alterations that had been made were in the way of improving the terms of the original order.

Telegraph Manufacturing Co.—The directors, after providing for depreciation and preference dividend for the year ended March 31 last, and placing £6 500 to reserve, recommend a dividend on the ordinary shares for the half-year ended March 31 at the rate of 12 per cent. per annum, and a bonus of 2 per cent. (which, with the interim dividend paid in December last, is at the rate of 10 per cent. for the year, and a bonus of 2 per cent.), carrying forward £7,500. In addition, the premium, amounting to £20 000, received on the issue of new ordinary shares in 1900, has been placed to reserve fund.

Amalgamation of the Yorkshire Electric Power Companies. When the Select Committee of the House of Commons presided over by Sir William Houldsworth resumed the consideration of the two rival Bills—the Yorkshire Electric Power Bill and the South Yorkshire Electric Power Bill—on Monday, Mr. Pember, K.C., announced that a settlement had been absolutely arrived at between the rival companies. Consequently the South Yorkshire Bill would be withdrawn. The main point of the agreement is that three of the directors of the South Yorkshire Company will join the Board of the Yorkshire Company.

Birmingham.—The report of the Electric Supply Committee, with the accounts and balance sheet for the past year, shows a steady increase in the business of the department, the number of units supplied being three quarters of a million more than last year and the cash receipts £10 500 more. On the trading account there is a profit of £27 233 sufficient to pay interest and sinking fund and to allow of £6,600 being carried to the renewal fund. The purchase of the old general hospital site has been completed, and the committee will at an early date consider the question of utilising it for lighting and tramway purposes.

Coventry.—Mr. Jeckell proposes, in order to get through the next winter's load at a minimum expenditure, that certain alterations be made to the present plant by forming a hot well and making up the feed supply from an evaporator. In addition to this, a new grease extractor and surface condenser will be procured, so as to save coal as well as wear and tear of boilers. Last week the works were thrown open to the members of the Coventry Working-Men's Hospital Saturday Committee at their request. The party was shown over the electricity works and the tramways depôt, the engineers in charge explaining the various items of interest.

Parliament.—In the House of Lords during the past week the following Bills were read a third time: Tyneside Tramways and Tramroads, Wigan Corporation Tramways, etc., Leeds Corporation (General Powers), Birmingham (City) Tramways, and Manchester Corporation. The Alkali, etc., Works Regulation Bill passed through committee. In the House of Commons the following Bills have been read the third time: Dublin St. James's Gate Brewery Tramways, Folkestone Corporation, Shannon Water and Electric Power, Bingley U.D.C., Burton-upon-Trent Corporation, and Derbyshire and Nottinghamshire Electric Power. The following have been read a second time: London United Tramways, Cumberland Electric Tramways, and City and South London Railway.

Penge.—A discussion took place at the last meeting of the District Council with regard to the proposed electric light charges. The Clerk reported that in the draft provisional order the maximum price was scheduled at 6d., but in the agreement entered into by the Council with the Lewisham and District Company it was fixed at 4½d. The following resolution was passed: "That this Council strongly objects to the maximum price mentioned in the fourth schedule of the draft provisional order, and instructs its clerk to make the strongest representation thereon to the Board of Trade with a view to expunging the same, and substituting for such prices fixed by the schedule of the agreement between the company and the Council, and should such representation be ineffectual that counsel be employed to appear and oppose the grant of the provisional order."

Stepney.—The Staff Committee are considering a recommendation from the Electrical Committee that Mr. Wright be appointed consulting electrical engineer to the borough of Stepney at a retaining fee of £800 per annum, subject to the following conditions: (*a*) that Mr. Wright's agreement with the late Whitechapel Board of Works be cancelled; (*b*) that Mr. Wright enters into an agreement with the Council whereby his services will be secured at the remuneration above mentioned for a period of five years from Feb. 14, 1091. It is also proposed to reappoint Mr. W. C. P. Tapper resident engineer. As electrical engineer for Whitechapel, he has been receiving £250 per annum, and it is now recommended that he be appointed borough electrical engineer and manager to the electricity department at a commencing salary of £350 per annum, rising by equal annual increments of £25 to £400 per annum.

Woking.—At the last meeting of the Surrey County Council the following report was adopted: "The General Purposes Committee have had before them a representation on behalf of certain inhabitants of the urban district of Woking with regard to increased representation for, and the lighting by electricity of, the Station and Maybury Wards. The committee do not think it desirable that any alteration should at the present time be made as regards the representation of the various wards, and with regard to the question of electric lighting of such ward, they are of opinion that, in view of the fact that the limit of the borrowing powers of the district is being rapidly reached, it is highly possible that such a scheme as that proposed would involve an expenditure which would prevent the execution of other and more important matters of the district. An intimation to the above effect has been sent to the forwarder of the representation."

Hampstead.—The electric lighting accounts show that the amount of the consumers' accounts during the quarter ended at Lady Day was £11 628. 16s. 9d., as compared with £9 346 1s. 2d. for the corresponding period last year. For the year ended at Lady Day the total amount was £32,003 0s. 9d., as compared with £30 652 10s. 9d. in 1900. The lighting of borough roads is before the Lighting Committee, who are considering a letter from the St. Pancras Borough Council, stating that a scheme had been under consideration for the extension of the public arc lighting throughout that borough, and that a number of lamps proposed to be erected fringed that borough and Hampstead, forwarding tracings showing the proposed positions of the new arc lamps, from Savernake-road to Rochford-street, and from Crogsland-road to Primrose Hill-road, and making alternative suggestions for the erection and lighting of such lamps by the two boroughs concerned.

New Issue.—An issue of £100,000 6 per cent. first mortgage debenture stock repayable at £110 on Jan. 1, 1933 is announced by the Kettle River Power Company, Limited, which has a share capital of £220,000. The objects, *inter alia*, of the Cascade Water Power and Light Company (to develop the concession, etc., of which company the Kettle River Company was formed) were to utilise the Cascade Falls of the Kettle River for the purpose of generating and supplying electricity for power, light, and heat in a 40-mile radius from Grand Forks City, Rossland, Cascade, Grand Forks, Phœnix, Anaconda, etc., and also the mines and smelters of both the Rossland and Boundary districts situated in the radius. The prospectus states that the directors intend to commence with the installation of 2,000 h.p., which is estimated to cost about £90,000. At present practically the whole of the local works, including the dam, are reported to have been completed at a cost of about £23 000.

Walsall.—The total number of consumers supplied on April 30 last was 185. The total units generated at the station during the month of April was 32 373. The total output from the main generators was 31 014 units. The total units from the transformers was 23 696. The total units registered on the motors was 29 657. The machinery has been run for 451 hours during the past month. The price of electric current was discussed at the last meeting of the Town Council, and it was stated that it might vary from 6d. to 1¾d. per unit. They had two systems of charging—one for electric light, and another for power. For lighting the charge was 6d. per unit for 1½ hours a day, and 2d. per unit for all other units. The charge for power was 2½d. per unit, and after the first four hours 1d., so that if it was used for eight or twelve hours the price would come down to 1¾d. per unit for power. The price for lighting purposes, if used for a considerable time, might come down to under 3d. per unit.

Lowestoft.—Mr. W. O. E. Meade-King has held an enquiry into the Town Council's application for sanction to borrow a further £20,000 for electric lighting purposes. The Town Clerk explained that the money was required for extensions of mains and plant,

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and prospective extensions of public lighting; some alterations to the electric light buildings, in order to strengthen the foundations, owing to a settlement; and for some extra work in crossing the harbour, made necessary by the requirements of the railway company. Since this application had been made the Town Council had decided to adopt a scheme to extend the electric light to the whole of the borough. The matter had been before the public, and there had been no opposition to the proposed scheme, which would cost about £10,000. Mr. Hawtayne explained that they proposed to extend the mains for public street-lighting to all parts of the town, and that was estimated at £10,483. Some of that work had been done. The increased plant they desired to secure would practically double the capabilities of output.

Radcliffe.—At the last meeting of the District Council the Clerk reported a statement made to him by the manager of the Lancashire Electric Power Company to the effect that the prices stated in the company's circular were 20 per cent. lower than the maximum price named in the Act; that the company could not make any alteration in the price named therein; and that the directors hoped to be in a position to supply power by Jan. 1, 1903. Messrs. W. Allen, Smith, and Yates were appointed a sub-committee to confer and generally decide upon any action to be taken, and from time to time to give necessary instructions upon and with reference to the prosecution of the Council's opposition to the South Lancashire Tramways Bill now before Parliament. The amended draft agreement between the Council and Messrs. Lacey, Clirehugh, and Sillar was referred to Mr. Clayton. Messrs. W. Allen, Hardman, Lund, and Yates were appointed a sub-committee to consider matters relative to the position, construction, and the general arrangement of the buildings required for the electricity undertaking.

Leeds—Following the gratifying statement concerning the Leeds Corporation tramways, says the *Yorkshire Post*, comes the yearly return of income and expenditure with reference to the electric lighting undertaking, which was municipalised in December of 1898. The figures are not so large as those relating to the tramways, but in view of the coal difficulty, they are considered satisfactory by the committee, who met on Tuesday, under the chairmanship of Mr. J. Green Hirst. The receipts for the year amount to £43,669. 2s. 6d., and the expenditure (including the payment of interest) to £29,154. 16s. 4d., leaving a net profit of £14,514. 5s. 10d. From this sum, however, £7 632. 15s. 2d. has been deducted in respect of sinking fund, so that the surplus of income over expenditure and provision for the future is really £6,881. 10s. 8d. Last year's surplus was £8,500. The difference of £1,621 between the two sums has gone to the coalowners. If it had not been for the high price of coal during the year, the committee would have had a surplus of over £9 000. There are about 2,000 consumers of electricity on the books of the Corporation.

Glasgow.—The following revised scale of charges has been adopted by the Corporation for the year 1901-1902:—For lighting: (1) shops, warehouses, offices, and all other premises, except those specified under heads (2), (3) and (4), to be charged on the demand indicator system, at the rate of 6d. per Board of Trade unit for the first 365 hours' use per annum of the maximum demand, and for all current consumed over this quantity 1d. per unit for 250-volt supplies, 1½d. per unit for 200-volt supplies, and 2d. per unit for 100-volt supplies. (2) Domestic consumers: a uniform charge of 3½d. per unit for 250-volt supplies, and 4d. per unit for 200 and 100-volt supplies. (3) Theatres, halls, and other places of entertainment: a uniform charge of 3½d. per unit. (4) Churches: a uniform charge of 3d. per unit. For motive power: a uniform charge of 1½d. per unit for 250 and 500 volt supplies, and 2d. per unit for 200-volt supplies, subject to such conditions as it may be necessary to enforce for the proper protection of the Corporation. It is not proposed to make any alteration on the rates charged for the current supplied under existing special agreements and for the public street lamps.

New Agencies.—We have been asked to state that the agency which has been held at different times by Messrs. Polland and Co., and also by the Union Cable Company, Limited, for the articles manufactured by the Elektrotechnische Institut, Frankfurt, has now passed solely into the hands of Mr. G. Braulik, and all orders for this firm's manufactures should be addressed to him at 218, Upper Thames-street, where a stock will be kept of Beez pocket volt and ammeters and other specialities of this firm.—We are informed that Messrs. De Grelle, Houdret, and Co., electrical and mechanical engineers, 130, London-wall, E.C., have been appointed sole representatives in Great Britain for the Braunschweigische Maschinenbau-Anstalt for the sale of their dynamos motors, and other electrical manufactures. We have received a list of the standard types of direct current dynamos and motors for belt driving manufactured by Braunschweigische Maschinenbau-Anstalt, and we note that a stock of the open and enclosed type machines will be kept in London ready for immediate delivery, and that most of the sizes may be had in three or four weeks from date of order. Messrs. De Grelle, Houdret, and Co. will supply the trade only.

Colchester.—Mr. W. O. E. Meade-King has held an enquiry into the application of the Council for sanction to borrow sums amounting to £15,900 for purposes of electric lighting. Mr. A. R. Sillar, the electrical engineer, explained that £1,970. 5s. would be required for alterations to machinery necessary upon the proposed doubling of the voltage. The extension was necessary, because they had already a great many more consumers than were anticipated; the change of voltage was necessary because last winter, during a heavy load, the loss was found to be 7½ per cent. They were also to have electric tramways, and for those they would require an increase of power. It was intended to increase the number of accumulators, to rewind two motors, and make alterations necessary for the higher voltage, etc. The rest would be for generating station extensions, building an underground water-feeder, purchasing new engine, feeder for the new barracks (£1,260), etc. The second item of £3,900 was for the purchase of the Osborne-street property adjacent to the electric light station, although the whole amount would not be immediately required. Without a portion of it, however, they could not make the necessary alterations. Mr. H. Goodyear, the borough surveyor, said the buildings alone were worth £2,000.

Cardiff.—The last report of Mr. A. Ellis shows that there are now 401 customers, with a consumption equivalent to 40,022 8-c.p. lamps (an increase of 45 per cent. on the number in the corresponding month of last year). During the month 2,668 8-c.p. lamps were connected. The number of units generated during the month was 72 579, an increase of 47 per cent. The calculated income for the month was £160. 12s. 6d. for street-lighting and £557. 11s. 6d. for private lighting, a total of £718. 4s. (against £514 last year, an increase of 39 per cent.). Messrs. Thomas Owen and Co., Limited, of Ely Paper Works, have decided to accept current from the Corporation, which will increase the income of the department to the extent of between £400 and £600 a year. Mr. Ellis stated on Tuesday that the estimated revenue for the year ending March 31 last was £9,969, while the actual revenue was £11 670. It had been reported that last year they had sustained a loss of £1,000. The loss for the year ended March 31, 1900, was £1,700. For the year ended March 31, 1901, the loss was about £300. In each case, however, it was after paying out between £5,000 and £6 000 on the capital and interest repayment account. In view of that they really made a profit last year, and were working at a profit at the present time.

Croydon.—Under the original lighting scheme of the Council 61 rectified arc lamps were installed. It has now been found, however, advisable to extend this system, but the recent additions are enclosed arc lamps, especially of the Lewis type, and these have been found to be a great success. There are already 152 of this type of lamp in various parts of the town, and as soon as the new tramway track is completed the whole route from Norbury to Purley (a distance of about six miles) will be lighted by these lamps at a distance of 60 yards apart. Considering the conditions under which the supply of electricity is being carried on, and the heavily-handicapped state in which it is working, due to the very large capital outlay required to reach the outlying districts, and, therefore, heavy sinking fund and interest, it is generally considered that the financial results of the past three years' working are very satisfactory. It is, of course, impossible to give at present the final correct profits for the year ending March 25, 1901, but the following figures will approximately show the result of the past year's working: cost of production, 1 536d. per unit; average price charged to consumers 4·44d. per unit; gross profits, £8,390. Current for lighting purposes is generated at 2,000 volts and transformed down to 200 volts at sub-stations, at which pressure it is delivered to customers.

Sell's World's Press, 1901.—The publishers, in presenting their "coming-of-age number," state that practically the whole book was burnt in January last in the disastrous fire in Pentonville; hence the delay in publication. Articles on the last century's newspapers and British journalism of 100 years ago take up a considerable portion of the first portion. The article "Journalism and the South African War," accompanied as it is by portraits of upwards of 20 of the leading war correspondents and the effect of the war on the newspaper world generally, will be found of more than usual interest, though it might have been more complete, for we miss amongst the portraits of Colonial scribes one Donald Macdonald, the representative of the *Argus*, the leading Australian daily, and the author of *the* book on "The Siege of Ladysmith." There are also many other articles in connection with the papers published in British possessions dealing with imports and exports, and their influence upon the trade of the British Empire, together with portraits, diagrams, maps, etc. Short summaries are given of each foreign country in regard to their various industries, chief physical features, productions, etc. The tariff charges of America and Canada will be valuable to business men as well as to journalists. The lists of papers, magazine lists, and class newspapers, which have been revised up to date, are easy of reference.

Southend Elevator.—We have already referred to the negotiations by the Highways Committee with the Reno Inclined Elevator Construction Syndicate for the construction of an elevator from the esplanade to the cliffs The Town Council have now agreed, on the suggestion of that syndicate, that a license be granted to Mr. W. H. Aston, of Eagle Wharf-road, for the construction of a Reno inclined elevator for the purpose of conveying persons from the lower esplanade to the top of the cliffs, and that the site be on the strip of land immediately adjoining the west side of the steps leading to the Jubilee jetty; the license to be for 10 years; the licensee to pay to the Corporation a royalty of 20 per cent. of the gross takings, with a minimum rent or royalty of £125 per annum; the elevator to be run daily in each year from Good Friday to the end of October, between the hours of 10 a.m. and 10 p.m., and at such additional times as the licensee may desire; the charge for each person to be 1d.; the licensee to take from the Corporation electric energy for working the elevator, and pay therefor at the rate of 3d. per unit; the Corporation to have the right of purchasing the elevator at the end of the third year of the term for the sum of £3,250, at the end of the seventh year for the sum of £2,250, and at the end of the tenth year for the sum of £1,500; the Corporation to be at liberty to determine the license upon breach by the licensee of any of the terms or conditions of the license.

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PROVISIONAL PATENTS, 1901.

MAY 13.

9840. Improvements in meter interrupters for use with induction coils. Herbert Charles Newton, 3, Fleet-street, London.

9844. An electrical transmission dynamometer and tachometer. Charles Vickery Drysdale, Clairville, Hadley-road, New Barnet.

9865. Improvements in apparatus for opening and closing electrical circuits. Joseph Devonport Finney Andrews, 75, Fulham Park-gardens, London.

9882. Improvements in and relating to electric arc lamps. George Munroe Lane, 36, Chancery-lane, London. (Complete specification.)

9915. Improvements in or connected with electric motors. Walter Herbert Flood and Alfred Edward Honey, 4, South-street, Finsbury, London.

9916. Improvements in collecting brushes and holders for dynamo-electric machines. Walter Herbert Flood and Alfred Edward Honey, 4, South-street, Finsbury, London.

9925. Improvements in the working of induction coils and other apparatus with alternating and pulsating currents. Herbert Charles Newton and Russell Stuart Wright, 3, Fleet-street, London.

9926. Improvements in and relating to transmission dynamometers. Ernest George Coker, Engineering Building, McGill University, Montreal, Quebec, Canada.

MAY 14.

9927. Improvements in or relating to the deposition of metals or compounds. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

9929. The electric revolving brush. Alfred Ernest Thomas and Joseph Buckley, 6, Exchange-chambers, Birmingham.

9933. Improvements in or connected with trolley arms and in attaching same to the outside covers of electric tramcars. Charles Henry Wilkinson, Market-place, Huddersfield.

9959. Improvement in incandescent electric lamp globes. Ernest Böhm, 99, Cannon-street, London.

9962. Improvements in or relating to the pole-pieces of dynamos and other magneto-electric machines. Albert Stockton and Sidney Harper Heywood, 70, Deansgate, Manchester.

9967. Improvements in electric cables. John Dunckley Gould, 53, Chancery-lane, London. (Complete specification.)

9993. An improvement in electrical lighting as applied to advertisements and the like. William Oscar Jennings, 19, Surrey-street, Strand, London.

10010. A new form of standard electric resistances for small and large current strengths. Hans von Kramer and Francis Greenwich Sharp, 115, Stirling-road, Glasgow.

MAY 15.

10053. An improved trolley wheel for overhead wire systems of electric traction. Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, Lloyd's Bank-buildings, Bristol.

10062. Improvements in moving-coil electrical measuring instruments. August Eckstein and Frank Panter, Peel Works, Adelphi, Salford, Manchester.

10063. An appliance preventing trolley wheel from leaving overhead wire in electric traction. Matthew Fitzmaurice Tilson Deane, 32, Garville-avenue, Rathgar, Dublin.

10080. Improvements in or connected with apparatus for wireless telegraphy. Henry Richard Belcher Hickman, 33, Chancery-lane, London.

10088. Improved apparatus for treating affected parts of the body with heat, light, or electricity, in certain cases simultaneously. Ignaz Timar, 55, Chancery-lane, London. (Complete specification.)

10102. Improvements in electrical switches. Evered and Co., Limited, and Charles Holt, 7, Staple-inn, London.

10120. Improvements in electric telegraphy. Alexander Muirhead, 323, High Holborn, London.

MAY 16.

10130. Improvements in life guards for electric tramcars or similar vehicles. Thomas John Kendrew, 8, Lombard-chambers, Bixteth-street, Liverpool.

10166. Improvements in printing telegraph receivers. Alfred Julius Boult, 111, Hatton-garden, London. (The Joy Printing Telegraph Company, United States.) (Complete specification.)

10188. Improvements in electric indicators for use in sectional telephone circuits. Charles Mark Jacobs, 70, Chancery-lane, London.

10191. Improvements in, and in apparatus for, the manufacture of the plates of electric accumulators. Arsène d'Arsonval and Georges Vaugeois, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 27, 1900, being date of application in France.)

10202. Improvements in safety devices for electric tramcars and other motor-driven vehicles. Alexander Rutherford, jun., 6, Lord-street, Liverpool.

10206. Improvements in electric railway systems. Baptistin Cruvellier, 72, Cannon-street, London. (Complete specification.)

10215. Improvements in and connected with casings or coverings for electric conductors in buildings Joseph Henry Golding and Charles Alfred James, 47, Lincoln's-inn-fields, London.

MAY 17.

10228. A new or improved combined system of electric lighting and fire alarms, and appliances connected therewith. Charles Cartwright Metcalf, 50, Oldfield-road, Sale, Cheshire. (Harry Cecil Blackwell, Russia.)

10238 Safety device for overhead electric wires (The Littler and Creary). John William Littler and Robert Wilson Creary, 62, Navigation-road, Broadheath, Cheshire.

10249. Improvements in or relating to electrical ignition apparatus for internal-combustion motors. Charles Alexander Hamilton, 18, Hertford-street, Coventry.

10250. An improved safety device for preventing the breakage of telegraph and telephone wires and the like. Edward William Martland, 5, John Dalton-street, Manchester.

10275 Improvements in controlling electric motors. The British Thomson Houston Company, Limited, Bush-lane House, Cannon-street, London. Maxwell W. Day, United States.) (Complete specification.)

10295. Improvements in electrically-operated desk-fans. Car Schwabe, 6, Lord-street, Liverpool.

MAY 18.

10345. Improved method of and means for forming joints on or connecting electric wires. James Lightfoot and Charles Monkman, 8, Quality-court, Chancery-lane, London.

10357. An improvement in electric conductors. Siemens Bros. and Co., Limited, and Frank Jacob, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

10374. Improvements in or relating to step-by-step telegraphic apparatus. William Morris Mordey and Walter Samuel Steljes, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 8.

1900.

8779. Electric switches and fuses. James Whitcher, Arthur Henry Lea, and Daniel John Evans, and Edward Paul Toller (executors of the late Cecil Herbert Warren).

9492. Ceiling roses and other similar electrical connections. Douglas.

9534. Method of starting and regulating multiphase-current motors. Boucherot.

10542. Electric couplings. Oppenheimer. (Actiengesellschaft Mix und Genest.)

10545. Switches or keys for electric lamp-holders. Oppenheimer. (Actiengesellschaft Mix und Genest.)

12716. Electric switches. Dale.

12743. Method of and apparatus for the local application of electrical treatment to the human body. Behrendt.

12827. Electrical switches. Bartlett and Robinson.

12944. Electrical switch. Clayton, Bell, and Berry.

12973. Indicator for high electrical tensions. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

13014. Fuses or cut-outs for high voltage circuits. Oppenheimer. (Actiengesellschaft Mix und Genest.)

13015. Insulated bases for switches. Oppenheimer. (Actiengesellschaft Mix und Genest.)

14409. Electric meters. Harris.

15642. Electric incandescent lamps. Hollub and Mignal.

23675. Process and apparatus for obtaining electric current. Britzke.

1901.

2659. Electric arc lamps. Helios Upton Company and Spencer.

3192. Electric furnaces. Jurie.

7150. Electromagnet motor. Englehardt, McNelly, and Gallert.

7547. Incandescence electric lamps. Lake. (Smithers.)

7783. Controllers for electric motors. British Thomson-Houston Company, Limited. (Potter.)

7834. Insulators for electric conductors. Bennet and Johansson.

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7955. Means or arrangements for regulating the excitation of alternating-current machines. Blathy.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	—	—	—	—	—	—
Birmingham Trams	May 18	4,669	4,611	+ 58	82,784	—
Blackburn Corp'rat'n	,, 17	539	439	+ 100	8,851	7,889b
Blackpool Corporatn.	,, 16	415	271	+ 144	3 032	2,462
Blackpool-Fleetwood	,, 18	413	526	- 113	4,698	5 110
Bolton Corporation..	,, 19	1,428	1,230	+ 198	27,109	18,183
Bradford City Trams	,, 19	955	453	+ 542	11,598	7,564
Bristol Tramways Co.	,, 17	4,430	2,764	+1,666	—	—
Carlisle Tr'mw'ys Co	—	—	—	—	—	—
Central London Ry.	,, 18	6,398	—	—	123 935	—
City & South London	,, 19	1,902	1,339	+ 563	39,633	24,965
Cork E. T. and L. Co.	,, 16	558	484	+ 74	7,593	6 680
Darwen Corporation	,, 17	200	157	+ 49	4,528	3,823
Dover Tramways	,, 18	188	173	+ 15	3 456	3,194
Dublin & Lucan E.R	,, 18	121	111	+ 10	1,707	1,584
Dublin U.T., elec. cars	,, 17	3 776	3,247	+ 529	—	—
Dublin S.D. Electric	,, 17	912	759	+ 153	—	—
Dundee Tram Co. ...	,, 15	678	391	+ 287	—	—
Glasgow Corporation	,, 18 1	1,441	9.714	+1,727	—	—
Halifax Corporation	—	—	—	—	—	—
Huddersfield Corp'n.	,, 18	839	625	+ 214	4,815	4,750
Hull Corporat'n E.S.	,, 18	1 600	1 097	+ 503	67 803	33,417
Liverpool Corporat'n	,, 11	8 850	7,144	+1 706	155 092	132,425
Liverpool Overhead	,, 19	1.644	1,476	+ 168	30,811	28,228
Portsmouth Corpn...	,, 18	527	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	,, 19	3 620	—	—	—	—
Southampton Trams	,, 16	760	430	+ 330	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—
Wolverhampt'nC'p'n	,, 19	195	164	+ 31	—	—

b Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £464 decrease.

Barcelona Ensanche y Gracia, £165 decrease.* Barcelona, £1 070 decrease.

Brisbane, £447 increase

Buenos Ayres and Belgrano Electric, £301 increase.

Calcutta, £233 increase.

Cape Town (month of February), receipts, £13,463; expenditure, £6,004.

Mexico Electric (month of April), receipts, £17,500; expenditure, £10,000.

Perth Electric, £305 increase.

Port Elizabeth (month of February), receipts, £3 043; expenditure, £1,803.

* Traffic resumed May 11.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum Pref, Nos. 1-70,000	1 ..	⅞ ⅞
Atlas Electricity Meter, 6 p c Cum Pref Shares, 1-120,000	1 —	11/16-13/16
British Electric Works, Ordinary 50,001-96,000	1 ..	1/16-3/16
—— 6 per cent Cum. Pref., 1-50,000	1 —	3/16-5/16
—— 4½ per cent First Mortgage Debentures	100 —	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	10-11
—— 6 per cent. Cum. Pref 1-40,000	5 ..	5⅞-6¼
—— 5 per cent Mortgage Debentures	100 —	100-102
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 —	4½-4¾ xd
Brush Electrical Engineering, Ordinary	2 —	1⅝-1¾
—— Non. Cum., 6 per cent. Pref	2 —	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 ..	101-104
Callender's Cable, Debentures	100 —	109-113
—— Ordinary	5 —	14½-15½
—— 5 per cent. Pref.	5 —	5½-6
Crompton and Co.	5 —	8¼ 8
—— 5 per cent. Debentures	— —	101-104
Edison and Swan United, Ordinary	2 —	1-1⅛
—— 5 per cent. Debentures	5 —	2⅝-2¾
—— 4 per cent. Deb. Stock, Red	100 —	87-89
—— 5 per cent, Second Deb. Stk., Prov. Crts.	— —	94 98
Electric Construction, Limited, Nos 1 to 112,100	2 —	1⅞-2⅛
—— 7 per cent. Cumulative Pref	2 —	2⅛-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	101-104
Giffre Electro-Chemical and Power, Ord, 80,001-130,000	1 ..	0⅛
W. T. Henley's Telegraph Works, Ordinary	5 —	15½-16½
—— 4½ per cent. Preference	5 —	5¾-6
—— 4½ per cent. Debentures	100 —	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 —	21-22
—— 4 per cent. Debentures	100 —	101-104
Telegraph Construction and Maintenance	12 —	35-39
—— 5 per cent. Bonds	100 —	102-105
Telegraph Manufacturing, Ordinary	5 —	10½-11½
—— 5 per cent. Cum. Pref.	5 —	5¾-6
Willans and Robinson, Ordinary, 1-30,000	5 —	10-11
—— 6 per cent. Cum. Pref., 30,001-60,000	5 —	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 —	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 —	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75 —	70-75
Bournemouth and Poole, Ordinary	10 —	11½-12½
—— 4½ per cent. Cum. Pref.	10 —	10-11
—— Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 —	7⅜-8⅛
—— 7 per cent. Preference	5 —	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 —	7-7⅛ xd
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 —	5-5½
Chelsea Electricity Supply	5 —	5⅜-6⅛
—— 4½ per cent. Debentures	100 —	109-112
City of London, Ordinary	10 ..	9½-9⅝
—— 6 per cent. Cumulative Pref.	10 —	12-13
—— 5 per cent. Debenture Stock	100 —	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	— —	101-103
County of London and Brush Provincial, Ordinary	10 —	8-9
—— 6 per cent. Cum. Pref.	10 —	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 —	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 —	5½-5⅝
—— 6 per cent. Cum. Pref.	5 —	5¾ 6
—— 4½ per cent. First Mort. Deb.	100 —	103-106
Electric Lt. & Tracto. Co. of Aust., Ld., 6 p c, Cm. Pf., 1-20,000	5 ..	4⅞-5⅛
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5-5½
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	102-105
Kensington and Knightsbridge and Notting Hill	100 —	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9⅜-10½
London Electric, Ordinary	2 —	1½-1⅝
—— 6 per cent. Pref.	5 —	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	98-101
Metropolitan, Ordinary	10 —	12-14
—— ,, 85,001-98,769	5 —	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100 —	110-113
—— 3½ per cent. Mortgage Debenture, Red	100 —	96-99
Notting Hill Electric Lighting	10 —	15½-16½
Oriental, 1879	1 ..	1⅝-1⅞
—— £5 Shares	5 —	7-7⅛
—— £4½ Shares, New	4½ —	5⅜-5½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 —	5¼-5⅜
River Plate Electric Light and Traction, Deb.	100 —	65-75
Royal Electrical Company of Montreal	$100 —	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 —	2-2½
—— 4 per cent. Debenture Stock	100 ..	89-90
South London, Ordinary	5 —	2½-2⅝
St. James's and Pall Mall, Ordinary, 101-20,080	5 —	14-15
—— 7 per cent. Pref.	5 —	8½-9½
—— 3½ per cent. Deb.	100 —	98-101
Westminster, Ordinary	5 —	12-13
Electric Railways.—		
Central London, Ordinary	10 —	9½-10
—— Pref. Half-Shares	5 —	4¾-5
—— ,, ,, deferred	5 —	4½-5⅛
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 —	52-54
—— Ordinary	10 —	5-5½
—— 4 per cent. Debenture Stock	100 —	111-113 xd
—— 5 per cent. Pref. Stock '91	100 —	122-127
—— ,, ,, ,, '96	100 —	122-127
Liverpool Overhead, 5 per cent. Pref.	— —	12-12½
—— Ordinary, 1-50,000	— ..	7⅝-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,760	— ..	102-104
Waterloo and City, Ordinary	100 —	94-97
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3⅞-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 —	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-2⅜
—— 5 per cent. Cum Pref., Nos. 1-75,000	5 ..	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	94-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 —	6½-7
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-10 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40 ..	99-101 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 —	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 —	130-133
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	1½-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 —	104-107
—— Prov. Cert., all paid	100 —	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1 —	1⅛-1⅜
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 —	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	103-105
New General Traction, Ordinary	5 —	3½-3⅝
—— 6 per cent. Cum. Pref.	10 —	4¾-5 xd
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 —	11¾-12⅛
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	11-12
—— 5 per cent. Cum Pref., 1-20,000	10 —	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-107 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £51,132 6 per cent Preference	6s. —	5/16
—— £50,000 ,, ,,	1 —	1
—— £500,000 4½ per cent. Debenture Stock	33½ ..	33½
Telephones.—		
National Telephone, Ordinary	5 —	3¾-3¾
—— 6 per cent. Cum. First Pref.	10 —	10-12
—— 6 per cent. Cum. Second Pref	10 —	10-12
—— 5 per cent. Non. Cum. Third Pref.	5 —	4¼-4⅜
—— per cent. Deb. Stock, Red.	100 —	98-99
—— ¾ per cent. Deb. Stock, Red.	100 —	87-90
Oriental Telephone and Electric Company	1 —	¾-1

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NOTES.

Book Received.—From Messrs. Longmans, Green, and Co., of Paternoster-row, E.C., we have received a copy of Mr. Wm. J. Hopkins's latest work on "Telephone Lines and their Properties." The book is published at 6s.

Electrical Engineers Volunteers.—The ceremony of opening the headquarters of the corps of Electrical Engineers (R.E.) Volunteers, of which the Right Hon. Lord Kelvin is hon. colonel, will take place to-morrow (Saturday) afternoon at four o'clock. The new headquarters are situate in Regency-street, Westminster.

Personal.—At a committee meeting of the Crawford Municipal Technical Institute, Cork, Mr. Edward A. O'Keeffe was unanimously elected to the post of head science master and organising secretary from 48 applicants. He is best known in connection with Finsbury Technical College, where he spent many years as senior demonstrator in the department of electrical engineering and applied science under Prof. Silvanus P. Thompson.

New Anglo-German Cable.—The landing of a new submarine cable between England and Germany at Bacton, on the Norfolk coast, has been successfully accomplished. The German cable ship "Von Podbielski" was engaged on the work, and having safely landed the English end of the line she left for Germany, paying out as she went. This makes three cables between Bacton and Emden, by way of Borkum Island, and brings up the number of wires to 12. The two former cables, laid in 1891 and 1896, were installed by English telegraphic staffs. This last addition was laid by the Norddeutsche Sea Cable Company of Emden.

American Institute's Transactions.—We have to acknowledge the receipt of the *Transactions* of the American Institute of Electrical Engineers for April last. This issue contains papers on "The Distribution and Conversion of Received Currents," by Mr. H. G. Stott; "The Transformer for Measuring Large Direct Currents," by Mr. H. J. Ryan; and "Electricity in Mountain Mines," by Mr. F. W. Brady. It also gives the discussions on two other papers—viz., "Floy on the St. Croix Plant" and "Behrend on Mechanical Forces in Dynamos." The proposed constitution of the institute is set out at the end of the volume.

Underground Moving Platforms. — The great success which attended the working of the moving platform operated by Westinghouse motors at the Paris Exhibition, has led the Paris authorities to consider the installation of another electrically-controlled moving platform. The novel feature of this installation, if it be ultimately decided upon, is that it will be built underground. The proposed track is to run under the Avenue de l'Opera, the Boulevards, Boulevard Sebastopol, Rue Turbigo, and Rue de Rivoli, a distance of just upon seven miles. The line is to consist of four platforms; the first will be stationary, the second will move at a speed of about three miles an hour, and the third and fourth at the rate of about six or eight miles an hour respectively.

Medical Exhibition.—The Medical Exhibition which was opened this week at the Queen's Hall, Langham-place, under the auspices of the Medical, Surgical, and Hygienic Exhibitors' Association, is the fifth of its kind, and may now be regarded as a well-established annual fixture. The latest developments of surgical instruments and appliances, hospital fittings, etc., are to be seen here, affording an excellent opportunity of comparison between the numerous specialities of the different firms exhibiting. Among the many interesting exhibits we noticed in particular the complete equipment of Röntgen coils and apparatus as fitted on board the "Princess of Wales" hospital ship and in the Yeomanry and Scottish Red Cross hospitals. This secured especial attention. The exhibition, which closes its doors to the public this (Friday) evening, has proved at least as successful as any of its predecessors.

Austrian Telephone System.—The city of Vienna is particularly fortunate in possessing an immense system of local telephones, and, what is more, the tariff, to say the least, is modest. In all there are close upon 20,000 telephones in Vienna, and for an annual payment of 10 guineas subscribers are not only connected with this extensive local system, but also with Berlin (450 miles), Lemberg (500 miles), Dresden, Budapest, and over 200 other towns in Austria-Hungary. Each of these places, many of them small towns with a few thousand inhabitants, has an excellent local telephone service. We understand that a scheme is now being considered by the Ministry of Commerce by which every house in Vienna could be supplied with a telephone. Vienna is built on the flat system, and there are rarely less than 20 families living in one building. It is therefore proposed to establish a small telephone "central" in each house.

Trend of Invention.—The remarkable progress in electric traction work within the last few years is given full prominence to in the report for 1900 of the Comptroller-General of Patents, Designs, and Trade Marks, just issued. The trend of invention in this direction has truly been most marked, and, according to the report before us, in the year under review there was an exceedingly large increase in the number of inventions relating to electric traction. The London electric underground railways and the numerous electric tramways now working in this country, the report states, have aroused considerable public interest in electrical subjects. Over 100 applications were made during the year by one firm of electrical engineers alone. Outdoor seats for tramcars, etc., claimed a large share of attention from inventors. Applications relating to motor-cars were numerous, but showed little increase, while those for cycles decreased, especially at the beginning of the year. There were several applications for military inventions, but no increase in this subject could be traced directly to the war.

Electricity and Seed Life.—The experiments described by Dr. A. D. Waller before the Royal Society a month ago raise a number of interesting speculations. The author experimented with a number of seeds and vegetables, and claimed that he was able to tell from the results of these experiments whether the seeds were alive or not. He placed the beans or other seeds to be experimented with between a pair of moist electrodes, and sent a discharge through the same by means of a condenser which had been previously charged up by a couple of Leclanché cells. After the discharge had taken place the bean was connected to a sensitive galvanometer. The author claims that if the bean was alive, the discharge obtained was very much higher than if the seed were dead. In the first case, if the bean were alive about 75 milli-volts were found, whereas if the seed were dead the voltage was hardly appreciable, not being more than one milli-volt. From the information before us we do not quite know how the author was able to determine beforehand if the seeds were alive or not, as we gather that the experiment itself was apt to destroy life if it existed.

The Telegraph Service.—In certain quarters the financial failure of the Government telegraph service is held up as an instance of the incapability of the Post Office

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authorities to carry on their affairs in a businesslike manner. This, however, is a mistaken idea. It must not be forgotten, in the first place, that the sixpenny telegram was introduced into this country as a public convenience, and not for the purpose of profitmaking. Within the last 30 years the telegraph system of the United Kingdom has been increased by five times as much. In 1870 there were 60,000 miles of wire, now there are 300,000, and in the same period the number of instruments has been raised from 4,000 to 32,000, the value of the system having increased from about £5,000,000 in 1870 to £40,000,000 in 1898. When it is considered that the whole cost of this development was defrayed out of the revenue, the capital account remaining unaltered, it will be seen that the case does not warrant the pessimistic view which has been taken of it, especially among the opponents of municipalisation and State ownership. In spite of all that may be said, we are getting a telegraph service in this country at less than half the cost of the United States service, besides having a national asset which is always increasing in value.

Unofficial Advice.—We regret to see that in certain instances where new electrical work is proposed to be carried out by local authorities, certain professional engineers are giving advice without their names appearing as the authors of such advice. In both of the two instances we have in mind the schemes have been tramway undertakings, and in each case a consulting engineer has been retained to advise the corporation as to the best means of carrying out the electrification of the tramways and the supply of power for the same. When the schemes suggested by these engineers have come before the town councils in question, there has been strong evidence from the debate that the leaders of the opposition have been coached up by outside experts, whose names are never mentioned, although reference has been made to the fact that the opinions expressed by the speakers are not their own. It is, of course, only right that when large sums of money have to be spent the town should have the most able advice as to the best results which can be obtained, and also as to the least cost at which these results can be secured. It is not, however, right that an engineer who has presumably not been selected as the most capable man to advise the corporation should afterwards go out of his way to give advice which tends to hamper the carrying out of the work.

The Manchester-Liverpool Express Railway.—The promoters of the so-called monorail railway between Manchester and Liverpool have succeeded this year in getting their preamble proved before the Parliamentary Committee. This, we consider, is an evidence of what can be done by untiring perseverance. The Bill in question has been strongly opposed by a number of vested interests for the last few years, and yet has at last succeeded in getting through committee stage. When before the committee certain experts raised the question, which we have had to call attention to at various times, as to the real advantage of the so-called monorail in view of the fact that a number of guide rails have to be employed to keep the train in balance. There are actually, we believe, five rails in all, although the one rail bears the whole weight of the train. In our opinion it remains to be proved that this construction really gives any advantage over an ordinary railway if laid out with the same care in avoiding curves, etc. The Bill has yet to get through its third reading in the House of Commons, while the crucial point as to whether the promoters can obtain the requisite capital to start the line is a still greater problem to solve. We do quite concur with the promoters, however, that electrical driving is the essential feature for trains which are to be run at the high speed of 120 miles an hour.

Sir Courtenay Boyle's Successor.—Mr. Francis J. S. Hopwood, C.B., C.M.G., whose appointment as permanent secretary to the Board of Trade, in succession to the late Sir Courtenay Boyle, was notified on Wednesday, entered the Board of Trade as assistant law clerk in 1886. Two years later he became assistant solicitor, and subsequently private secretary to the then president, Sir Michael Hicks-Beach. When in 1893 the late Sir Courtenay Boyle succeeded Sir Henry Calcraft as permanent secretary, Mr. Hopwood was appointed secretary to the railway department, which post he filled until his present promotion. In that department he has been especially connected with legislation for the promotion of light railways, the development of electric traction, the prevention of accidents to railway servants, and the regulation of their hours of labour. He was also a member of Mr. Asquith's Commission on the Metropolitan Cab Service, and a British delegate to the International Railway Congress in 1895. Mr. Hopwood has on several occasions been entrusted with official business in the United States, Canada, and Newfoundland, and it will be remembered he took a prominent part in the settlement of the Taff Vale Railway dispute last year.

National Electrical Contractors' Association.—A meeting of the promoters and supporters of this movement was held at the offices of the secretary on Tuesday, when the chairman (Mr. H. Bland) delivered a most interesting address, dealing with the need for such an association and the good work which had already been done by the local associations in existence up and down the country. In the discussion which followed, encouraging reports were made by representatives from provincial associations, and a number of points affecting the well-being of the association were gone into. A resolution was then unanimously adopted to the effect that: "Having regard to the desirability of forming a national association for the purposes, *inter alia*, of protecting and consolidating the interests of electrical contractors in Great Britain and Ireland, it is hereby moved that the representatives of local associations and others present at this meeting hereby form themselves into an association to be called the National Electrical Contractors' Association." A large and influential general committee representative of England, Scotland, and Ireland was appointed, and it will be one of the duties of this committee to use its best influence in forming local associations in centres where they do not already exist, so that the movement may become universal throughout the United Kingdom.

Pipe-Line Transportation.—The current number of *Cassier's Magazine* contains an article under this heading, in which the extent to which the pneumatic tube principle will be employed to expedite transportation, now entirely dependent on steam locomotives, is considered. It does not seem altogether unreasonable, the editor says, to think that just as the miles of tank cars loaded with oil, which were seen in former years, have disappeared, and that commodity is now sent hundreds of miles through pipe lines, so may coal, grain, and ore be sent speeding through tubes to central depôts for local distribution. In the matter of coal transportation, in fact, just such pipe-line conveyance was tried experimentally something like 10 or 12 years ago by the late W. C. Andrews, of New York—the coal for that purpose being ground into powder, mixed with water in sufficiently large proportion, and carried through the pipes in semi-liquid form. At the delivery end of the pipe line there were to be settling chambers for

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the mixture, enabling the water to be drained off and the coal paste, if it may be so termed, to be pressed into cakes and dried for consumption. The project, however, did not extend beyond the experimental stage. In woollen mills, on the other hand, it is a common thing to blow wool from one building to another through pipes by means of fans, and in potteries, too, clay paste is frequently carried from one point to another through pipes. There is, thus, the article concludes, a fairly good beginning for pipe-line engineering with solids.

Whit Monday Traffic Returns.—Of the many returns prepared showing the enormous extent of suburban traffic on Whit Monday conveyed by tramways, omnibuses, and underground railways, perhaps those supplied by the London United Tramways Company with reference to the traffic on the new electric trams in the West of London are the most striking, and constitute a record. From seven o'clock in the morning until an hour after midnight a one-minute service was maintained on the lines westward of Shepherd's Bush and Hammersmith, during which time no less than 209,636 passengers were carried over the nine miles of route now being worked by electric traction. The success of the undertaking may be judged from the fact that for the corresponding day last year, when the horse cars were in operation, the total was 81,500, and for the Easter bank holiday, when the electrical system was in operation for the first time, 164,000 passengers were carried. During the evening the pressure was so severe that gangs of labourers employed upon the Ealing and Southall extension had to be requisitioned in order to regulate the traffic, and were placed in cordons around the trams at the termini and stations. Turning to the Central London Railway, we find that 128,000 passengers were conveyed over the line, including 40,000 bookings at Shepherd's Bush Station. The only other electric railway at present in operation in the Metropolis (the City and South London Railway) shows a total of between 30,000 and 40,000 passengers carried during the day.

An Electric Typewriter.—In the *Electrical World* of New York Mr. B. C. Washington, jun., has an interesting description of an electric typewriter, a large number of which machines are now in daily use in Washington. The amount of current required to operate the machine would appear to be very small. In Washington current is as a rule taken from circuits of the city light and power company, while in other cases a battery of primary cells is the means of securing power. Again, two small storage battery cells also furnish ample current for operating the machine. The workings of the different parts of the typewriter, which is of simple mechanical construction, are extremely quick, and greater speed and better work are among the results claimed. The most satisfactory feature of the invention is that the running legato touch is obtained in a type-bar machine, a point which had not been accomplished before. Other advantages claimed for this machine are that there is but one electromagnet for operating all the type bars, one motor frame, one contact frame, and but one place where the electric circuit is closed and opened. Again, the power of the electromagnet is under ready control, and a copy of perfectly uniform distinctness is thus secured. These machines can be operated by direct or alternating current, by a storage or primary battery, as stated above, and can be regulated to take current ranging in E.M.F. from 4 to 500 volts. A very weak current is ordinarily used. A touch of from $2\frac{1}{2}$ to 4 or 5 ounces is said to be quite sufficient to operate the keys. The operator, therefore, is relieved practically from all physical work, his services being required merely in the capacity of a director.

Velocity of Ions.—Some short time ago there appeared in the *Physical Review* an article by Mr. C. D. Child offering an explanation of the electric arc on the assumption that the current in the arc is carried by ions. In another article on the subject in the same journal Mr. Child refers to a method of investigating the arc further. The experiments carried out by the author may be summarised as follows: A study of the rate of discharge from an arc to a neighbouring body showed that under varying conditions of difference of potential, distance, and current in the arc itself, the positive ions drawn from the arc moved more rapidly than the negative ones. This is not to be explained as an effect due to ultra-violet light or any phenomena previously studied. The positive ions from a carbon placed in an oxy-hydrogen flame also moved the more rapidly. In cases of an arc between metals the negative ions again moved the more rapidly. While this work did not prove that the positive ions in the arc itself moved more rapidly than the negative ones there, it is in every respect consistent with such a hypothesis, and it shows that it is possible for the positive ions to do so. The question why the positive ions here showed this peculiarity is, of course, entirely unanswered. In all the cases so far studied we have had carbon, and also a very high temperature. It would at present be useless, the author concludes, to speculate as to whether this phenmenon is to be ascribed to one or the other of these facts, or to some one entirely different. In time the author hopes to publish further experiments bearing on this point.

Alternate-Current Meters.—A goodly number of various types of alternating-current meters were exhibited in the Paris Exhibition last year, and these were experimented on by Mr. Janet, who gives his results in the *Bulletin de la Société Internationale des Electriciens.* In an introduction he points out that while for a number of years there has not been much change in the construction of direct-current meters, a number of new types of electricity meters for working on alternating-current circuits have been devised. With these improvements has come a reduction in the no-load losses in the meters, and also improvements in the construction, which enable them to start with exceedingly small currents. For instance, the author found out that the electricity meters of 1,000 watts capacity exhibited at the exhibition had on an average a no-load loss of about three watts. The average starting current for this size of meter came out to about 90 milliamperes. These figures show a great improvement on the earlier types of alternate-current meters. The author considers, however, that the low starting current is too often got by introducing a few shunt-turns to overcome the starting resistance. These turns are apt to produce inaccurate readings, for instance, in places where there is a considerable amount of vibration. In such cases it sometimes occurs that the meters will continue to run on the shunt alone, which makes a considerable error in the course of a year. On the other hand, a meter without the shunt-turns is likely to read against the supply company, as it is apt to stand when only one 8-c.p. lamp is switched on. The author also deals with the best way of overcoming other errors arising in alternating-current meters to be used on circuits of low power factors.

Electromobiles.—So far we have not had the pleasure of recording the financial success of any of the various electric vehicle enterprises which have been launched in different parts of the world within the last few years. We have, however, referred to two or three failures, notably

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the Boston and the Paris electric cab companies; and we are glad, therefore, to note that "the earnings of the New York Electric Vehicle Transportation Company have been steadily increasing," and that "the company has now reached a point where the directors deem it wise, in the protection and furtherance of its interests, to immediately make provision for the better establishment of its present business and the proper meeting of future requirements." At least, this is the state of things as set out in a circular to the stockholders of the company announcing an assessment of £2. 10s. per share. That success is attending the undertaking of the company is undoubted, in face of the fact that "the demand for vehicle service has been constantly in excess of the vehicle equipment." Again, the new main station at Forty-ninth-street and Eighth-avenue, and the various sub-stations conveniently located at necessary points throughout the city, have shown most satisfactory results. Additional stations, it is stated, must be provided before next winter, delivery wagons facilities in particular being required. The Buffalo branch of the company, too, is proving a desirable investment, and considerable extensions are there in progress. This, however, is more especially to meet the very profitable demand that is anticipated during the Pan-American Exhibition. A new type of battery giving, it is claimed, more than double the mileage on one charge of electricity has been comprehensively experimented with, and after operations covering 25,000 miles has developed but few defects.

Localising Faults in Tramway Conduits.—In the issue of *L'Industrie Electrique* for the 25th inst. we notice an interesting description of a method developed by Messrs. G. Claude and L. B. de Villiers for localising insulation faults in conduits for electric tramways. The great advantage of the system used is that the faults can be localised while service of cars is still going on. The method depends for its success on the fact that the resistance of the tramway conductor is exceedingly high when the frequency of the testing current is as high, as is the case with currents generated by the discharge from Leyden jars. The apparatus consists of the usual Ruhmkorff coil for producing these oscillatory discharges, and the discharge is made to pass through two condensers and then through a solenoid. Two points of this solenoid are then connected, the one through a hot-wire ammeter on to the tramrails, and the other through a condenser on to the contact rail. The object of the condenser is to prevent any continuous current from the tramway conductor passing back through the solenoid. The whole of the apparatus is mounted on an ordinary tramcar, which is then taken along the track. It is said in the article that when the two contacts rest on the rails at from 20 to 30 yards distant from the voltage, the ammeter is not appreciably deflected, owing to the high resistance of these conductors to the oscillatory current. As the car moves over the fault, however, the deflection of the ammeter increases to a maximum value, which maximum is reached when the brushes are just over the point of low insulation. The method works exceedingly well in practice, and is one which will commend itself to tramway engineers who have to do with the conduit system of electric traction.

Electric Light and Heat Bath.—Dr. F. C. Eve, house physician at the Royal Infirmary, Hull, describes in the *Lancet* a simple form of electrical light and heat bath, which appears to have met with considerable success in practical use. The apparatus consists of three 32-c.p. lamps fixed on an aluminium base, and protected by a wire cage from contact with the skin of the patient or with the blankets forming the walls of the chamber. A piece of flexible wire connects the apparatus with the socket of any domestic lampholder, the cost of the current coming out at about 2d. per hour. The apparatus may be used to heat up either a single limb or the whole body, and eight cases of chronic joint disease have been treated by it, with the result that mobility has been markedly increased and pain almost entirely relieved in each instance. The *modus operandi* is this: The limb, the apparatus, and a thermometer are all placed together under a chamber formed of several blankets thrown over a cradle. The limb is covered with a single layer of lint to prevent any risk of scorching a particularly tender skin. This is gradually withdrawn in successive baths. The temperature of the chamber rises in from 15 to 30 minutes to from 200deg. to 250deg. F. Under this treatment, Dr. Eve says, the limb sweats copiously, and a general perspiration is induced. As a rule the body temperature rises two or three degrees, especially when the whole body is treated. In the eight cases of rheumatoid anthritis referred to, the ages ranged between six years and 60 years, and the results obtained as regards pain and stiffness are accepted as being very satisfactory; but in other cases which have come under Dr. Eve's treatment it was found impossible to obtain improvement beyond a certain point. The author's conclusion, however, is that at the end of a bath a stiff joint is much more supple and less tender, so that an excellent opportunity for massage is afforded.

The Westinghouse Company.—We gather from notices which appear in our American contemporaries that the Westinghouse Company has recently opened its works to the editors of all the numerous papers of the States. In view of the fact that these works are not, as a rule, open to English visitors to the States, a perusal of the report of those who went through the works on this occasion will be of interest. What strikes us most in the articles before us is the great size of the individual machines which are now in course of construction. Certain of these are for the Manhattan Railway, contracts for which equal to one million sterling have been placed with the Westinghouse Company. For instance, the firm are supplying no less than eight 5,000-kw. three-phase generators to work at a voltage of 11,000. They have also under this same contract to make 28 1,500-kw. rotary converters and the step-down transformers required in connection with the same. In view of the large size of the first-mentioned machines, extensions have had to be made in the building, as in the older structures there was not sufficient height under the travelling cranes. A good part of the machine tools in these new extensions will be of the portable type, the tool being taken to the work instead of the work to the tool. The portable machine tools are being driven by three-phase induction motors supplied from the generating station on the works. We gather also that the 15 large machines for the St. Lawrence Power Company are now well under way in the shops, as the first of these generators is almost ready for delivery. In fact, a glance down the list of the machines of over 1,000 kw. capacity now going through the Westinghouse works makes us wish that the English manufacturers were having a share of the large orders now being placed in America. This, of course, is not likely in view of the present high tariff, but we see no reason why our manufacturerers should not reorganise their works so as to prevent the converse taking place so frequently in the future as it has done in the past.

Dublin Local Section.—The first report of the committee of the Dublin Section of the Institution of Electrical Engineers covers the period from the inauguration of the section up to the present time. At the outset reference is

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again made to the irreparable loss to the Institution by the death of the first chairman of the section, Prof. G. F. FitzGerald. He was most keenly interested in the welfare of the section, he was enthusiastic as to the advantages to be derived from the promotion of it, and he acted on the provisional committee charged with the preliminary arrangements. Altogether 10 general meetings have been held since the inauguration of the section. A conversazione was given on Nov. 29, 1900, and was very successful. Seventy-seven exhibits were mentioned in the programme, but the actual number was much greater. During the evening Prof. FitzGerald gave a most interesting demonstration of rotating magnetic fields, and the committee feel that this has a pathetic interest in that it was his last public lecture. The average attendance, including visitors, was about 40, and members would do well to remember that, by their presence and assistance at the meetings, they have it in their power to make the work of the section a success or otherwise. The committee express their sincere hope that members will freely come forward with papers during the next session. Since the formation the membership has increased from 41 to 58. The number of new members of all classes was 28, and the difference is caused by members leaving the area of the section. The committee desire to record the indebtedness of the section to the council of the Royal Dublin Society for their kindness in permitting the section to hold meetings at the society's offices. The committee also desire to thank the council of the Royal College of Science and Monsignor Molloy for a similar hospitality on certain occasions. The constitution of the committee for the ensuing year is as follows: Prof. W. F. Barrett, F.R.S. (chairman), Messrs. J. W. Towle (vice-chairman), C. A. Burge, C. P. C. Cummins, F. Gill, Monsignor G. Molloy, D.D., D.Sc., Messrs. A. E. Porte, W. Tatlow, P. S. Sheardown, F. T. Trouton, D.Sc., F.R.S., G. F. Pilditch, and M. C. Olsson.

Metropolitan District Railway.—The last we have heard concerning the electrification of the Inner Circle is not of a character which does credit to the companies owning this line. It is to the effect that contractors are now being asked to send in new tenders on revised lines. By this we presume is meant that the directors of the two companies have now agreed to a certain extent as to the system which they will adopt, and are asking the various contracting firms to tender all on the same lines. While this is most desirable in order that the line may be equipped at competition prices, we have to object most strongly to the way in which the directors of the companies have arrived at what they consider to be the best system. In the first instance, when they asked for tenders, they left every detail of the equipment in the hands of the parties tendering. While this left the contracting firms a free hand to make use of standard articles, it also left with them the selection of the actual system of generation and distribution to be used. The question also as to whether locomotives should be used, or if motors should be placed on a number of cars, had also to be decided by the contractors, who were desired to give every information as to the working of the system they proposed to adopt. In consequence of the freedom given to the contractors, they had in every case to work out full details themselves, and to expend three or four times the amount of skilled labour on the preparation of their tenders which would have been required if they had all to tender on a firm specification. In other words, if the companies, in the first instance, had gone to eminent consulting engineers they would have obtained—of course, for a large fee—the information which they only acquired at the expense of the contractors. As the position now stands, the firm who in the first case offered to supply plant of the type approved by the company's experts, will now have to face competition from all its competitors whose proposed systems of conversion have not been approved. This is not the only case in which the same procedure has been followed, as we know of one, for instance, at the present time in which, after tenders have been received on an exceedingly loose specification, new tenders are being asked for on the strength of the information obtained from the contractor who sent in the most complete information as to how the work in question should be carried out. In this latter instance, a consulting engineer's name appeared on the loose specification which first was issued, and we should think it would be only fair if he were made to pay the costs of all the manufacturing firms who really did his work for him.

Lightning Conductors.—In the matter of protecting overhead wires from lightning discharges, we in this country are much behind America and the Continent in experience. This is because the Board of Trade have objected to overhead power wires, and also because up to the present we have not the long overhead lines for conveying power in bulk at high voltages, which are becoming common in the countries above mentioned. An interesting editorial in the *Electrical World* of New York deals with the efficiency of lightning conductors. In this article it is pointed out that so long as the voltages were low, there was not much difficulty in protecting the machinery from lightning discharges. The question is raised as to whether the placing of the conductors underground is a sufficient protection against lightning in view of the fact that some submarine mines were exploded during the late war with Spain, although all the conductors leading to them were either underground or under water. The editor of our contemporary divides the lightning discharges into two kinds, the first of which is the direct stroke from discharge from the sky to earth, while the second is the induced discharge which always follows after the first discharge has taken place. The first of these is much less frequent than the others, but is apt to do much more damage. Again, the protection required varies with the class of electrical insulation involved. In a continuous-current system, by adding reactance in the circuit, one can protect against lightning, but of course such reactance can only be partly introduced into alternate-current circuits. Damage is very often done in these high-voltage lines, because after the discharge has once taken place the arc is maintained by the large power of the machines supplying the circuit. The question then comes to so set the spark-gaps that they are just sufficiently wide to hold up against the maximum working voltage, and that they will readily discharge in the event of the overhead wires being struck. On the other hand, if they are adjusted too accurately, a certain amount of resonance in the alternate-current machines and line is apt to cause interruption owing to the current leaping the spark-gap. The conclusion of the whole matter is that lightning protectors should be placed in extremely accessible positions where they can be easily inspected and cleaned, and the engineer in charge should experiment with the same in order to see exactly what is the best condition of the arrester in order that only lightning shall cause a discharge, and that this discharge shall take place before any damage can be done to the machines. The remaining problem of how to prevent the current from the machines maintaining the discharge when once started by the lightning is, in our contemporary's opinion, yet to be completely solved.

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ROTHERHAM ELECTRICITY WORKS.

The ancient municipality of Rotherham successfully inaugurated its electricity supply on the 24th inst., when Councillor D. L. Winter, J.P., the chairman of the Electric Lighting and Tramways Committee, formally opened the new electricity supply works erected by the Corporation in Rawmarsh-road, and also set the generating plant in motion. The works have been erected according to the plans and specifications of Messrs. Kennedy and Jenkin. The total cost of the undertaking up to date has been about £224,500, though borrowing powers for £226,500 have been obtained. The site of the generating station buildings, being about 10 acres in extent, affords ample room for the extensions which may be found necessary at an early date, should the much-discussed subject of electric trams for the town and district be favourably settled.

The three-wire, low-tension system of supply has been adopted, with a pressure of 230 volts at the consumers' terminals. Plant has been put down sufficient to serve between 4,000 and 5,000 lamps at one time. The mains, however, are of sufficient capacity to serve 10,000 lamps at once. There are already about 2,000 or their equivalent connected up to the mains. The price to be charged for electricity per unit for lighting purposes is the moderate one of 5d. It may be mentioned in this connection that the gasworks are Corporation property, the price of gas being 2s. 4d. to 2s. 11d. per 1,000 cubic feet, according to the situation of the consumers' premises.

Before entering into a detailed description of the undertaking, it may be mentioned that the whole of the elo-

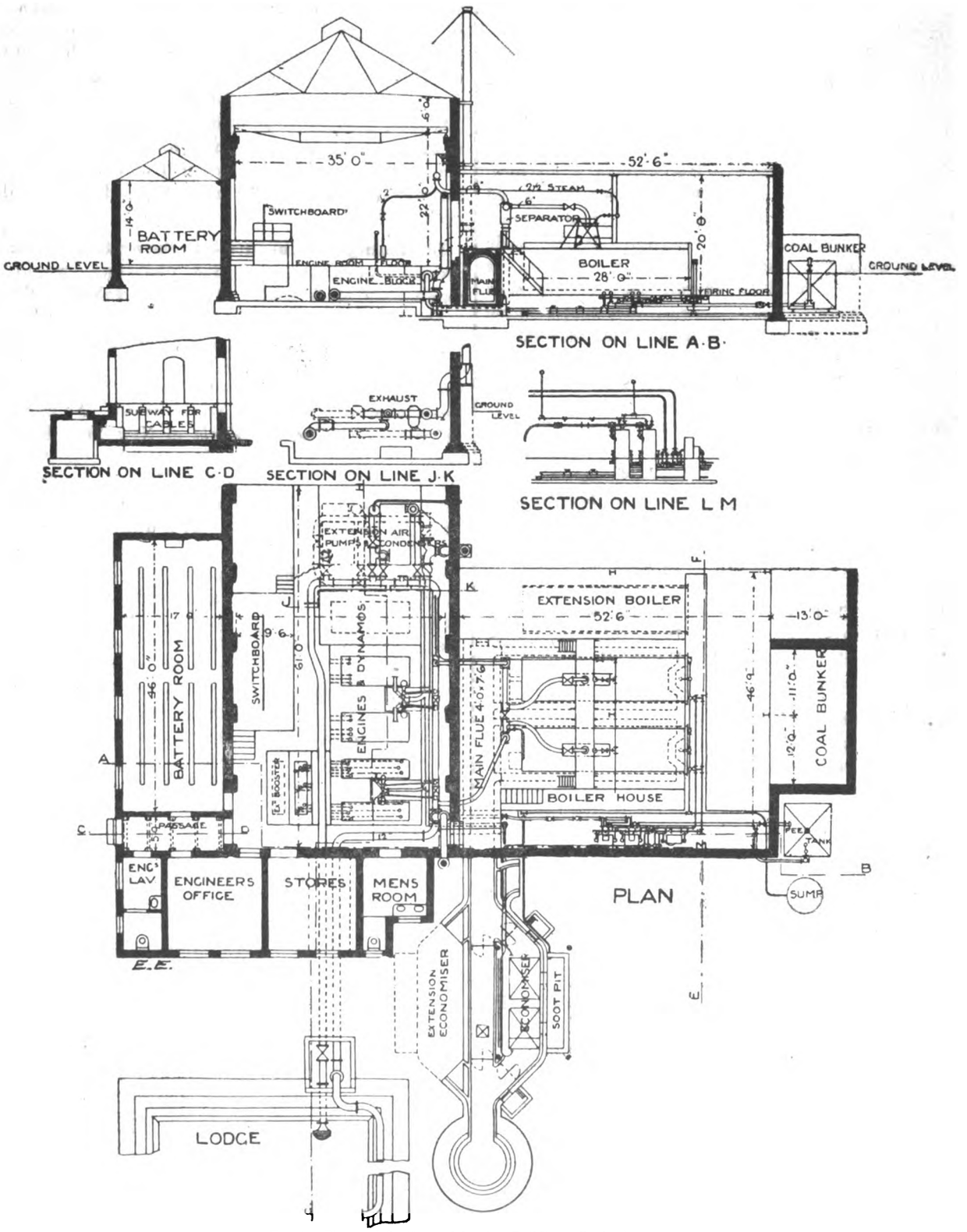

FIG. 1.—Plan and Sections of Station Buildings, Rotherham.

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trical engineering work has been executed under the supervision of Mr. A. F. Davis, representing the consulting engineers. The resident engineer, to whose charge the works have now devolved, is Mr. Edward Cross. This gentleman commenced his electrical engineering experience in 1887 with the National Telephone Company at Whitehaven. His experience in lighting commenced in the year 1891 under the Preston Electric Supply Company, one of the

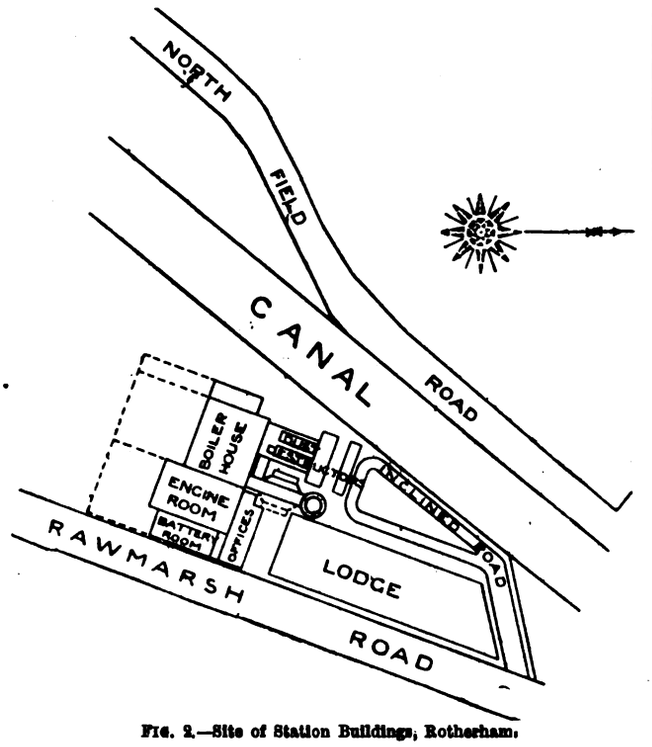

FIG. 2.—Site of Station Buildings, Rotherham.

oldest in the kingdom. With this firm he became acquainted with the change from the old overhead to the three-wire system now in use. Subsequently, under the Bradford Corporation as an engineer-in-charge of the lighting station, he conducted the conversion of the low-pressure three-wire system to the higher pressure, which is now commonly adopted by the large cities. At Bradford, too, he was engaged in the new large generating station for combined lighting and traction work, and after four years' service in that city he removed to Aberdeen, where, as chief assistant, he worked with the combined systems. Before Mr. Cross left that city the resources of their plant were increased from 1,100 i.h.p. to 2,700 i.h.p. In February of this year Mr. Cross received his appointment under the Rotherham Corporation.

We may now proceed to describe the works. The buildings, which were commenced in May, 1900, are of a substantial character, and comprise boiler-house, engine-room, battery-room, engineer's offices, storeroom, workmen's messroom, and water lodge. Their general arrangement will be seen on referring to Fig. 1, while Fig. 2 shows the position of the site and also the position of the refuse destructor, which it is proposed to ultimately combine with the scheme. Close to the chimney shaft, which is 160ft. high, is situated a large cooling pond for receiving the condensed steam from the engines and storage purposes. The boiler-house (see Fig. 1) contains at present two boilers of the Lancashire type, supplied by Messrs. Tetlow Bros., Hollinwood. They have shells 28ft. long by 8ft. in diameter, butt-jointed longitudinally and riveted with six rows of rivets. The furnaces and flues are 3ft. 3in. diameter, each consisting of 14 solid-welded steel rings united to each other by flanged seams with strengthening rings between. There are four conical cross tubes welded in each flue. Each boiler is fitted with a horizontal steam receiver measuring 8ft. long by 2ft. diameter. These receivers are attached to the boilers by solid-forged wrought-steel necks. The boilers are hand-fired, and have two lengths of firebars in each furnace, each length being 2ft. 9in. The working pressure is 160lb. per square inch. Hopkinson's fittings are used. With regard to the arrangement of the steam and exhaust piping, this is sufficiently clear in Fig. 1 as to make further description unnecessary. A Green's economiser is fixed, as shown.

In the engine-room (see Fig. 1) there are at present installed two large and two small sets of engines and dynamos, all of which plant, together with the condensers, which will be described later on, was supplied by Messrs. W. H. Allen, Son, and Co., Limited, Bedford. The engines are of the enclosed high-speed compound type, having two cranks at 180deg. actuated by two cylinders—one high-pressure and one low-pressure. The larger engines are each capable of developing 180 i.h.p. when running at a speed of 400 revolutions per minute, the steam pressure being 150lb. on the square inch. The high-pressure cylinder has a diameter of 11in. and the low-pressure cylinder a diameter of 19in., the stroke in each case being 8in. The cylinders are cast separately, and each cylinder is fitted with one piston valve. All the ports

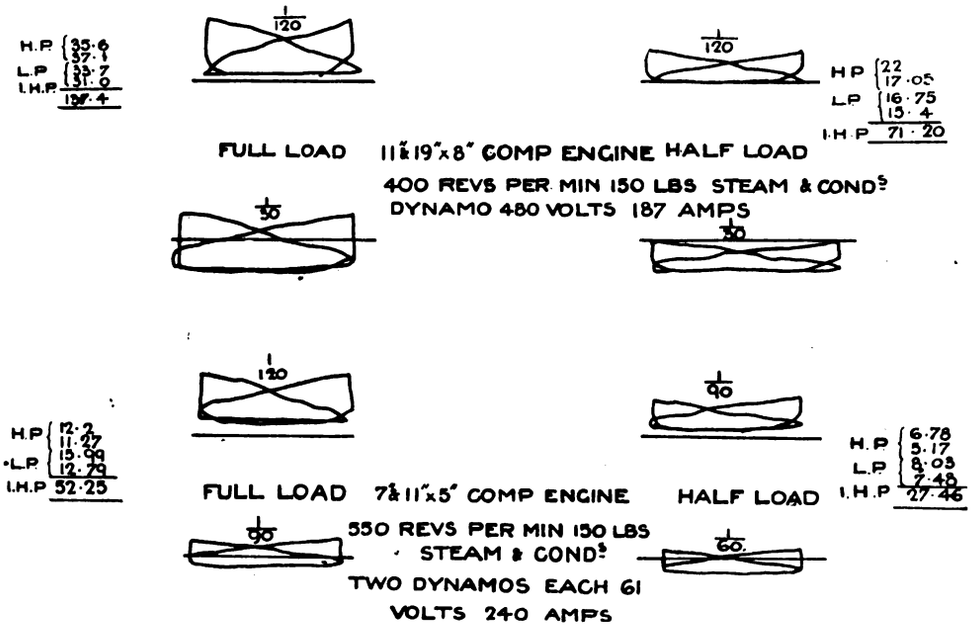

FIG. 3.—Indicator Diagrams taken from Large and Small Engines, Rotherham.

in the cylinder are made straight, so as to be as short as possible and self-draining. The cylinders are mounted on a cast-iron trunk, having a special arrangement of bush in the bottom of the distance piece by which the water is prevented from finding its way into the trunk. The trunk is fitted with two hinged doors at the front. This point is one of some importance, as one of the most usual complaints against engines having closed working parts is that of the trouble of opening the bolted doors. The working

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parts are then easily accessible. The whole of the working parts are made of Siemens-Martin steel, and the pins for the cross-heads of a special hard and tough steel. The eccentric sheaves are forged solid with the shaft and have straps of cast steel. All the bearing surfaces are unusually large in order to ensure that the engine will run steadily, and without giving trouble at all speeds and loads. The crankshaft is 4½in. in diameter. An additional large bearing is provided at the flywheel end of the shaft to carry the weight of the armature without any appreciable amount of wear, so that the armature can be kept truly central with regard to its field. The main bearings and big ends are all lined with white metal, the shells of the bottom half main bearings being made of cast iron and the caps of steel. The engine is fitted with a system of forced lubrication, the oil being forced to all the working parts by means of a special valveless oil-pump worked from one of the eccentrics under an average pressure of about 25lb. per square inch. The result is that the mechanical efficiency of the engine is very high, being about 92 per cent. The governor is capable of being regulated by hand when running so as to give a variation of 5 per cent. in speed above or below the normal. Some of the indicator diagrams taken from both the large and small engines are shown in Fig. 3, while Fig. 4 gives the efficiency curves for one of the larger sets.

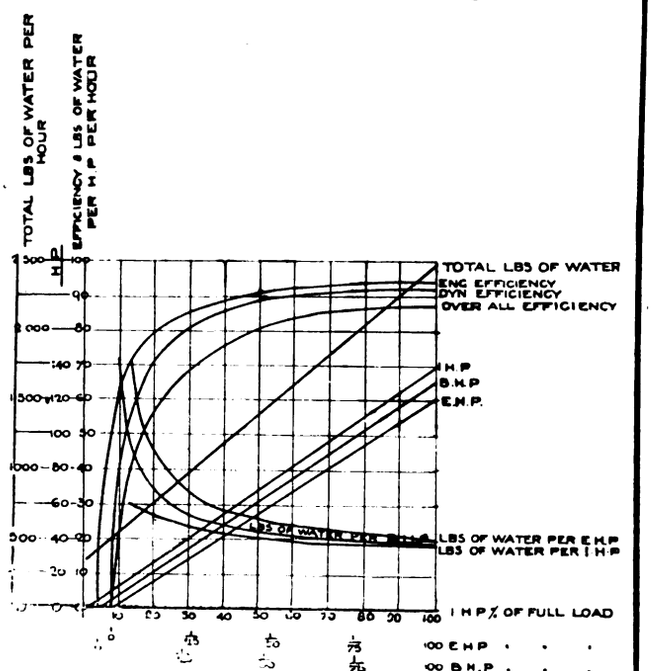

Fig. 4.—Efficiency Curves for one of the Larger Generating Sets, Rotherham.

The dynamos for the larger sets are capable of giving an output of 90 kw. each at full load, and are direct coupled to the engines. They are of the four-pole type, with barrel-wound armatures, and have four sets of carbon brushes. The loops of the barrel winding are formed in one place on special shapers, and are connected up in due order by the commutator lugs. The field-magnet winding is compound, the shunt being arranged to give an E.M.F. from 460 to 520 volts when working as a shunt machine, while the series winding raises the volts from 500 at no load to 550 at full load when required for traction load. A special regulator, designed in principle by Messrs. Kennedy and Jenkin, is placed in the circuit of the series winding, so that when the two larger machines are worked in parallel, the compounding effect of the series turns may be altered without affecting the equal division of the current between the dynamos. This is secured by a switch which, in proportion as the current is diverted from the series winding, inserts an equivalent resistance, so that the total resistance of the main lead to the switchboard is unaltered. The efficiency of the dynamo is as follows: full load, 92·4 per cent.; three-quarter load, 91·7; half-load, 90; quarter load, 83·7; one-eighth load, 72·6. The arrangement of the series regulator is shown in Fig. 5. The above plant is capable of developing an overload of 20 per cent., with a maximum boiler pressure of 180lb. on the square inch, non-condensing. Each of the two smaller sets consist of one engine and two dynamos, the engine being similar in construction to the larger sets, and having high-pressure cylinder 7in. diameter and the low-pressure cylinder 11in. diameter, the stroke in each case being 5in. The engine runs at a speed of 550 revolutions per minute. The two dynamos have a combined output of 29 kw., and are coupled one on either side of the engine. They are of a similar construction to the larger sets, and are of the two-pole inverted horseshoe type, with drum-wound bar armatures, and can be run as balancers on the three-wire system. The brushes in this case are of copper gauze, and are arranged on the horizontal diameter of the commutator. The engine-room plant also comprises two motor-driven boosters mounted on a common shaft. These were supplied by Messrs. Thomas Parker, Limited.

The condensing plant consists of a condenser, air-pump, and circulating pump, and is driven by a compound engine. The condenser has a surface of 1,000 square feet. The casing is of cast iron, cylindrical in form, fitted with suitable branches to take the main exhaust, air-pump suction, and circulating water inlet and outlet. The tube plates are of the best rolled brass, 1in. thick, and all the tubes are of solid-drawn brass, ⅝in. external diameter by 18 B.W.G. thick. The tubes are fixed in the tube plates by means of screwed ferrules and tape packing, and the ferrules are provided with lips to prevent the tubes from slipping out of place. One of the water heads of the condenser is divided by a diaphragm, so that the water will first pass through the lower half of the tubes and thence through the upper half to the discharge outlet at the top of the condenser. The air-pump is of the Edwards single-

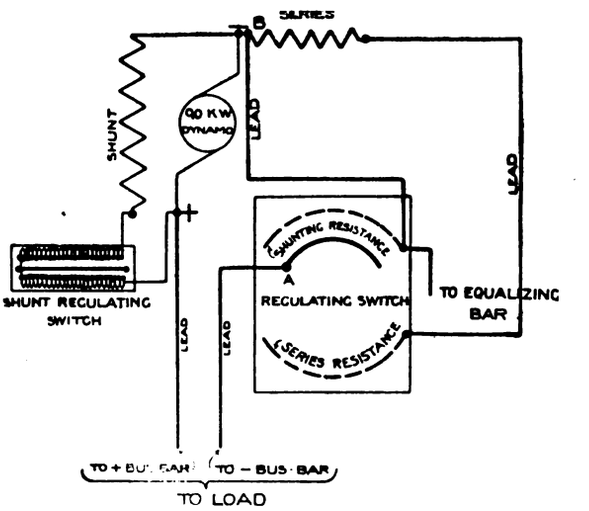

Fig. 5.—Arrangement of Series Regulator, Rotherham.

acting vertical type, having a diameter of 20in. by 11in. stroke. The outer casing of the pump is of cast iron, and the working barrel, valve seatings, and guards of gunmetal. The bucket rod is of bronze, and the valves are of the best rolled brass. The pump is capable of dealing with 12,000lb. of exhaust steam per hour. The circulating pump is of the double-acting type, having a diameter of 15in. by 11in. stroke. The outer casing of the pump is of cast iron, the working barrel and valve seatings of gunmetal, and the suction and delivery valves are of best vulcanised rubber with gunmetal guards. Both the air and circulating pumps are driven direct by means of side rods by one compound engine, having cylinders 9in. and 15in. diameter by 11in. stroke. A crankshaft, flywheel, and governor—of the "Pickering" type—are provided to ensure steady running. All the working parts are of Siemens-Martin steel, and have a tensile strength of 28 to 32 tons per square inch, with an elongation of 28 per cent. in 2in.

The equipment of the battery-room consists of 256 K.W.T. type cells manufactured by the Electrical Power Storage Company, Limited, the battery being capable of maintaining a discharge of 50 amperes for five hours, or 75 amperes for three hours, or 100 amperes for 30 minutes. The containing boxes are of glass, and each cell contains 15 plates, separated by glass tubes held in position at the top and bottom. The cells are erected on two-tier stands, with iron

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standards and wood bearers. The approximate weight of each cell complete, with acid, is 240lb.

Coming now to the main switchboard, this is of the usual type specified by Messrs. Kennedy and Jenkin for three-wire systems. The board is mounted on a platform raised about 3ft. from the floor level, and has been supplied and equipped by Messrs. Kelvin and James White, Limited, of Glasgow and London. It consists of enamelled slate slabs mounted on a steel framework neatly faced on the front and edges with a polished teak moulding, and an electrically-driven clock of this firm's make is fitted at the centre. The total length of this switchboard is 16ft. 6in., and it is divided into 11 separate panels, three of which are at present filled in with roughened glass, as it is intended at a later date to fit the apparatus required for traction purposes on these panels. Each panel contains both the positive and negative switching apparatus for the machines and feeders, as well as the plugging bars for connecting the dynamos or batteries to the 'bus bars and from the 'bus bars to the feeders. The two upper panels to the right contain all the instruments and switch gear for the two large dynamos, and space is left at the top for the addition at a later date of two lighting feeders. The next panel in order contains all the voltmeters and voltmeter switches, as well as the earthing and middle-wire ammeters. The panel at the extreme left contains all the apparatus for the batteries and motor-driven boosters. The other two panels contain all the apparatus for the two balancing dynamo sets, as well as two feeders. The switchboard as at present arranged is capable of dealing with two 500-volt dynamos, four balancing 250-volt dynamos, two three-wire feeders, as well as two boosters and two batteries. As mentioned above, however, space is provided by which instruments and switch gear for two other three-wire feeders, and the traction apparatus for the two large dynamos, can be fitted. All the ampere gauges on the board are of the Kelvin sector or edgewise pattern, the voltmeters are of the Kelvin S.R. (siphon recorder) pattern, and in the earth circuit there is fitted a Kelvin recording ammeter and short-circuiting switch. The automatic cut-outs fitted in the dynamo and steam balancing sets are double-pole, and are of the Ferguson and White's patent type, being arranged to work either as a maximum-current cut-out or a minimum-current cut-out. During working it is set as the former, and when it is desired to shut down a machine it is changed to act as a reverse-current cut-out. This change is made by turning over a small key from position marked "maximum" to "minimum." By the

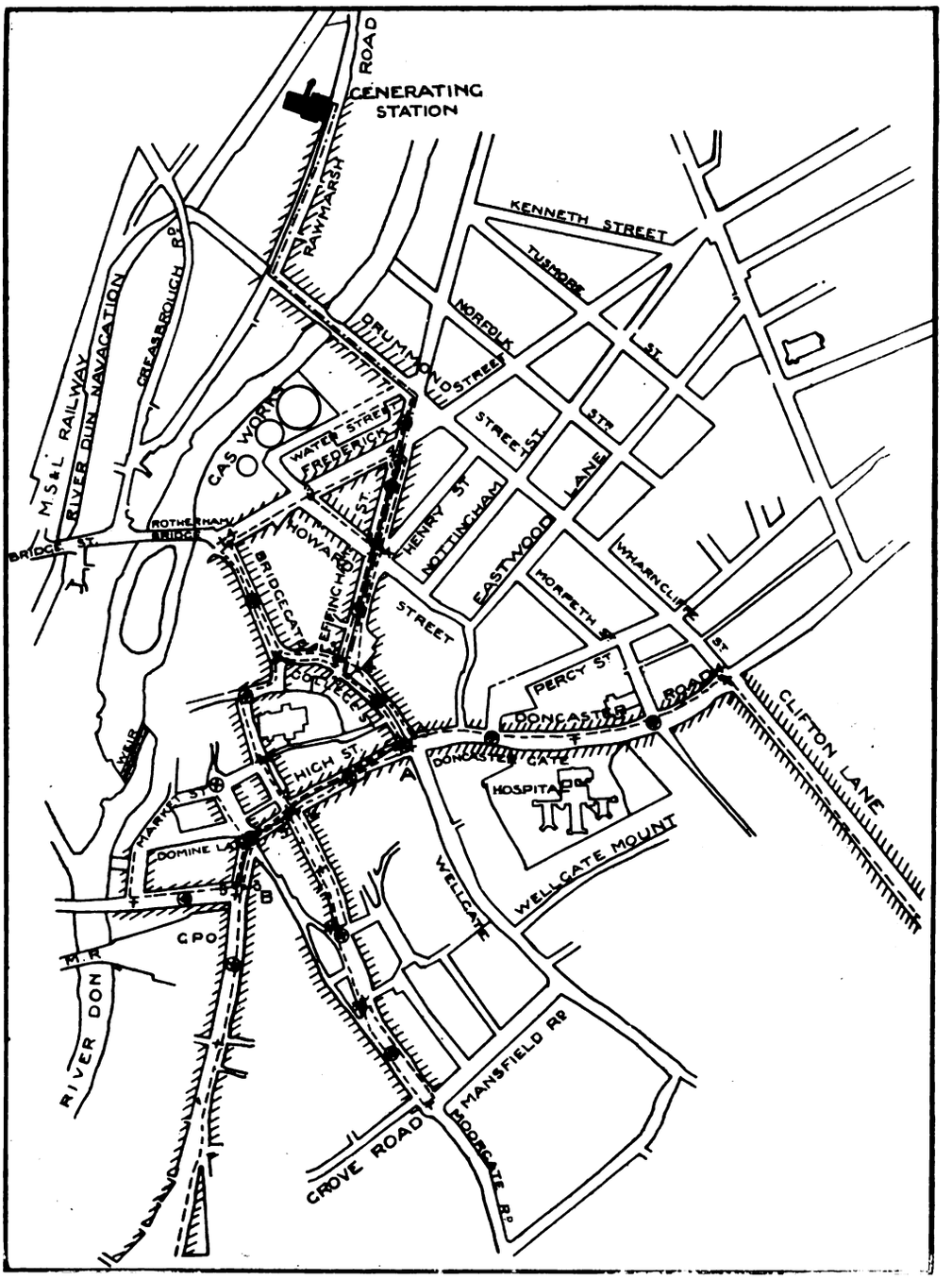

Fig. 6.—Map of Mains, Rotherham, showing Feeders marked ——; Distributors — — — Feeding Points •; Proposed All-Night Arcs ⊹ and Half-Night Arcs (+).

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adoption of this type of cut-out it is impossible to hold the switch closed should an excess current be passing, and the same handle is arranged so that it can be used as an ordinary switch. Carbon breaks and asbestos screens are provided for taking and effectively wiping out any spark that may occur. In conjunction with the booster, a reversing switch is fitted, which is interlocked with the battery regulating switch so that it is impossible to move the former, except when the latter is in one of two equivalent positions in which the whole of the cells are in circuit. The booster can then be used either to charge the battery or to assist in the discharge. Two sets of 'bus bars are provided at the back of the board, and consist of bare copper bars supported on insulators, which are fitted to a steel frame fixed to the framework of the board. The shunt regulating switches for the dynamos, batteries, and boosters are mounted on the handrail, and are of the rectangular sliding pattern, the leads from these being carried down the pillars supporting the handrail to the resistances fitted in the trench below the switchboard. Ferranti meters are fitted in the dynamo and balancer circuits, and Chamberlain and Hookham meters are fitted in the battery circuits. Two of the latter instruments are provided for each battery, one of them registering charge and the other discharge, and arrangements are provided in these meters so that, although both of them are always in circuit, only one of them will read, depending on the direction of the current.

With regard to the outside work, the contract for the supply and laying complete of the mains in connection with this station was placed in the hands of Callender's Cable and Construction Company, who have also excavated the trenches and done all roadway work in the borough. The cables are concentric and triple-concentric, and are of Callender's vulcanised-bitumen sheathed type. They are laid on the solid system in a wooden trough run in with Trinidad bitumen, the main thus made being protected by a tile cover. Starting from the generating station, two ·3 concentric cables are laid as feeders. Three-core pilot wires are laid along with these cables, and there is also a neuter wire, consisting of a single-conductor ·1 cable, which extends from the generating station to the network, where it is connected with the middle wire at a special neuter box. The lengths of the feeders are respectively 1,040 and 780 yards. Each feeder supplies its own network, but the two networks are interconnected by means of dividing-up boxes which are placed on the run of the distributors in special pits by themselves. If necessary, therefore, either feeder can be cut out and the entire network supplied by the other. Spare ways have been provided along the line of the feeders to be available for further extensions. These consist of stoneware conduits made by the Albion Clay Company, and terminate in the centre of the town. The distribution network consists throughout of triple-concentric cable, having a sectional area of ·10, ·10, ·05 square inch. These distributors are laid in a trough separate from the feeders, and are also on the solid system. Arc light cables have been provided, and are generally laid along with the distributors. These cables are provided in view of future contingencies, although for the present it is not intended to deal with any arc lighting in the borough. Fig. 6 shows the positions of the feeders and distributors, and also of the proposed arcs. The whole of the main work was carried out by Mr. W. C. Knight, who acts as the Callender Company's resident engineer in the district.

It will be gathered from the above that Rotherham has come into possession of a thoroughly well designed and equipped electricity works, and one, therefore, which may be reasonably expected to render a good account of itself. For our part we wish the undertaking every success.

ILFORD INAUGURAL CEREMONY.

At the invitation of the Urban District Council, a large number of ladies and gentlemen assembled in the parochial hall on Saturday afternoon to witness the ceremony of the inauguration of Ilford's electricity supply undertaking. The chairman (Councillor B. Bailey) presided, and was supported on the platform by Mr. L. Sinclair, M.P., Mr. W. C. C. Hawtayne (consulting engineer to the Council), Mr. A. H. Shaw (the resident electrical engineer), the Mayor of West Ham, the members of the Council, and others.

After the Chairman had described the undertaking and Mr. Hawtayne the works (a full description appeared in our last issue), Mr. L. Sinclair proposed a vote of thanks to the Electric Lighting Committee, and in doing so he expressed the opinion that the works had been constructed on the most economical basis. He complimented the committee on the excellent work they had carried out so successfully.

Other speeches followed, and then the chairman called upon Mrs. Henry Weeden, the wife of Councillor Weeden, a past chairman of the Electric Lighting Committee, to declare the works open and switch on the light. This pleasing formality over, Mrs. Weedon was presented with a handsome silver lamp fitted for the electric light, a gift which she gracefully acknowledged in a few well-chosen words. More speeches followed, and then an adjournment was made to an adjoining room, where several electrical firms are exhibiting this week. These firms include the Robertson Lamp Company, the General Electric Company, Messrs. Veritys, Limited, and the Magnet Electrical Engineering Company, with the usual show of heating and cooking apparatus, electric fans, telephones, motors, fittings, etc. A noticeable feature of the exhibition, which remains open till to-morrow evening, is an interesting demonstration of the manufacture of Robertson lamps by a glass-blower specially lent by the General Electric Company, Limited. The various processes of manufacture are shown in a popular manner, and should do much towards familiarising the Ilford public with the nature of the lamp.

In the evening a banquet in honour of the occasion was given by the Council at the Angel Hotel, at which some 70 gentlemen were present. An excellent dinner was served. After the loyal toasts,

Councillor HENRY WEEDEN proposed "Ilford's Electricity Undertaking." He emphasised the fact that it was the people's undertaking, and that the Council in deciding upon the work had pledged the credit of the town. The success of the undertaking depended upon the people themselves, and if they took up the electric light in the way the Council hoped they would, it would be possible in a very short time to give a supply at an infinitely cheaper rate than it was at present necessary to enforce. With regard to traction, it must be admitted that the Council had done wisely in securing the right to run tramways in the district. Trams would not only benefit the town enormously, but would develop the trade of the whole district. The Council intended to work them solely with the view of benefiting the community, and he hoped to see a tram service running within a very short time. In conclusion, Councillor Weeden acknowledged the good work done by Mr. Hawtayne in his capacity as consulting engineer to the Council.

The CHAIRMAN (Mr. B. Bailey), in reply, said they had embarked upon an undertaking which must prove of great value, not only to the town of Ilford, but to the district at large. In keeping the electrical undertaking to themselves on behalf of the ratepayers, the Council had stopped the financier from stepping in and taking money out of the town. A number of syndicates of financiers had approached the Council with a view to obtaining the powers conferred upon the Council, but the Council were not going to allow such vast and valuable undertakings as the electric light and the electric tramways to pass out of their hands. He had not the slightest fear whatever with regard to the future of Ilford's electrical undertaking.

Mr. SINCLAIR, M.P., in giving the "Engineers and Contractors," said municipal trading was always questionable when you could get companies to do the work. But for all that, it was the duty of a council to see that efficient light and tramway communication in the district was provided for the inhabitants. The concord which had existed throughout between the Council, the engineers, and the contractors was exceedingly gratifying, and when they saw

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that they had pulled together with one object, giving the town as good a light and plant as science could produce, they were to be heartily congratulated.

Mr. G. SUTTON, of W. T. Henley's Telegraph Company, testified to the cordial relations between the Council, engineers, and contractors which had existed on all occasions. Referring to the question of a day load, he expressed the hope that the Council would offer cheaper rates for the supply of current for heating and cooking purposes.

Mr. HAWTAYNE also responded to the toast. He thought the ratepayers ought to be very thankful to the Council for having refused to lease their tramway undertaking to the syndicates which had come forward. There were as many as 130 tenders for the work which had just been completed, and he never wished to see a more responsible set of contractors than those who had carried out the work.

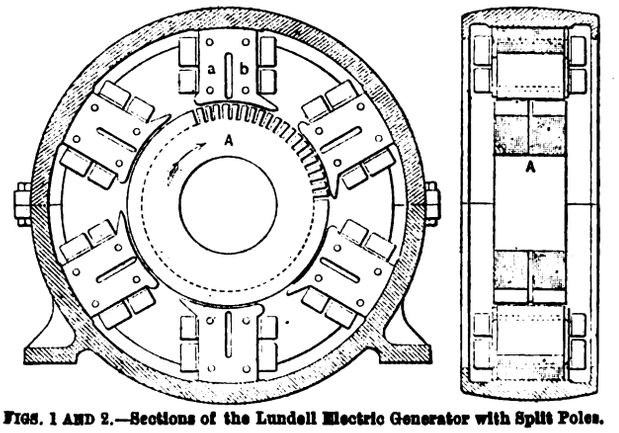
Mr. MAX BYNG and Mr. A. SHAW also acknowledged the toast in appropriate terms.

During the evening the CHAIRMAN called attention to the fact that the electric light had just been switched on in the streets for the first time with complete success—an announcement which was received with cheers. Of the success which is certain to attend the Council's venture we ourselves entertain not the slightest doubt, and it only remains for us to congratulate the town of Ilford on the expedition with which the terms of the provisional order have been fulfilled.

MESSRS. J. H. HOLMES AND CO.'S WORKS.

We recently had the opportunity of paying a visit to the works of Messrs. J. H. Holmes and Co., at Newcastle-on-Tyne, in order to witness a trial of two 150-kw. direct-current dynamos of the Lundell type, which that firm are now manufacturing in large numbers in this country. At the same time, through the kindness of Mr. J. H. Holmes, we had an opportunity of inspecting again the whole of the works and of seeing the improvements which have been made in the equipment of the same by the use of electric motors for driving isolated tools in positions in which they could not be placed unless they were so driven. The economy obtained in this way in the floor space of the works, as compared with the quantity of work which can be turned out, is most remarkable. We propose, however, to deal first with the description of the two large dynamos we saw under test.

As some of our readers may not be conversant with the details which distinguish the Lundell type direct-current dynamo from other multipolar machines, we propose to give a brief *résumé* of the essential features of the same. These



FIGS. 1 AND 2.—Sections of the Lundell Electric Generator with Split Poles.

are shown in Figs. 1 and 2. The great feature in this electric generator, apart from the well-balanced design, is the split pole-piece, the object of which has been previously explained by us, but which will bear repetition. Thus, when the armature of a dynamo is run in the direction indicated in Fig. 1, the armature currents tend to weaken the field strength under the edge of the pole-face which the conductors approach. This weakening results in a shifting of the neutral axis and also of the axis of commutation. Mr. Lundell prevents this weakening of the induction by imposing a reluctance in the path of the cross field. He also ensures by the design that the action of the compound winding shall tend to slightly increase the induction at the point where it is useful for commutation. Thus the half of the pole marked (*b*) in the figures has a large pole-shoe, which reduces the air-gap reluctance, and results in the iron of (*b*) being strongly saturated when the half of the pole marked (*a*) is still magnetised considerably below the

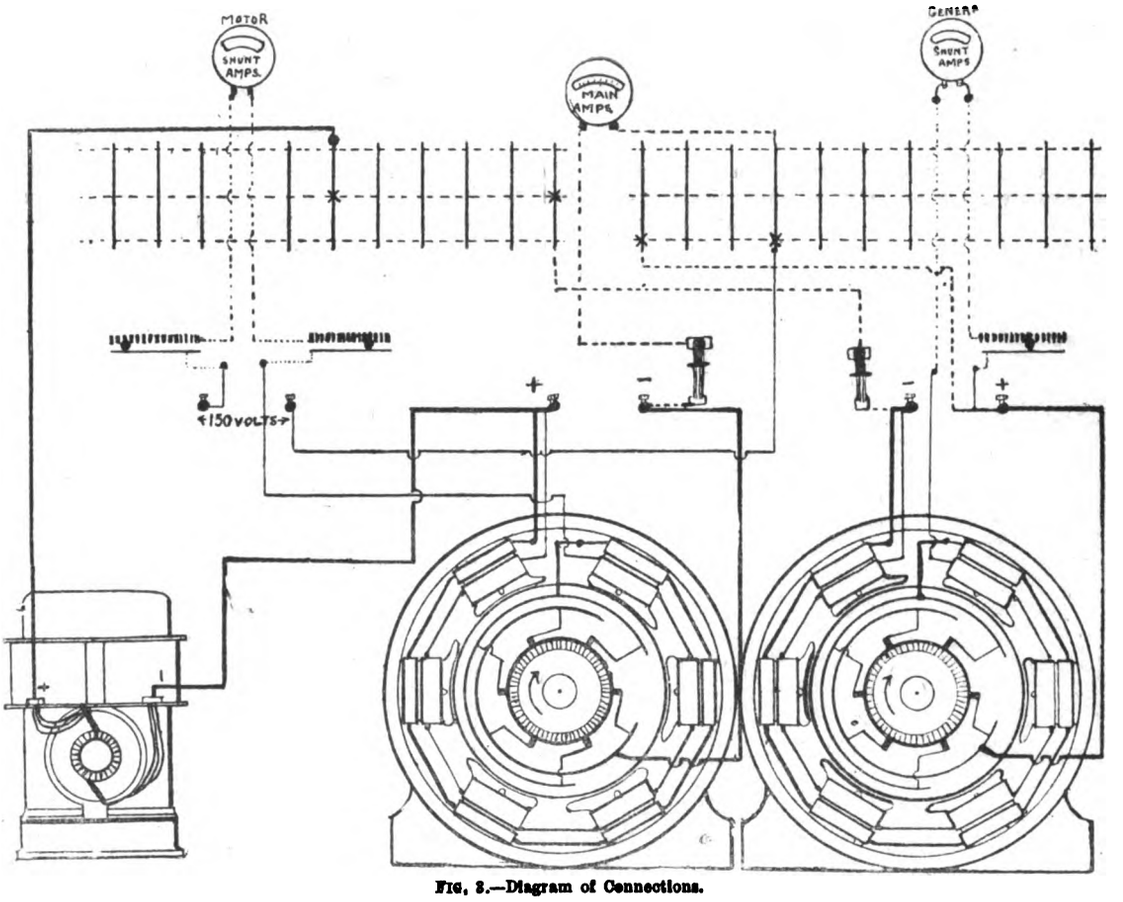


FIG. 3.—Diagram of Connections.

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saturation point. Any increase in the magnetising force consequently increases the induction through (*b*) but slightly, but greatly strengthens the induction through (*a*), and hence keeps up the commutating field.

From actual curves obtained on these machines, it is proved that by careful design the induction at this point can be kept either absolutely constant for all loads, or can be actually increased if it is found necessary to do so. The split pole also halves at least the cross-magnetising effect of the armature current on the induction issuing from any one pole. The two machines of which we witnessed the tests are designed for coupling to high-speed engines running at 300 revolutions per minute. As the engines were not at the works, the tests were carried out on the Hopkinson principle, the diagrams of connections being as shown in Fig. 3. From this it will be seen that the two machines are connected in series, and in series with them again was connected a smaller generator which added sufficient energy to keep the two machines going with their normal current and practically full voltage. The field strength was so far varied that the one machine acted as a motor while the other acted as a generator. It was found that the series connection gave more stability in running than if the two machines were connected in parallel, and current added from an external source. As will be seen from the connections in the diagrams, the smaller dynamo supplying the excess energy had to be able to take the field current of the machines while giving comparatively low voltage. Each of the dynamos under test was designed to work at any voltage from 240 to 275, the current varying from 625 to 687 amperes. The normal speed of the machines was 300 revolutions per minute. Again, while the normal output of the dynamo was 150 kw., it was specified to stand 165 kw. for at least two hours. The normal load trial was made for 10 hours. The machines in question are somewhat of the style shown in Fig. 4, which is a photograph of a somewhat smaller set. The winding of

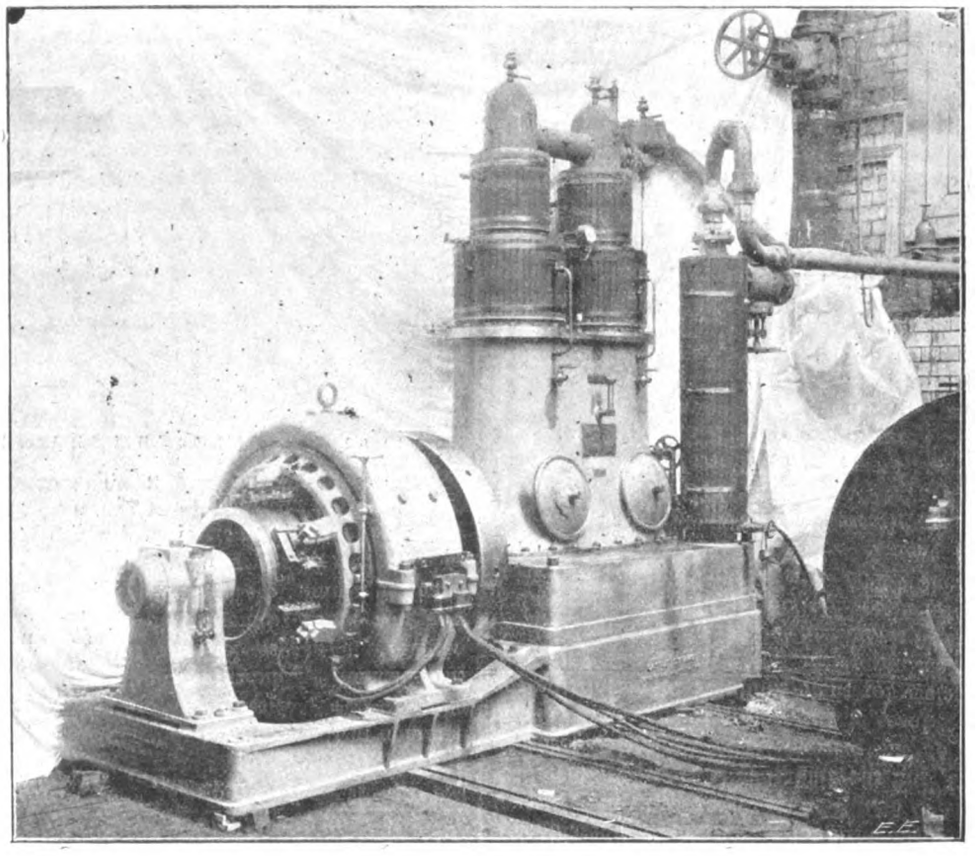

FIG. 4.—View of Lundell Generator, manufactured by Messrs. J. H. Holmes and Co., and coupled to a Willans Engine.

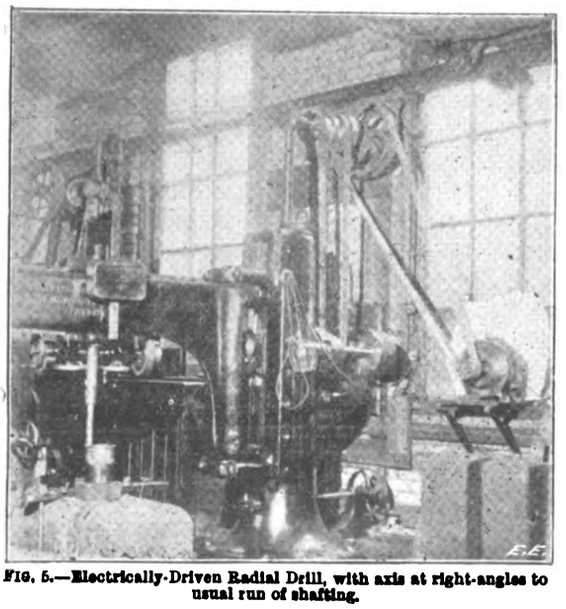

FIG. 5.—Electrically-Driven Radial Drill, with axis at right-angles to usual run of shafting.

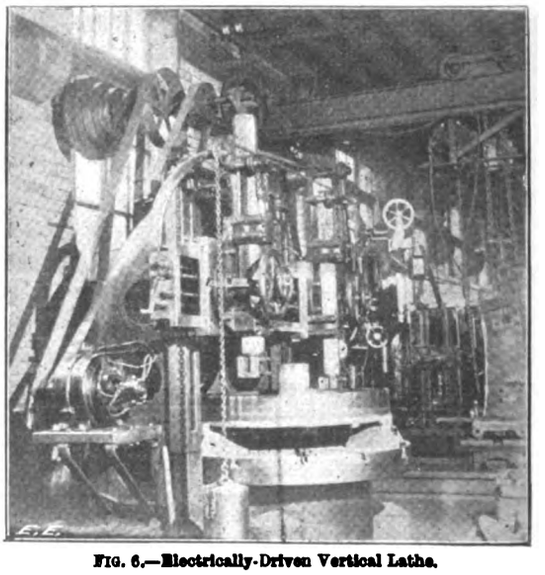

FIG. 6.—Electrically-Driven Vertical Lathe.

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the field magnets is done by a combination of shunt and series coils, there being nine series turns on each pair of poles. This raises the vexed question as to whether there are 4½ turns on each pole or five turns on the one and four on the other. These series turns have a considerable advantage with the Lundell construction, in that the extra excitation as the load increases tends to

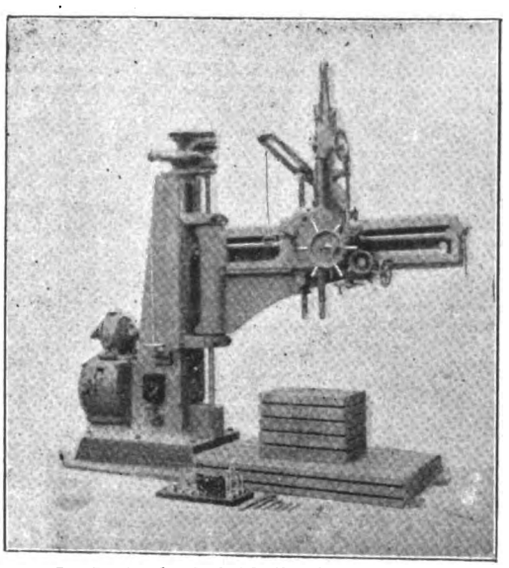

FIG. 7.—Another Radial Drill with Geared Motor.

keep the commutating field absolutely constant. The results obtained on the 10 hours' trial are given in the accompanying table. After this 10 hours' run the following temperatures were taken on the various parts of the machine: Thus, on the machine acting as the motor, the temperature of the armature was such that the increase over the temperature of the air was only 36deg. The temperature rises on the other parts were as follows: armature conductors, 46deg.; pole.tips, 36deg.; armature core (teeth), 44deg.; and the armature spider, 31deg. As the motor was really working at more than normal load, these rises are appreciably more than were found for the

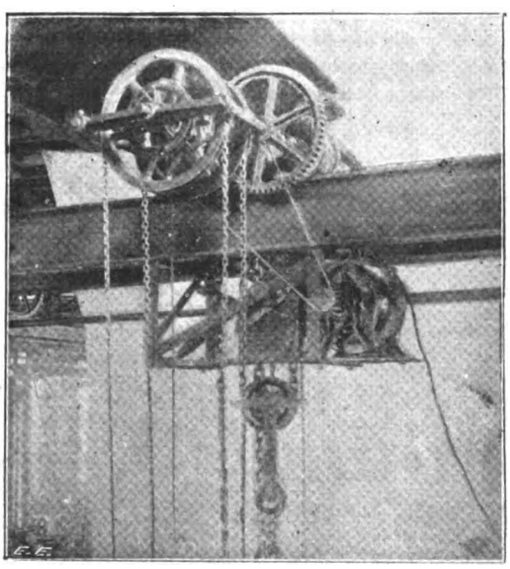

FIG. 8.—Motor with Chain Drive to Crane.

other machine acting as the generator. In this the following were the temperature rises: commutator, 32deg.; armature conductors, 38deg.; pole-tips, 31deg.; the projecting core teeth of the armature, 40deg.; and the armature spider, 23deg. On the day the tests were made the temperature of the atmosphere was about 65deg. F. These abnormally low temperature rises show that the machines are well within their rated output. Another test applied was to see how far the brushes could be moved round the armature at full load without causing sparking. This we found to be no less than 2½in. on a commutator 2ft. 4in. in diameter. From this we are sure that the brushes of the machine could be kept fixed for all loads without any sparking occurring. As, however, the machines were not connected directly to any prime mover, a direct observation on this point could not be made. But the tests we applied showed how well the Lundell split pole is capable of overcoming the distorting effects of armaturing action on the field magnet. As regards

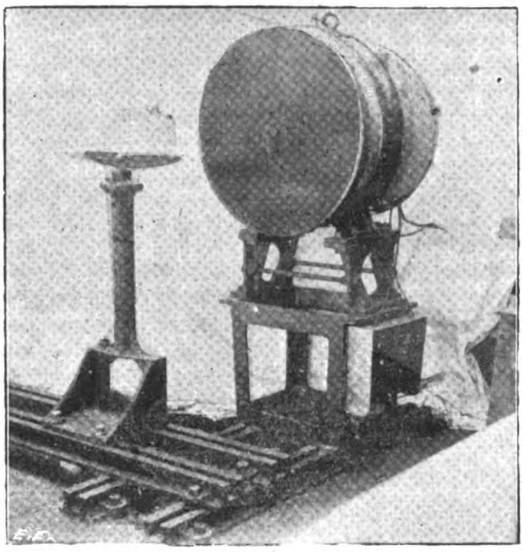

FIG [9.—Motor acting as a Face-Plate Lathe.

the overall efficiency of these machines, this can be readily ascertained from the figures given in the table.

TEN HOUR TEST OF TWO 150-KW. LUNDELL DYNAMOS MANUFACTURED BY J. H. HOLMES AND CO.

Time.	Speed, revolutions per minute	Generator				Motor.		
		Volts at terminal.	Amperes.	Shunt resistance, ohms.	Shunt current.	Volts at terminals.	Shunt resistance, ohms.	Shunt current.
a.m.								
8.0	300	246	638	21 6	4 6	300	6·8	6·8
9.20	,,	246	638	21·6	4·6	300	6 8	6 8
10.0	,,	244	625	21 6	4·5	297	2 4	6·9
10.39	,,	243	625	,,	4·4	300	,,	6 8
11.0	,,	243	625	,,	4·3	300	,,	6 6
11 30	,,	240	620	,,	4 25	281	,,	6·5
noon	,,	242	625	,,	4 28	300	,,	6 6
p.m.								
12 30	,,	243	625	,,	4·3	297	,,	6 5
1.0	,,	243	625	,,	4 3	294	,,	6·4
1.30	,,	240	625	19·8	4 28	291	6·8	5·8
2.0	,,	239	620	,,	4·25	288	9·2	5·6
2 30	,,	240	627	,,	4 3	289	9 2	5 65
3 0	,,	240	628	,,	4 3	286	9 2	5·62
4.20	,,	241	625	18	4 5	290	9 6	5 75
5 0	295	240	620	14·8	6 25	297	9·8	6·25
5 30	300	240	625	16 2	4 5	292	9 6	5·8
6 0	,,	240	625	18	4 5	291	7·2	5·75
—	—	241 5	500	18	4·55	295	—	7·0

As the current is constant, one only needs to take the ratio of the voltages of the generator to that of the motor. For instance, in the present case, assuming that the average voltage of the generator was about 241, and that of the motor 293, the overall efficiency of the two sets is 241 ÷ 293, or 82½ per cent. This brings the overall efficiency of each machine to about 91 per cent. It must be remembered that when making the tests the machines were coupled up temporarily and run in bearings which were by no means rigid, which would certainly increase the frictional losses. The results obtained, therefore, are exceptionally good. The following are the weights of the various parts of these dynamos:

	t.	cwt.	qr.	lb.
Field, complete	3	4	1	0
Armature, complete	2	12	0	0
Bearing bracket	0	10	0	14
Brush gear	0	6	1	8
Bedplate for two dynamos	2	11	0	0
Spindle (included in armature weight given above)	0	17	0	0
Total of two machines, complete on bedplate	15	17	0	0

Coming now to the descriptions of the mechanisms used

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in various parts of the shop for driving tools, it is well to mention, in the first place, that in the heavy machine shop most of the tools are placed in one bay, while the next bay parallel with it was formerly used as an erecting shop. The pitch of this was not sufficient to allow of the erection of countershafting under the rails of the travelling crane. It meant, therefore, that the erecting shop could not well be used for machine tools until some method of motor driving had been devised. This can be seen well from Fig. 5, which is of a radial drill. The rail seen just over the top of the drilling machine carries the travelling crane, and shows what little headroom is left. In the case of this radial drill, the motor, which is of the Lundell type, is carried on a small bracket from the wall, and drives the tool by means of a belt. Somewhat the same method of driving is used for the vertical lathe (seen in Fig. 6), except that the motor is carried from a small bracket on the machine itself in order that the machines may be set back close to the wall. Each of these tools is placed near the wall of the erecting shop, leaving ample space in front of them for the normal work of the department.

Another and, perhaps, more compact way of connecting the motor on to a radial drill is shown in Fig. 7, in which the use of belts is dispensed with. In this case the motor drives by means of a Hans Renold chain the main shaft of the radial drill. This use of a bicycle chain has also been employed in the overhead crane in this erecting shop, which is shown in Fig. 8. This has proved to be of very great service. The motor is carried on the under side of the crane girders, and is switched on and off by cords from the floor level. Where considerable lifts have to be made, as is the case in these works, in getting material raised and lowered from one floor to another, the quick speed which is obtained by the motor drive results in a very great saving of time. In the pattern-making and carpentering department of the works—of which we regret we have not more photographs—almost all the motors are carried on the underside of the floor. The space so occupied near the ceiling in a store is of exceedingly little value, whereas the space that the motor otherwise would require on the floor of the pattern-making department is exceedingly valuable. These motors are, in most cases, hung on a hinged frame, so that the weight of the motor is used to give the required tension in the belt. This is adjusted by means of a counter-weight, also connected with hinged framework, the result being that a very steady drive is obtained which is quite independent of the stretching of the driving band. Fig. 9 is a view of another ingenious device which was rigged up temporarily in time of emergency, but which, in consequence of the good work it has done, has remained a permanent tool in this wood-working department. It consists of an electric motor with especially heavy and coned bearings, to which an iron face plate is attached. The motor drive on this face plate is, of course, quite positive, and it has been found to be of very great service when turning woodwork of large diameter. The power for driving these motors and for the supply of the energy required in the testroom is obtained from a central station in the works themselves.

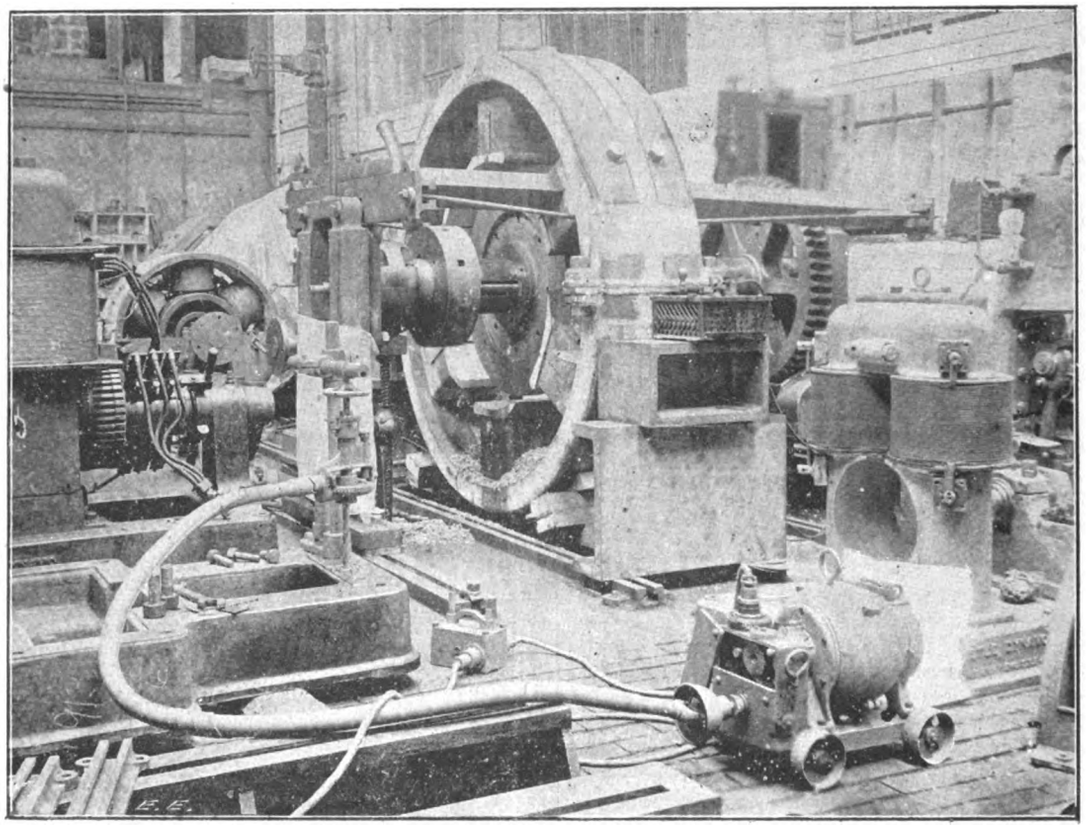

FIG. 10.—View in Messrs. J. H. Holmes's New Erecting Shop, showing Portable Electric Drill.

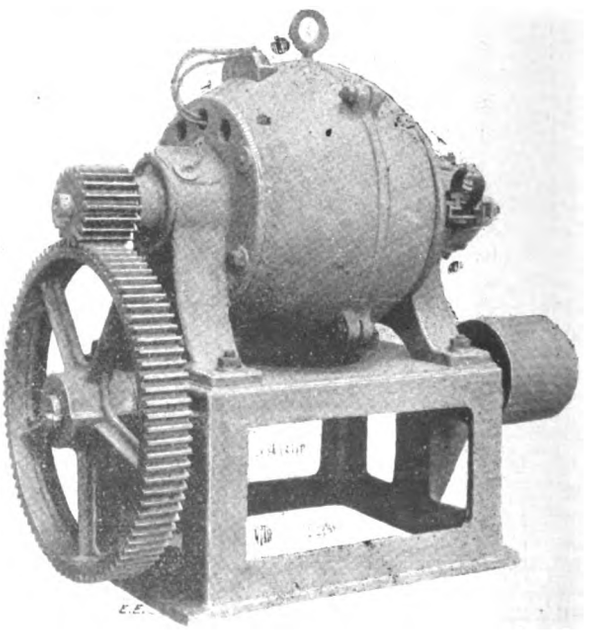

FIG. 11.—Typical Geared Motor.

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THE COMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

The Cable Works of the Allgemeine Elektricitats-Gesellschaft

(Concluded from page 750.)

Cables for submarine telegraph purposes are not lead-covered, as the weight has to be kept as small as possible in consideration of the great lengths used. They can be made by the Allgemeine Elektricitäts-Gesellschaft up to lengths of 6,000 km. without jointing. Guttapercha is used as the insulating material, being pressed round the core in several jointless covers. This material possesses high insulating properties, and is not affected by salt water. Over the guttapercha several layers of impregnated jute string are wound, and over this again an armouring of steel wire—light for deep-sea cables, and heavy for shore cables to protect it against ships, anchors, etc.

The displacement of bare overhead telephone cables by underground cables with insulated lead and return, which is rapidly taking place in towns, has given rise to a large demand for lead-sheathed cables made up of many pairs of wires. The Allgemeine Elektricitäts-Gesellschaft have laid down special machinery to meet with this demand, and manufacture telephone cables containing as many as 250 pairs. Each pair consists of one tinned and one untinned wire. The separate wires are loosely insulated with paper, so as to allow a free passage of air from end to end. This air insulation is of great importance, as experience has shown that the better the ventilation the lower the capacity of the cables, and the better their speaking properties. Telephone cables which are laid directly in the ground are generally further protected by the addition of an armouring of wire, trapezoidal in section. Cables which are to be laid in conduits are not armoured, but the lead covering contains an admixture of tin.

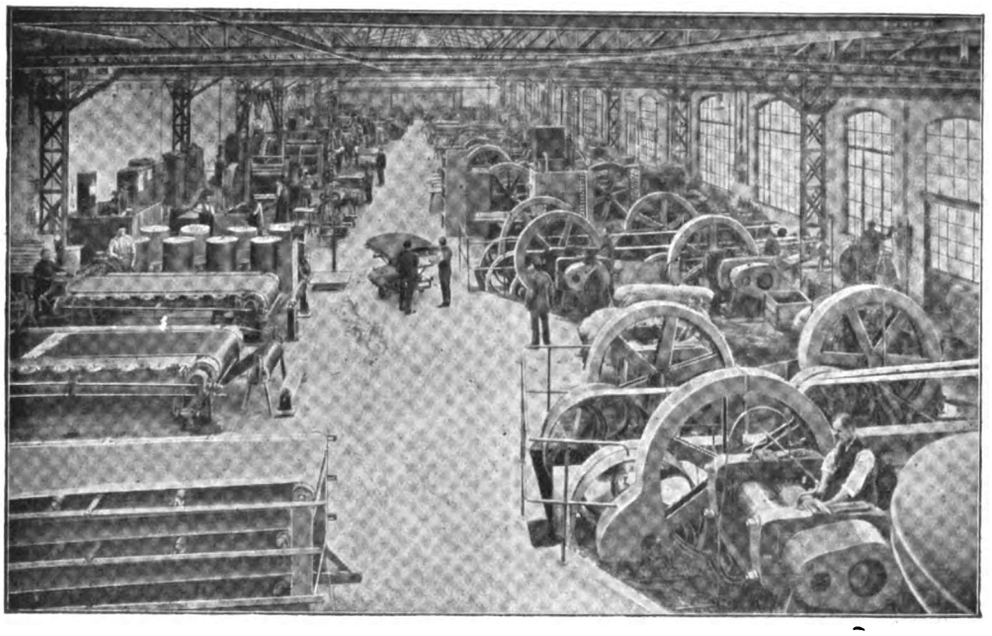

FIG. 5.—Insulation Kneading Mills, Oberschoneweide.

Besides the manufacture of cables, the Allgemeine Elektricitäts-Gesellschaft have specially-equipped departments for the manufacture of all kinds of wires, cotton and silk covered. The insulation of these is either a simple lapping of cotton or silk or jute, or a braiding, or a combination of lapping and braiding. There is a large demand for wires for damp or wet situations. The first class, those for damp places, are covered with cotton, then pure Para rubber, then another covering of cotton, and then braided over all. This class of wire is extensively used for the exposed system of wiring rooms, etc., with insulators, so much in vogue on the Continent. For wet

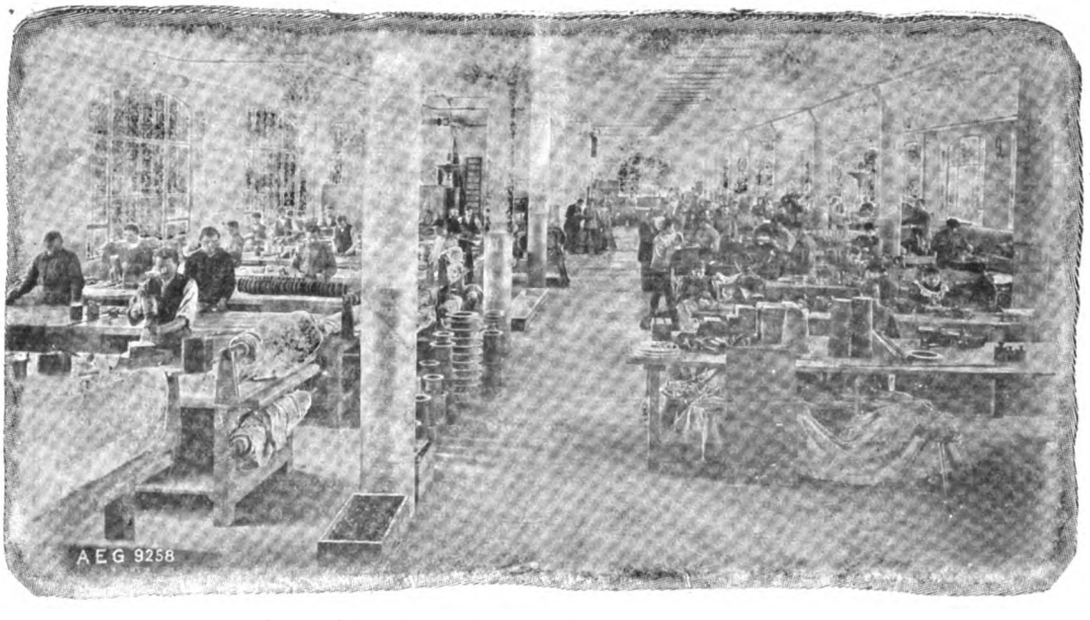

FIG. 6.—"Vulcasbeston" Insulation Department, Oberschoneweide.

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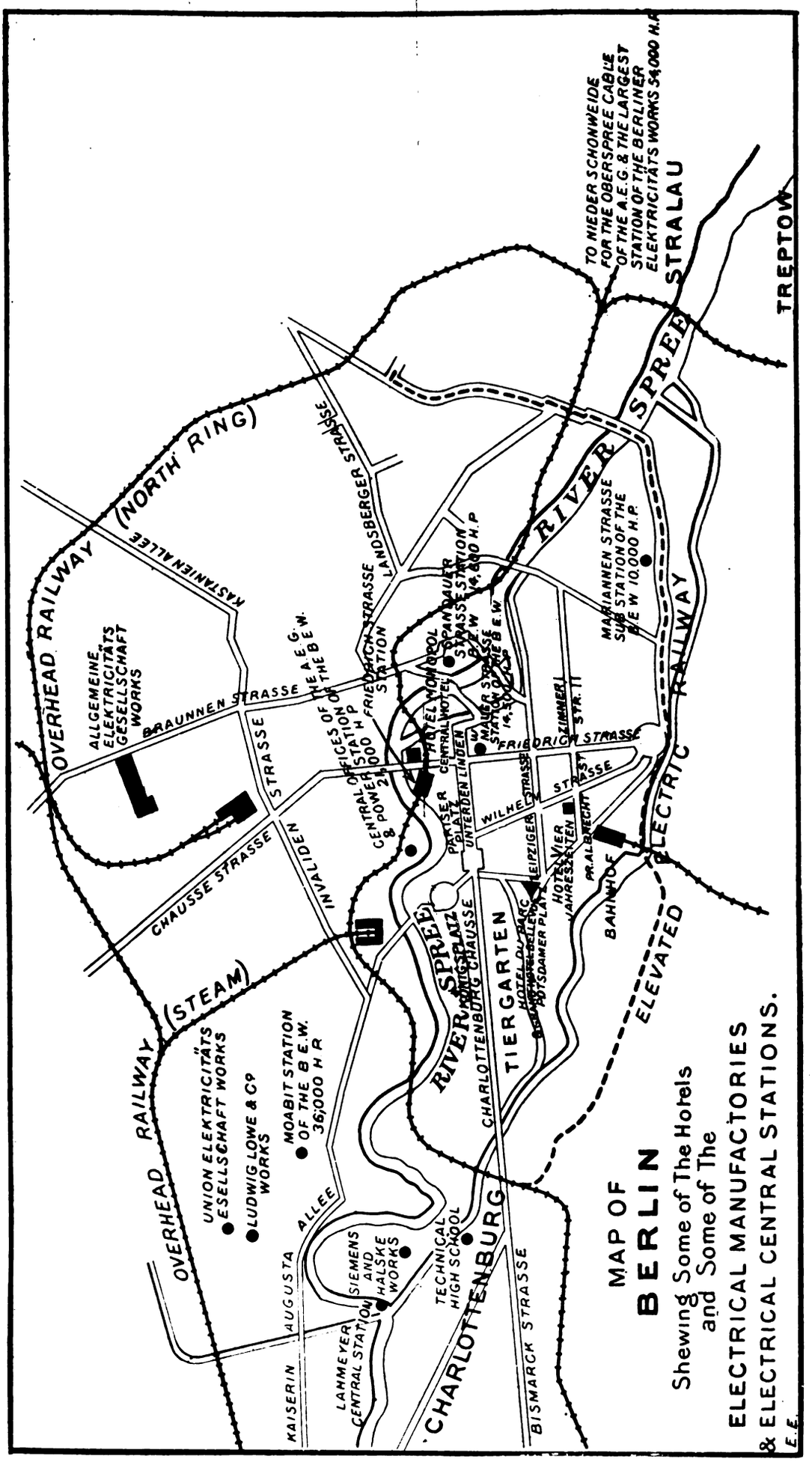
positions the wires are given first a seamless covering of strong vulcanised rubber, then a layer of rubber tape, a covering of cotton, and finally impregnated so that they are impervious to moisture. To protect wires against external damage, they are braided with fine steel wire. In addition to the cable and wire departments, the manufacture of all descriptions of insulating material is conducted at these works, including the Allgemeine



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Elektricitäts Gesellschaft's special products, "stabilit" and "vulcasbeston." The processes of working up the raw rubber into its finished condition are very interesting. The raw material is shredded, purified, and dried in the vacuum ovens. It is then kneaded in the rolling mills (Fig. 5) and drawn through calenders into sheets 20m. to 30m. long and 800mm. wide. Stabilit is a special preparation, consisting principally of Para rubber; it possesses excellent insulating properties, is non-hydroscopic, and is very readily moulded. "Vulcasbeston" (Fig. 6) is a composition of stabilit and asbestos, and is capable of withstanding very high temperatures without injury. It is used very largely for transformer and field winding spools. In another department (Fig. 7) micanite paper and cloth is built up from flaked mica. An extensive use of this excellent insulating material is made in armature winding and commutator building.

In conclusion, we should like to mention the elaborate arrangements which exist for the comfort and welfare of the employés. In addition to the ambulance wagon and first-aid accessories, there is a very completely equipped hospital room, with a skilled man always in attendance. When the works were first started accidents were frequent, but as the workpeople became familiarised with the machinery the number of cases considerably diminished, and the attendant has been heard to complain of a slack time of late. Shower and other baths are provided free for those engaged in the more uncleanly operations; others can have the use of the baths by the payment of one halfpenny. Separate dining-rooms are provided for the management, the foremen, and for the male and female employés. Instruction is also given to the girls after working hours in needlework, etc., and periodical entertainments are also given. We feel sure that those who will have the pleasure of visiting these works will agree with the statement we made at the beginning of this article, that they are quite model in every respect.

Fig. 7.—"Micanite Insulation Department, Oberschoneweide.

CATALOGUES RECEIVED.

The General Electric Company have brought to our notice their new "Papriwire" insulation, which the firm intend to substitute in place of their "Excelsior" insulation. It is claimed for this new insulation that it is in every way equal to rubber insulation for bell wires in ordinary housework. These bell wires as supplied by the General Electric Company consist of high-conductivity copper wire, tinned, lapped with impregnated paper, and then braided with cotton and highly paraffined.

We have received from Messrs. Dorman and Smith their catalogue of electrical apparatus and accessories. These include different types of switches, circuit breakers, porcelain wall sockets, ceiling roses, lampholders, etc. We particularly notice in this catalogue a description of a new patent circular enclosed cut-out. These cut-outs are said to successfully stand any number of dead short-circuits at 250 volts. The arc blows itself out through a tunnel furnished at its end with the firm's wire-gauze vent. Without this vent, the flame which issues from the tunnel's mouth when the fuse blows is stated to be capable of setting fire to flimsy articles. We gather that the use of this wire-gauze vent is fully protected.

APPOINTMENTS VACANT.

Resident Electrical Engineer, Epsom Urban District Council, £3 per week, June 8. Full particulars in our advertisement columns.

Shift Engineer, electrician-in-charge for Canterbury electricity works, £78 per annum. Apply to Mr. N. Staniland, chief engineer.

Assistants (Two), Birkenhead Corporation electric tramways, 30*s.* per week, June 11. Apply to Mr. W. Bates, borough electrical engineer.

Chief Clerk, Wimbledon Urban District Council electricity department, £100 per annum, June 8. Apply to Mr. F. Barnes Spencer, electrical engineer to Council.

FORTHCOMING EVENTS.

FRIDAY, MAY 31.

Physical Society.—At 5 p.m., ordinary meeting.

MONDAY, JUNE 3.

Royal Institution.—At 5 p.m., general monthly meeting. Liverpool Self-Propelled Traffic Association. Trials of heavy motor vehicles commence. These will take place in the Liverpool and Manchester district on every day of the week up to and including Friday, the 7th. Monday: Hill-climbing tests at Everton and manœuvring tests at the Liverpool Docks. Tuesday: Liverpool to Manchester, *via* Warrington. Wednesday: Manchester to Liverpool, *via* Bolton. Thursday: Liverpool to Blackburn, *via* Chorley. Friday: Blackburn to Liverpool *via* Preston.

Society of Engineers.—At 7.30 p.m., ordinary meeting. Paper on "Concrete Subways for Underground Pipes," by Mr. A. Taylor Allen.

THURSDAY, JUNE 6.

Royal Institution.—At 3 p.m., Prof. Dewar on "The Chemistry of Carbon" (Lecture III.).

Rontgen Society.—At 8.30 p.m., general meeting. Paper: "X-Ray Diagnosis of Aneurism," with lantern demonstration, by Dr. Hugh Walsham.

FRIDAY, JUNE 7.

Royal Institution.—At 9 p.m., Prof. Raphael Meldola on "Mimetic Insects."

Accident.—Mr. and Mrs. W. B. Esson were thrown out of a trap at Maidenhead on Saturday afternoon last. Mrs. Esson was badly bruised and shaken. Mr. Esson escaped with little more than a sprain. We wish them both a speedy recovery.

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THE VISIT TO GERMANY.

By the time these words are read most members of the Institution will have received the provisional programme of this visit. The work as arranged will test the physical condition of the members, even if the mental pabulum be taken as a pleasing change to the labours of each day. The *savants* of Germany have ever been in the forefront of scientific advancement, and its business men have never failed to stand similarly in applied science. We heartily welcome these international meetings. They introduce a better means of rubbing shoulders and exchanging opinions with men whose names are familiar as household words, broadening the minds and increasing the knowledge of all who take part in them. A healthy mind loves competition, and loves its competitors, luxuriating in friendly social intercourse. Neither the scientific man nor the business man cries out for official help, but prefers to work out his own aims in his own way to his own advantage. The man who is too old or too conceited to learn is too good to live. His position is with the angelic host, being of no further use in mundane spheres of life. On the other hand, the man whose brain is ready to receive new impressions, to discuss their value, to decide as to their use, is the man who is still wanted. Visits among other workers both in pure and applied science are object lessons, the value of each lesson being determined by the mental characteristic of the individual. There is much to see in Germany, and many details of practice to be studied by the visiting engineers. The provisional programme gives the arrangements made for three groups—one group ending the visit at Berlin, another at Dresden, and the third at Frankfurt-a-Main. Each day's work is sketched out, but as all members of the Institution will in the ordinary course receive a copy of the programme, it is unnecessary to give it at length. It will be enough to say that the party leaves England on June 22, *viâ* the Harwich and Hook of Holland route of the Great Eastern Railway, whose service, both as regards trains and boats, is probably the best that caters for Continental traffic. The detail arrangements have been placed in the hands of Messrs. T. Cook and Sons, whose great experience ought to ensure comfortable travelling. The estimated expense, so far as it can be estimated, is moderate in amount, and should ensure a full meeting. There are one or two points too often forgotten by those who take part in meetings of this kind, the principal, perhaps, being the enormous strain thrown upon the organisers, and this is made greater by the selfishness and carelessness of individual travellers who ought to know better. It seems ridiculous to accuse men of business, even when accompanied by ladies, of imposing upon the time and patience of the leaders of the expedition, and of neglecting the most simple precautions taken by individual travellers; but, unfortunately, this happens to far too great an extent. It should be held to be a privilege for every member to lighten the burden upon the officials as much as possible, and, so to speak, when in doubt, to forage for themselves. During the past

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few weeks we have given some notes upon the visit and the places to be visited. These will be continued, and in this issue we give a sketch map which may assist members in obtaining an indication of the works to be visited in Berlin, and the principal points of guidance in that city.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRIGHTON CABLES.

SIR,—Some weeks ago you published a series of letters which had passed between the Brighton Corporation and the Cable Makers' Association *re* the contract for the supply of cables to the former, which my company was fortunate enough to secure. I have waited to see whether any further letters would be published, but the correspondence appears to have stopped very abruptly.

The Cable Makers' Association stated and seemed to prove to their own satisfaction that the prices of the Union Cable Company, Limited, were higher in the aggregate than those quoted by some members of the association. It is impossible for anyone to say whether this is so or not without having the actual tenders for reference. I have a copy of the Union Cable Company's tender—which was in strict accordance with the Brighton specification—and, assuming that the members of the Cable Makers' Association based their tenders on the "standard" tables set out in the printed circular issued by the association in October last, their statement with regard to price would appear to require some further proof.

In making their comparison of prices, the Cable Makers' Association altogether ignore the question of conductor resistance, but, if they quoted in accordance with these "standard" tables, the resistance is a considerable factor in the calculation. The greater portion of the contract price is for one square inch conductor cable, of which seven miles are required. For this conductor (and for all others in proportion) the Union Cable Company, Limited, guaranteed a resistance of ·0422 ohm per mile at a temperature of 60deg. F., whilst the Cable Makers' Association guarantee only ·044176 ohm at ——— temperature. The "standard" tables omit all mention of the temperature at which resistance is to be measured, but if we assume that it is to be at the usual 60deg. F., then it seems to me that, all other conditions being equal, the value of the cables to the engineer is in inverse proportion to these resistance figures.

The Union Cable Company's resistance is 4·68 per cent. better than the Cable Makers' Association's, and as the Cable Makers' Association's lowest tender (£13,365) is only 4·2 per cent. lower than the Union Cable Company's (£13,952), it would appear, taking the one square inch conductor cable as a standard, that the Union Cable Company's tender really was lower than the lowest association tender by ·48 per cent. on the value of the cables alone. If we add to the association tender (*a*) cost of return of empty drums, and (*b*) the one-third cost of drums which the Cable Makers' Association insist on being paid in the event of drums being retained for a longer period than three months, even leaving out of consideration the fact that the buyers' engineer is buying exactly what he wants to buy, and not just what the seller wants to sell to him, I do not think there can be much doubt as to which is the more favourable tender for the buyer.

I trust that in fairness to my company you will be good enough to find space in your next issue for the above.—Yours, etc.,

J. A. BLACKWOOD,
Secretary to the Union Cable Company, Limited.

INSTITUTION OF ELECTRICAL ENGINEERS.

The report for the past year of the Council of the Institution of Electrical Engineers has now reached us, and it shows that many new departures have been made by the Council during the year. The report commences with a reference to the death of her Majesty Queen Victoria, and to the votes of condolence and loyalty which were passed by the parent Institution and its various local sections. After some notes as to the success of these local sections, including the new ones at Calcutta and Birmingham, reference is made to the lamented death of Prof. G. F. Fitzgerald. The increase in the membership of the society continues satisfactory. During the past 12 months there have been elected 21 members, 89 associate members, five foreign members, 140 associates, and 173 students, making a total of 428.

A long list of papers read is then given, and we are pleased to congratulate the following gentlemen on the premiums awarded them. These awards are: The Institution premium, value £25, to Mr. M. O'Gorman, member, for his paper entitled "Insulation on Cables." The Paris Electrical Exhibition premium, value £10, to Mr. W. Duddell, associate member, for his paper entitled, "On Rapid Variations of the Current through the Direct-Current Arc." The Fahie premium, value £10, to Mr. A. C. Eborall, member, for his paper entitled "Some Notes on Polyphase Sub-Station Machinery." An extra premium, value £10, to Mr. J. S. Highfield, member, for his paper entitled "Storage Batteries in Electric Power Stations controlled by Reversible Boosters." Four extra premiums, value £5 each, respectively to Mr. M. B. Field, member, for his (Glasgow Local Section) paper entitled "A Method of Compensating Voltmeters for Voltage Drop in Large Feeders"; to Mr. W. Wyld, associate member, for his (Birmingham Local Section) paper entitled "Polyphase Equipment of Factories"; to Mr. G. Ralph, associate member, for his (Newcastle Local Section) paper entitled "Electrically-Driven Machine Tools and their Advantages for Use in Engineering Workshops"; and to Mr. F. Holden, member, for his paper entitled "A Watt-Hour Meter." The first students' premium, value £10, to Mr. C. B. Nixon, student, for his paper on "Application of Electrical Power to Machine Tools." The second students' premium, value £5, to Mr. F. J. Hiss, jun., student, for his paper on "Recent Work on Hertz Wave Phenomena and its Application to Wireless Telegraphy." The third students' premium, value £5, to Mr. J. H. Vigor, student, for his paper on "Rotatory Converter Problems." An extra students' premium, value £3, to Mr. J. H. West, student, for his paper on "Accumulators." The Council has awarded two Salomons scholarships, value £50 each—one to Mr. J. D. Griffin, of the Central Technical College, and one to Mr. Herbert Ashlin Skelton, of King's College. The sum of £2,000, referred to in the last annual report as having been bequeathed by the late Prof. Hughes to found the David Hughes scholarship in the Institution, has now been received from the executors, and the Council has determined that for the present the manner of award shall be the same as that of the Salomons scholarship. They have selected Mr. C. J. Hopkins, of the Central Technical College, as the David Hughes scholar for the present year, the amount of the scholarship being £50. Mention is then made of the 20 students who were given £5 towards their expenses in visiting the Paris Exhibition. A list of these students is given, and also of the special class of exhibits about which each student had to write a report.

We learn that four sub-committees of the Council have been appointed, each consisting of one or two members, with power to add to their number. These committees are supposed to represent the following interests, and to see that good papers on the same are obtained: (1) traction, light, and power distribution; (2) telegraphs and telephones; (3) manufacturing; (4) electro-chemistry and electro-metallurgy. The Council also hopes that these committees will report on the relations between the Institution and their respective branches of electrical engineering, and on the special conditions or requirements for the time being of those branches. Reference is also made to the Paris visit, and to the welcome to the American Institute of Electrical Engineers. This institute has forwarded an illuminated address, which was presented at the meeting last night, and reads as follows.

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The American Institute of Electrical Engineers has the honour to transmit with fraternal greetings to the Institution of Electrical Engineers of Great Britain the following resolutions:

Whereas, the American Institute of Electrical Engineers during the visit of its members to London and Paris in connection with the International Electrical Congress of 1900, and also in connection with the joint meeting immediately preceding the same of the British Institution and American Institute of Electrical Engineers held in Paris on Aug. 16, 1900, was the recipient of many courtesies and much hospitality from the British Institution of Electrical Engineers,

Resolved, "That the American Institute of Electrical Engineers herewith respectfully tenders to the Institution of Electrical Engineers of Great Britain its sincere thanks for the many courtesies extended to its members in connection with the above-mentioned visit to London, and with the joint meeting of the two institutions in Paris, both of which have left many pleasurable recollections."

Resolved, "That a copy of these resolutions be forwarded to the Institution of Electrical Engineers in London, and that a copy of the same be published in the *Transactions* of the American Institute of Electrical Engineers."

The above resolutions were unanimously adopted at a meeting of the Council of the American Institute of Electrical Engineers held in New York City, U.S.A., March 22, 1901.

(Signed) CARL HERING, President.
RALPH W. POPE, secretary.

Three special committees of the Council have been elected, dealing with the following three subjects: (*a*) the revision of the wiring rules; (*b*) the drawing of model general conditions for electrical contracts; (*c*) the general matters arising out of Mr. W. L. Madgen's paper on the Electrical Power Bills. There are many other items of interest in the report, but the last to which we can refer is the formation by the Council of an employment register. This latest move is open to some objection, as will, we believe, be found after a year or two of experience.

The following is an abstract of the receipts and expenditure account and of the balance-sheet for the past year:

STATEMENT OF RECEIPTS AND EXPENDITURE.

Dr. Receipts.	£ s. d.
Annual subscriptions	5,126 8 0
Entrance fees	596 17 0
Cash balance paid by Northern Society of Electrical Engineers	184 12 7
Advertisements in the *Journal*	72 0 0
Publishing fund	1 1 0
Dividends on investments—viz.: life compositions, £153. 15s. 10d.; general fund, £113. 11s. 8d.	267 7 6
Interest on cash on deposit	17 2 1
	£6,265 8 2

Cr. Expenditure.		£ s. d.
Salaries		891 13 6
Retiring allowance		300 0 9
Accountants' fees, 1899	£10 10 0	
Accountants' fees, 1900	15 15 0	
		26 5 0
Shorthand reporter		61 19 0
Attendance, refreshments, advance proofs of papers, and petty expenses connected with evening meetings		149 16 1
Printing, illustrating, and advertising *Journal*	636 1 9	
Less copies taken into stock	62 10 0	
		573 11 9
General printing and stationery		240 4 10
Insurance		9 15 0
Office rent, electric light, and firing		330 14 2
General office expenses—viz: sundries	85 17 3	
Diploma cases	5 1 0	
Hon. solicitor's out-of-pocket expenses	5 5 0	
Repairs to typewriter	1 5 8	
Memorial wreath for the late Lord Armstrong	1 11 0	
Postage of *Journals*, etc.	447 0 2	
		546 0 1
Petty expenses of local hon. secretaries		3 14 5
Bank charges		2 18 3
Conversazione expenses (irrespective of printing and postage)		230 15 3
Premiums (1899-1900)	85 15 11	
Grants to student reporters for Paris Exhibition	100 0 0	
		185 15 11
Expenses relating to the Paris meeting		128 9 11
Ditto reception of the active-service contingent of the E.E. Volunteers		203 5 10
Contribution to *Science Abstracts*		730 0 0
Expenses connected with local sections		101 2 10
		4,716 1 10
Balance carried to general fund, being excess of receipts over expenditure		1,549 6 4
		£6,265 8 2

BALANCE-SHEET.

Dr. Liabilities.		£ s. d.
Life compositions—balance uninvested		32 0 0
Subscriptions received in advance		85 7 8
Salomons scholarship fund—balance of income account		53 10 5
Wilde benevolent fund—balance of capital uninvested, £6. 3s. 9d.; and balance of income account, £21. 2s. 11d.		27 6 8
David Hughes scholarship fund—balance of capital uninvested		1 5 0
Building fund—balance uninvested		208 18 11
Suspense account—amount of subscriptions paid in advance of election		4 8 0
General fund—balance as per last account	£4,714 4 9	
Add further amount received for photographs connected with the Swiss visit	1 19 1	
Estimated value of books presented	38 15 0	
Excess of receipts over expenditure	1,549 6 4	
	6,304 5 2	
Less amount transferred to building fund	729 11 10	
		5,574 13 4
Sundry creditors		125 15 10
		£6,113 5 10

Cr. Assets.		£ s. d.
Investments, general fund		3,563 0 7
Furniture account (as per last balance-sheet)	£239 3 6	
Add card catalogue cabinet	2 17 0	
		242 0 6
Stock in hand of *Journals*, etc. (as per last balance-sheet)	309 13 3	
Add cost of additions in 1900	62 10 0	
	372 3 3	
Less amount realised during the year	129 5 6	
		242 17 9
Stock in hand of "Cooke's Manuscripts"		18 5 2
Books, pictures, etc., other than the Ronald's library (as per last balance-sheet)	1,336 19 7	
Add value of books and periodicals since purchased and cost of binding	21 18 10	
Value of books and periodicals presented	38 15 0	
		1,397 13 5
Stock of vellum diploma forms		3 19 10
National Telephone Company deposit		0 10 0
Sundry debtors for advertisements, etc.		97 19 3
Balance in hands of local sections		9 8 0
Cash balances at bankers—General account	456 2 11	
Swiss visit account	19 4 8	
Petty cash account	62 3 9	
		537 11 4
		£6,113 5 10

THE PROTECTION OF OVERHEAD TRAMWAY CONDUCTORS.

The recent accident at Liverpool has brought to the front a number of inventors who have worked on the great question of the protection of the public from all such dangers as resulted from the fatal accident in that city. We have already described some four or five devices having for their object either the disconnection of a trolley wire from the main supply in the event of a telegraph or telephone conductor falling across them, or the insulating of the broken ends of the trolley wire in case a fracture should occur. This week we have had information forwarded to us from two other inventors. The first apparatus now under consideration is that manufactured by Messrs. Bostock and Cheetham, of Brighouse, Yorks. The manufacturers of this safety device have recently experimented with it at Hull, where successful trials were made to prove that the ends of a broken trolley wire were quite dead before they reached the ground. The arrangement requires, however, that each span shall be independent of its neighbours. It is decribed by its inventors as follows: Attached to the arm of the overhead wire by means of an insulated clip is a frame, in the centre of which is an upright piece to which a pair of weighted L lever

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arms are hinged and insulated. Each inner arm of the lever is connected by a hinged link with a block free to slide within the frame, the inner face of each block being insulated, and the outer face of each block carries a hook to which the overhead wire is attached. The communication way for the wheel or pulley for taking the electricity from the wire is made by means of a pair of hinged concave arms, which are held in position by means of two loops and two hooked pins which engage in the said loops, holding them in a horizontal position, so that a continuous wheel race is provided from one length of wire to the next length of wire. The action is as follows: In the event of a wire breaking, there being no longer tension on the wire and hook, the lever arm of the broken wire falls, and through its fall gives motion to the connecting link, and draws back the block in its side until the inner end of the block is brought into contact with an insulated case of the upright, and the current is shut off instantly and automatically. The same current of the slide piece withdraws the hooked pin from the loop of the concave arm, which at once falls into a vertical position and so moves clear of the broken wire.

From the illustration which is given by Messrs. Bostock and Cheetham, it would seem that the device is chiefly adaptable for side-pole suspension, as the weight of the levers and switch gear would be very heavy to carry on a span wire. The apparatus is, of course, only intended as a protection against a broken wire, and does not at all effect the protection of the public if a telegraph or telephone wire falls down on the trolley wire without breaking it. The chief disadvantage, in our opinion, in the device is that a continuous trolley wire is not employed. It also adds somewhat to the unsightliness of tramway construction, which is a matter for consideration in most towns.

The other device brought to our notice is that of Mr. C. J. R. Mesurier, of 19, Perrymead-street, Fulham. Of this device we have received a diagrammatic sketch, as shown in Fig. 1. It is particularly impressed upon us that this sketch is merely to show the arrangements, and not the actual details of the design of the electrically controlled switch release and electromagnets. The inventor's description of the apparatus sent us with the drawing is as follows: "A is the main overhead wire, B B guard wires, which are not merely a mechanical protection, but are insulated, and form a complete loop circuit, through which the battery, C, maintains a small but uninterrupted current; *b b* are non-conducting attachments, linking the main overhead wire, A, to the guard wire, B, so that in the event of the main, A, falling it would sever and carry with it the guard wire, B. D is a main switch between the generators and the main A; F is an electromagnet in circuit with the battery, C, and loop guard wire, B B; G is a larger electromagnet, which comes into action only under certain conditions. The working of this safety system is as follows: the battery, C, constantly maintains a small current through the loop guard wire, B B, the connection between the generator and the main overhead wire, A, being made dependent on the continuity of this loop circuit. This is effected by arranging that the powerful spring, H, will instantly actuate the main switch whenever the latter is freed by the release of the detent, K, which is held permanently latched by the electromagnet, F, through which the small current of the battery, C, is uninterruptedly maintained. The larger electromagnet, G, with an earth connection, E, is merely to provide for the case of a telegraph or telephone wire falling across (without severing) the guard wire, B B, and connecting it with the main overhead wire, A. A large current would then instantly pass through the electromagnet, G, which would overpower the small electromagnet, F, drawing the armature away from it, thus actuating the pivoted lever, M, and releasing the detent of the main switch. Apart from the falling across the system of telegraph or telephone wires, there is the possibility of a section of the main overhead wire becoming detached from the supports and trailing in the roadway. In this case also the main circuit would be broken.

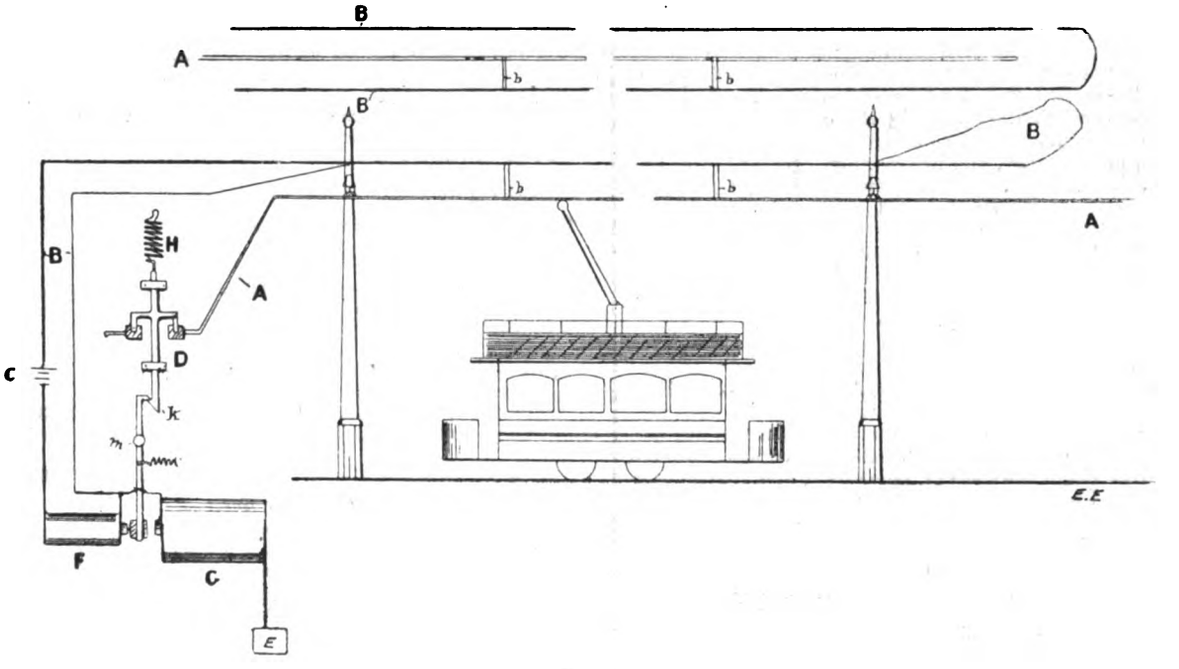

FIG. 1.

as the falling wire must necessarily carry with it and thus sever the guard wire, B, by virtue of the non-conducting connecting links, *b b*."

We have had an engineer representing the inventor to see us, and have discussed the details of the device with him. We gather that the guard wires over each section of the line controlled from a switch pillar would be connected up in a ring, and that the inventor claims a great advantage from having a current circulating in this ring, because in the event of the wire becoming broken the high-voltage current would immediately be cut off the trolley wire underneath it. Our objection to the device is the suggested weakness of the guard wires, which are supposed to break in the event of the trolley wire becoming fractured. It is conceivable in our opinion that it would require exceedingly delicate handling when erecting these guard wires in order to so adjust the tension that the weight of the length of trolley wire, which would be supported by the insulators from the guard wire, would be sufficient to cause a fracture. Assuming that it could be done, there would then be the question as to whether wind and snow would not cause endless trouble by interrupting the guard wires and throwing off the switches. It was suggested to us that the difficulty referred to could be overcome by having the ends of the guard wires secured to a plug held in a sleeve with a spring grip, which could be adjusted

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to release when a slight addition to weight was put on. On the whole, it seems to us that the electromagnet through which the current would pass to earth would really give the most protection, and that the current circulating in the loop has not really the advantages which at first sight would appear. Of course, unless the mechanical conditions of making the guard wires give way when a trolley wire breaks can be overcome, the device does not give the protection which is desired in such cases, but it would still protect against telephone wires which make contact with both the trolley and guard wire.

ELECTRIC TRAMWAYS FOR LEICESTER.

Report of Mr. E. Manville, M.I.C.E.

(Concluded from page 752.)

Situation of a Generating Station.

I have gone very carefully into the relative advantages of an independent central power station, a power station in connection with the existing Corporation gas and electric light works at Aylestone, and a combination of the various dust destructor installations existing in the borough with electric generating stations, supplemented by coal-fired boilers. Dealing in the first place with the last proposal—*i.e.*, the production of as much as possible of the electrical energy required for the tramway from steam raised by the various dust destructors, and supplementing these with coal-fired boilers installed at the dust destructor stations—I have considered this very carefully, and am absolutely satisfied that any advantages that might accrue to this system through the saving in the consumption of coal would be so much more than counterbalanced by extra capital expenditure, maintenance, and increased charges of labour and supervision, that I could, under no circumstances, recommend it to your serious consideration, and I am of opinion that this alternative may be entirely set aside. The question, therefore, resolves itself into the consideration of the two other alternatives of an independent station situated at a site favourable for distribution to the tramway system and of the installation of the requisite machinery, as an addition to, and in conjunction with, that required for the generation and distribution of electricity for lighting and other purposes at the present existing gas and electric light works at Aylestone. In order to arrive at a conclusion on this important subject, I have inspected the gasworks site and existing power station, and also the site adjoining the Lero dust destructor, and I have since worked out in complete detail the costs of generation and distribution for both sites. I have also prepared detailed schemes and estimates of the sizes, arrangements, and costs of an efficient system of feeders and distributors for the tramway system. Appended to this report are plans of the mains and distributors that would be required in both cases, and charts showing the loss in E.M.F. that would be occasioned by the use of either system, from which will be gathered the efficiencies I am proposing in both cases. Recognising as I do the importance of this question, I have thought it better to go into complete detail rather than to make approximate estimates.

The following, then, are my two estimates of the capital expenditure and costs of production in the cases of the respective sites :

General Data.

Cars in service	85
Probable number of car miles run per annum on the basis of the various services indicated on the plan herewith	2,922,920
Average amount of electrical energy per car mile, including power required for battery charging, sundry motors, lighting in power stations, car-sheds, etc., and including losses in low-tension feeders	1 B.O.T. unit
Therefore kilowatt-hours to be generated per annum : (*a*) continuous-current power station situated on Lero site	2,922,920

(*b*) High-tension power station on gasworks site to be supplied to low-tension tramway feeders after transmission and transformation.

From	B.O.T. units supplied to low-tension feeders.		B.O.T. units generated.
Gasworks site	674,500	.....	758,000
Lero sub-station	1,318,300	.....	1,550,000
Highfields sub-station	930,140	.....	1,100,000
	2,922,900	.....	3,408,000

or, say, 3,410,000 Board of Trade units generated per annum.

It will be observed that the difference between the Board of Trade units supplied to the low-tension feeders at the gasworks and two sub-stations differs from the high-tension Board of Trade units generated at the gasworks, the difference representing the losses in transmission and transformation.

Lero Site.

Estimated Capital Expenditure for Low-Tension Power Station on Lero Site and Low-Tension Feeder System in connection therewith :

	£
Boiler-House Plant.—Five Lancashire boilers, complete with mountings and erected on settings ; complete system of steam, feed, drain, and water pipes, with valves, etc. ; feed pumps, economiser, tank, and sundry ironwork ; coal and ash conveyor plant, automatic stoker gear, and overhead coal store	19,210
Engine-House Plant.—Three direct-driven generators, each 375 kw., at 500 to 550 volts, coupled to vertical medium-speed engines, complete with separately-driven surface-condensing plant ; complete system of exhaust, intake, and discharge pipes, and sundry ironwork ; battery of accumulators to absorb the fluctuations in load, having a discharge capacity of 630 amperes for one hour ; switch-board, consisting of the necessary feeder panels, generator panels, negative booster panels, battery panel, Board of Trade panel, etc., with connections, testing instruments, etc. ; booster for charging battery and negative boosters	22,900
Travelling crane, tools, spares, etc.	800
Total for plant	42,910
Feeders.—Positive : 9,040 yards ·2 square inch, 9,000 yards ·3 square inch, 3,300 yards ·15 square inch. 11,330 yards ·1 square inch, 6,580 yards ·25 square inch, 2,550 yards ·35 square inch, including drawing in and jointing	8,740
Negative : 1,100 yards ·5 square inch, 4,930 yards ·4 square inch, including laying on the solid filling-in system	2 647
Telephone and pilot wires—28,000 yards three core, 8,000 yards four core, including drawing in and jointing	1,848
Excavation and reinstatement of roadways and pavements, 29,000 yards at 3s. 6d. per yard	5,100
Stoneware pipes for above system of positive feeders, laid and jointed	2,373
Brickwork drawing-in boxes, with frames and covers, feeder switch pillars, and section boxes	5 340
Total for feeders	26,048
Total	68,958
Engineering and contingencies, 10 per cent.	6 896
	£75,854

Estimated Cost of Production of 2,922,920 Board of Trade Units, including Interest on Sinking Fund at 5½ per cent. on Capital employed.

	Pence per unit.	£	s.	d.
Coal, water, oil, waste, and sundry stores ; wages, including supervision, repairs, and maintenance	·66	8,037	8	0
Interest and sinking fund, 5½ % on £75,854	·358	4,361	12	0
Total	1·02	£12,399	0	0

Gasworks Site.

Estimated Capital Expenditure for High-Tension Power Station on Gasworks Site, High and Low Tension Feeders, and Sub-Station Plant in connection therewith.

	£
Boiler-House Plant.—Five Lancashire boilers, complete with mountings, and erected on settings ; complete system of steam, feed, drain, and water pipes, with valves, etc. ; feed pumps, economiser, tank, and sundry ironwork	10,210
Engine-House Plant.—Three direct-driven two-phase alternators, each 450 kw. at 2 000 to 2,200 volts, coupled to vertical medium-speed engines, with exciters ; complete surface-condensing plant, together with exhaust, intake, and discharge pipes, and sundry ironwork ; two 165-kw. rotary converters with complement of static transformers ; battery of accumulators having a capacity of 95 kilowatt-hours ; battery-charging motor booster ; main switch-board, comprising the necessary high-tension generator, and high and low tension feeder panels ; transformer battery and Board of Trade panels, etc., connecting cables and testing instruments	26,175
Tools and spares	750
Lero Sub Station.—Three 165-kw. rotary converters with complement of static transformers ; one battery-charging motor booster ; one negative feeder booster ; battery of accumulators having a capacity of 190 kilowatt-hours ; main switchboard, comprising high-tension receiving and transformer panels, low-tension feeder and generator panels, battery motor booster and Board of Trade panels, cable connections, etc.	8,583
Highfields Sub-Station.—Three 115-kw. rotary converters with complement of static transformers ; one battery-charging motor booster ; battery of accumulators having a capacity of 140 kilowatt-hours ; main switchboard, comprising high-tension receiving and transformer panels, low-tension feeder and generator panels, battery motor booster and Board of Trade panels, cable connections, etc.	6,325
Total for plant	14,903
Feeders.—High-tension two-phase, 8 140 yards ·10 by ·10 by ·141 sq. in., 7.760 yards ·066 by ·066 by ·093 sq. in.	6,870
Low-tension : 3,097 yards ·05 square inch, 16,052 yards ·10 square inch, 8,419 yards ·125 square inch, 6,291 yards ·150 square inch, 2,710 yards ·175 square inch, including drawing in and jointing	4,410

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Telephone and test cables—15·7 miles three-core, 57 miles four-core, including drawing in and jointing	1,439
Excavation and reinstatement of roadways and pavements—27,000 yards, at 3s. 6d. per yard	4,730
Stoneware pipes for above system of high and low tension feeders, laid and jointed	2,300
Brickwork drawing-in boxes, with frames and covers, feeder switch pillars and section boxes	4,860
Total for feeders	24 609
Total	76,652
Engineering and contingencies, 10 per cent.	7 665
	£84 317

Estimated Cost of Production of 3,410,000 Board of Trade Units including Interest and Sinking Fund at 5¾ per cent. on Capital Employed.

	Pence per unit.	£	s.	d.
Coke, water, oil, waste, and sundry stores; wages (including supervision), repairs, and maintenance	·614	8,723	0	0
Interest and sinking fund (5¾ per cent. on £84,317)	·341	4,848	0	0
Total	·955	£13,571	0	0

The foregoing estimates are founded on the basis that if a separate generating station at the Lero site is erected, current will there be generated at a pressure of from 500 to 550 volts, and distributed directly to the trolley wire through low-tension distributors; whilst if the gasworks proposition is adopted, high-tension two-phase plant would be installed at the gasworks, producing electrical energy at a pressure of about 2,000 volts each phase. Static and rotary transformers would then be installed on the gasworks site to feed that part of the tramway system nearest the gasworks site with low-tension continuous current, as shown on the plan of the mains accompanying this report; and high-tension transmission lines in duplicate would be run from the gasworks site to two sub-stations, situated one at or near the Lero site and the other in the neighbourhood of Highfields, in both of which sub-stations transformer plant similar to that installed at the gasworks would be erected, and each sub-station would have its own low-tension system of distribution to those portions of the system taking energy from the respective sub-stations. In the estimate of capital cost I have entirely eliminated the cost of buildings. The buildings of the gasworks site monopolised by the machinery for supply to the tramways would cost less than the buildings on the Lero erected expressly for the purpose of the electric generating station; but, on the other hand, if the supply were effected from the gasworks site, the two sub-stations near Highfields and near the Lero site would have to be erected, which would, in my opinion, just about counterbalance the extra cost of the buildings of the Lero power station over those at the gasworks.

From the estimates, your Council will observe that the capital that would have to be expended by the Corporation, exclusive of buildings—in the case of the power being generated at the gasworks—would amount to £84,317, whilst in the case of the separate power station on the Lero site, the capital to be expended would amount to £75,854. The larger expenditure in the case of the gasworks site, of course, tells on the cost of the energy generated, when interest and sinking fund is added, as compared with the smaller cost of the other station. The total costs, including interest and sinking fund, amount on the whole to ·95d. per unit in the case of the gasworks site, or a total sum per annum of £13,571 and 1·02d. per unit for the Lero site, or a total expenditure of £12,399 per annum. It will be observed from these figures that the cost of the unit generated at the gasworks site—even including the extra capital expenditure—is less than the cost per unit if the current were generated at the Lero site, and this notwithstanding that in the estimate of maintenance at the gasworks site is included the requisite wages for attendance at the two sub-stations. But this saving in the cost of generation at the gasworks site over that at the Lero site is more than counterbalanced by the larger number of units required to be generated at the gasworks site to allow for the losses in the high-tension transmission and the ultimate transformation to low-tension current, this in the end giving the Lero site an annual advantage on the estimated car service of £1,172 per annum. In making these estimates of maintenance I have taken the cost of coke at the gasworks at the average of the prices obtained by the gas department for the surplus coke during the last 10 years, and in the case of the Lero site I have taken in the same manner the average price paid for engine slack at the sewage works for the last seven years, and I have further been careful to allow what I estimate to be the full difference of calorific value in favour of the coke over the engine slack. If, however, it be ultimately decided to erect the generating station on the Lero site, and it should be found that coke could be more economically used than engine slack at the prices charged by the gas department for the surplus coke, there would be no reason why coke should not be used there in place of engine slack. The calculations of the costs of the low-tension feeders, with either site, are on the basis that the overhead trolley system is used, and not the conduit system, as mentioned earlier in this report. If a conduit system be used, it becomes necessary to abandon the rails as a return system, and to use an insulated return circuit, with a consequent considerable increase in the cost of the low-tension feeders; and I find that this increase would be in the case of the Lero site £15,568 above the cost with the overhead trolley system, and in the case of the gasworks site, with the distribution from sub-stations, £11,404, maintaining in both cases the same efficiency of distribution as in the case of the overhead trolley system. The above figures point distinctly to the better economy that would be achieved in both capital and costs of production if the Lero site be adopted in place of the gasworks site; but there are other considerations which accentuate this fact, as follows: the difference in cost between the current generated on the two sites in favour of the Lero site is calculated on the number of car miles likely to be run on the tramway system soon after its completion, as at present contemplated; but when, as is tolerably certain will be the case, both the services and the length of lines of the tramways are increased in the future, this difference in cost will become proportionately larger.

The direction in which the extensions at Leicester are progressing will tend to make the Lero site more and more a centre, so far as the ultimate tramway system is concerned, which will reduce the cost of the feeders required from this site for further extensions as compared with the gasworks site. The system that would be used in conjunction with the Lero site is the simplest and most reliable, involving the fewest number of moving parts to depend on, and being entirely without the extra risk always present when high-tension transmissions of electrical energy have to be employed, although, of course, this would not affect the question seriously, especially with the provisions I have made in my estimates for duplicating high-tension feeders, were there any appreciable saving to be made by taking a supply from the gasworks site. Perhaps, however, the most important point of all is the fact that in these comparative estimates I have given only the estimated costs of production of the current, together with interest and maintenance on the plant employed, with both of the proposed plants. It is, however, hardly to be expected that the gas department would be content to supply the tramways with current at this estimated cost of production, which at the best would only just cover their out-of-pocket expenses. I understand from Mr. Colson that he thought his committee would be prepared to supply the tramways with current, should their site be selected, at a price not exceeding the present works cost of the current sold to private consumers from his electric supply station, and which amounted in 1900, according to the figures he has furnished me with, to 1·75d. per Board of Trade unit. Obviously this price, or anything approaching it, would mean such a very large increase on the rates at which the Tramway Committee could generate current for themselves at the Lero site that it would put the taking of a supply from the gasworks site out of the question. There is yet another point in favour of the Lero site, and that is the fact that the heat generated by the cremation of refuse in the destructor might be utilised for saving a part of the fuel I have estimated as being required on this site. By the additional expenditure of £3,600 over and above my capital estimate for the Lero site three new tubular boilers might be added, and a further two cells and a Babcock and Wilcox boiler, which would enable steam to the value of about 200 i.h.p. to be realised, whilst at the same time the two extra cells would enable a further quantity of the town's ashbin refuse to be cremated at this destructor. The above extra expenditure is arrived at by deducting the cost of one of the Lancashire boilers—which would not then be required—from the cost of the additional work to the destructor. As regards the relative facilities at the gasworks, and on the piece of ground adjoining the Lero destructor for accommodating the generating plant, I have inspected both sites, and given consideration to the subject, and I attach herewith a sketch plan showing at least one way in which the piece of ground adjoining the Lero destructor might be utilised for accommodating the plant that would be required for the tramway system, as at present contemplated, with room for further considerable extensions, without acquiring the strip of land at present occupied by the limekilns, which would, should it ever be desirable in the future, allow of still greater extensions being made there.

At the gasworks there is also ample room for the accommodation of the tramway plant, though if the demand for electrical energy for private purposes increases constantly in Leicester, as it is likely to do, the time may rapidly approach when either the tramway plant should be accommodated in a separate building from the electric lighting plant, or the extensions of the electric lighting plant be placed in a second building, in either of which cases some of the economies of the combination of the two systems would disappear. On the gasworks site there exists a well-equipped workshop, in which repairs of all

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machinery can be very economically affected, and that is an advantage which would pertain to the selection of this site. On the other hand, if a separate generating station be erected on the Lero site, it will be within a very short distance of the principal car depôt, where a very complete equipment of tools will necessarily have to be provided, and having regard to the very small number of repairs that are required in connection with electric generating plant of the best description, I do not consider that the question of possessing a fully-equipped workshop on the spot, or within a short distance of it, would make any material difference.

I trust that the particulars I have placed before your committee in this report will enable them to come to a definite conclusion on the matters referred to me. I would further point out that, should they decide on installing the conduit system, they could not alter it in the future in favour of one of the surface contact systems, should that become in the future entirely practicable. In fact, the whole of the tramway would want entire reconstruction, and only the rails would be available when the change were made. On the other hand, should they decide to adopt the overhead trolley system for the present, and the surface-contact systems become practicable in the future, there would be no difficulty in replacing the overhead sytem, in any part of the town where it was thought desirable, with a surface-contact system at very little expense over and above what would be incurred were that system installed at the outset; whilst the steel standards and overhead gear, which in that event would be dispensed with, could be sold for a large proportion of their original cost, and the profits made out of the tramways with the overhead system during the first few years would certainly more than compensate for any loss of capital involved. The difference in capital cost between the conduit system and the overhead trolley system of at least £357,000 represents an extra annual payment, by way of interest and sinking fund, at 5¾ per cent. of, say, £20,500; and so long as the car miles run on the length of tramways proposed did not exceed 3,000,000 this extra payment would represent an extra cost of nearly 1¾d. per car mile; whilst if the overhead trolley system is installed, either the fares could be reduced by this amount or the very large sum which it represents could be utilised for the reduction of the rates.

You have not asked me to investigate the financial prospects of the tramways in Leicester, when extended and electrically equipped, but from the inspections I have made I should like to state that it is perfectly obvious that, with the installation of the trolley system, the tramways cannot fail to be a most remunerative investment for the Corporation. The time taken in reconstructing and electrically equipping the Leicester tramways, on whichever system may be adopted, must necessarily be considerable, and as the complete system can hardly work smoothly and be of full advantage to the town until the re-equipment is completed, I think it would be very desirable that the whole of the work should be carried out as quickly as possible, section after section being put to work as completed.

In conclusion, in my opinion it will be best for your Council (1) to adopt the overhead trolley system of electrical traction; (2) to erect a separate power station for the purposes of the tramways on the Lero site. I should like to express my thanks to Mr. Colson, the gas and electric light engineer, and Mr. Mawbey, the borough engineer, for the great assistance they have afforded me in making the necessary investigations into the matter, and for the trouble they have taken in providing me with the requisite data. (Signed) E. MANVILLE.

The above report was considered in detail by the Tramway Committee, who recommended to the Corporation that the same should be adopted in full, and that Mr. E. Manville, of the firm of Kincaid, Waller, and Manville, should be appointed consulting engineer to carry out the work.

On Tuesday, May 21, this report of the Tramways Committee came up before the Council for discussion. Its adoption was moved by Councillor FLINT, who gave a brief *résumé* of the steps which had led the committee to call in expert advice. He explained that out of six names submitted for the consideration of the committee that of Mr. Manville was unanimously agreed upon. He added that he knew from careful enquiry that Mr. Manville was favourably disposed towards combined power stations, but he considered him an independent expert in whom they could have complete confidence, and whose decision might be loyally accepted. Councillor Flint then referred to the figures mentioned in the report to show how much more expensive the conduit system was than the overhead trolley system. He finally urged the Council to support the committee, so that the Bill for new powers could be deposited in Parliament before next November, otherwise it would be three years before the system could be in operation, whereas a prompt decision would allow of the work being done in two.

The resolution proposed by Councillor Flint was then seconded by Councillor T. SMITH.

The MAYOR, in opposing the motion, expressed his regret that he had to take up the matter, but owing to the large outlay proposed of £400,000, felt that he could not be only a listener. He urged that they should go slowly with respect to the electrical equipment, improving the present system in the meanwhile. While they would like to have the conduit system, if its cost were not prohibitive, he had never ventured to hope for more than a surface-contact system, and that only in the centre of the town. He regretted that there was not more in Mr. Manville's report concerning the Dolter surface-contact system, which was already in work in Paris. He had had good reports of the working of this system during the past winter. He had received a letter addressed to him by Mr. E. Garcke, chairman of the Dolter Company, offering to equip a line or lines in Leicester at the company's expense on the condition that if it were not satisfactory it should be removed, and if it were satisfactory it should be paid for at an agreed price. The Mayor said that there was no man holding a prominent position in the electrical world who did not recognise that the trolley system was doomed, and he personally believed that it would be prohibited by the Board of Trade as soon as a reliable surface-contact system or a cheap conduit system were available. The next point taken up by the Mayor was the question of the power station. He objected to Mr. Manville quoting the figure of 1·75d. per Board of Trade unit as the price at which the Gas Committee would be prepared to supply electricity to the Tramway Committee. Mr. Colson was said to have supplied this, but the matter had not been discussed by the Gas Committee. He also objected to Mr. Manville assuming that high-tension transmission would be required if the generating station was placed at Aylestone, because the Gas Committee had not decided what plant they would put down. In the estimated expenditure on the Lero site of £75,854, Mr. Manville had not included the cost of new buildings, which he (the Mayor) estimated at £10,000. They would also have to buy a new site to build car-sheds, at a cost of £5,239, whereas if they used the Aylestone site for the generating works, the Lero site could be used for the car-sheds. This brought the capital outlay on the Lero site to £91,193, while the capital cost at Aylestone was estimated at £84,317. He estimated the additional buildings required at Aylestone would only cost £5,000. They would not require more than one sub-station, and he concluded that with the Aylestone site the first cost would be £17,376 less than with the Lero site. As regards the running expenses, the extra plant at Aylestone would, the Mayor estimated, only amount to £7 per week, whereas the cost of labour in the proposed station at Lero would be at least £23. 10s. per week, which meant a saving of £858 per annum. With a saving in the carriage of fuel of £260, and together with the interest in sinking-fund charges of the decreased capital cost, the Aylestone site showed an advantage of £2,169 per annum. He did not dispute Mr. Manville's figures, but considered that they were founded on an assumption which did not exist. He, therefore, asked that the report should not be passed that night, and that the committee should adopt the Aylestone site as the cheapest and best.

Councillor WALTERS held that the Mayor ought to have given the information he had collected to the Tramway Committee rather than in full Council, as Mr. Manville was present at the committee, and could have been examined with regard to his own figures and also those brought forward by the Mayor. With regard to the two sites, the Mayor could not in one breath claim that it was an advantage to go to Aylestone to utilise the present machinery, and in the next state that they did not propose to use the present machinery at all. Again, on the question of buildings, he disputed entirely the Mayor's figures, as the cost of the buildings would be the same in each case, being proportional to the cube contents. Again, the growth of Leicester was not in the direction of Aylestone, but rather in the other direction, so that the station would become more inconveniently situated as time went on. The Lero site was not only the best under the present conditions, but also it would be about the centre of gravity of the area in the future. Seeing that the current required for the tramways was not the same as that generated at Aylestone, he thought it would be better not to have one staff for the two systems. As regards the need for expert advice, they had chosen their expert, who, he believed, had a bias in favour of an underground system. Having then obtained an expert's advice, he thought it was time to act. They had quite enough evidence before them to enable them to decide, and he hoped they would go forward with the unanimous vote of the Council to get their Bill in Parliament next year.

Alderman WOOD, knowing the urgent necessity there was for improving the tramway system, suggested they should accept the report with the exception of the position of the site. After a long debate, in which most unnecessary personal remarks were made, this course was agreed upon. In the course of this debate it was elicited from the Mayor that he had received assistance from an expert as well as from Mr. Colson, and that he proposed to have this expert present at the committee meeting. This raised the question as to whether each private member could retain his own expert and have him heard at the deliberations of the committee.

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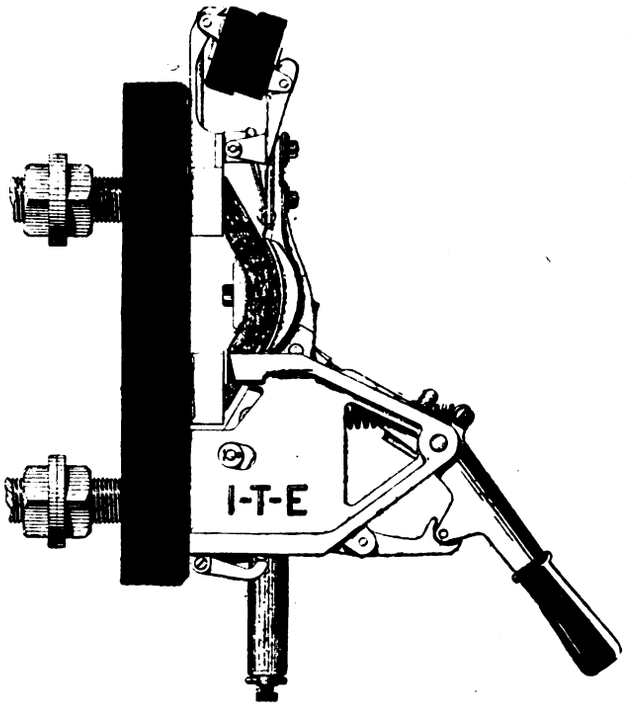
"I. T. E." CIRCUIT BREAKERS.

Messrs. R. W. Blackwell and Co. have recently published a complete list of circuit breakers, which they are supplying in this country under the general name of "I. T. E." circuit breakers. The first thing which an electrical engineer wants to know is, what is the meaning of these letters. They refer to the fact that with these circuit breakers the heavier the excess current is over the normal, the shorter will be the interval of time required in opening the circuit breaker. In the ordinary way the device will open in about 1/100th of a second if the excess current is heavy. This quickness of action makes the circuit breaker of much more use in certain instances than the ordinary fuse can possibly be, in that it interrupts the circuit before the excess current has had time to do damage to the various machines or mains of the circuit. We give in the



Laminated Edgewise Type of Circuit Breaker.

above illustration a typical form of one of these circuit breakers in order to show what are the essential parts, and the makers claim that this form has a distinct advantage over those at present in the market, where the circuit is interrupted by means of falling levers or weights. Here again the advantage lies in the quickness of action. When one comes to look through the list to see the enormous types and numbers of sizes of circuit breakers that are listed, the advantage of standardising will be at once recognised. These circuit breakers are all made to gauge, and can be ordered from stock. The sizes, however, are so exact that if they are to be mounted on a main switchboard, the holes in the slate which have to receive the parts can be drilled before the circuit breaker is delivered. Of course, the list contains circuit breakers for interrupting at overload or for the reverse currents, or even for both overload and reverse currents. There is, however, a new form which commends itself to electrical engineers, in which the circuit can actually be broken at the time it is made if the switch has been closed at the wrong instant. In other words, if a circuit breaker of this kind were used as a main switch, and the machine should accidentally become reversed, no harm would be done if the attendant in the switch-room tried to connect it in parallel with other machines, as the automatic circuit breaker would give relief even at the very instant it was being closed. In every case these circuit breakers have a certain range of adjustment by which they can be set for either overload or reverse current, which is a great advantage in central-station practice.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

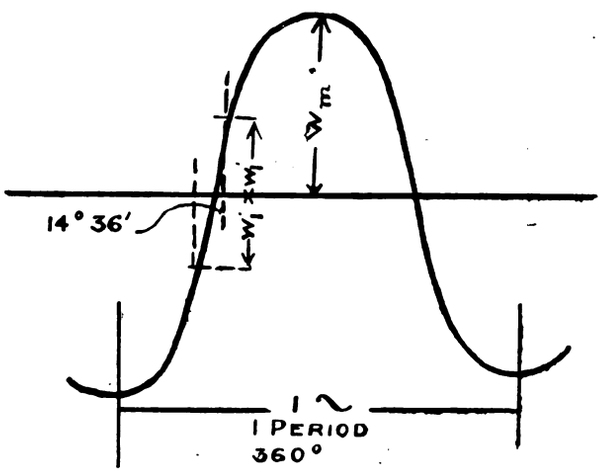
381. On a three-wire system, when the balancing set is shut down for repairs, and the remainder of the set is connected across the outers at 440 volts, and the motor-transformer is connected up for charging the regulation cells only, what would be the best method of charging-up the main battery?—W. M.

382. What is a paralleling voltmeter? How is it connected when used on a three-wire system, and is it a necessary instrument?—H. W.

ANSWERS.

Question No. 375.—Two 120-kw. and one 60-kw. alternators were running in parallel. The exciting circuit of the last named was broken, causing a dead short-circuit across the other two. The main switch on the 60-kw. set was opened and broke with a very small spark. Was this almost sparkless break due to the choking effect of the 60-kw. alternator armature, which was iron-cored? Working pressure, 2,100 volts.

Answer to No. 375 *(awarded 7s. 6d.).*—"R. W." may congratulate himself. If he had opened the switch a small fraction of a second earlier or later than he did, the switch, and probably the panel, would have had to have been renewed. The reason why the switch broke with so small a spark, was because it happened to be opened at the moment the watts were at zero, or nearly so; it could with a frequency of 80 be opened 100 times per second



with the same effect (the watt curve passes the zero line twice per period), but the time during which this may be done is very small. For instance, say the short was equal to 200,000 watts, the switch sparkless at 2,000 watts, frequency 80, then the sine of the angle during which the switch may be opened sparkless = sine = $\frac{W_1}{W} \frac{\sim}{2\pi}$

$= \frac{2,000 \times 80}{200,000 \times 2 \times 3{\cdot}14} = {\cdot}127$ angle = see table = 7° 18'.

This multiplied by 2 will equal the total angle during which the switch is sparkless = 7° 18' × 2 = 14° 36'. Time $= \frac{14° 36}{360 \times 80} = {\cdot}0005$ of a second; the total time during which the switch may be broken sparkless per second = ·0005 × 80 × 2 = ·08 of a second. "R. W." is also fortunate in having an iron-cored armature (60-kw. machine); otherwise the impedance to the impressed voltage would have been so small, that the current density would have risen to such a degree that it would have "busted up" his machine.—F. W. S. H.

Answer to No. 375 *(awarded 7s. 6d.).*—The smallness of the spark is due to the fact that as soon as the exciting

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circuit was broken, the 60-kw. alternator immediately became transformed into an asynchronous alternating motor supplied by the two other alternators. It has long been known that when the circuit of a motor, whether continuous or alternating, is opened very much, less arcing occurs at the switch than when a circuit carrying the same current at the same voltage, but consisting of a dead resistance, such as incandescent lamps, is broken. The difference is especially noticeable when the motor armature has a large flywheel effect and is lightly loaded. The explanation is simple. When a current is broken at a switch, the amount of the sparking depends (neglecting inductive effects, which are practically absent in the present case) on the current which is still passing when the switch contact is opened to an appreciable extent. This current has to pass across the small air-gap thus formed as a visible arc. If by any means the current in the circuit can be reduced by the time the contact is broken, the sparking will be correspondingly reduced. Take the case of a continuous-current motor, and so avoid the complications introduced by change of phase relations in the alternating case.

Let E = the supply voltage (assumed constant at all currents);

e = the motor back voltage;

R = the motor armature resistance;

C and C_1 the currents in the circuit when the switch is closed and when it is just open respectively;

then $$C = \frac{E - e}{R}.$$

Now, during the fraction of time taken to open the switch, we may assume that the motor speed, and consequently e, will remain practically constant, due to the momentum of the armature, so that at the moment when the switch is sufficiently opened to introduce an additional resistance, r, into the circuit, the current will be $C_1 = \frac{E - e}{R + r}$.

In the case of a dead resistance load, R_1, supplied at E volts, and taking a current of C amperes, the two currents would be $C = \frac{E}{R_1}$ and $C_1 = \frac{E}{R_1 + r}$.

The great difference between the two cases will at once be seen by replacing the symbols by actual values. Let the motor be one supplied at E = 100 volts and taking 200 amperes = C. Such a motor would have an armature resistance of about ·02 ohm = R. Then $e = 100 - (200 \times ·02) = 96$ volts. When the switch is opened so as to add, say, only ·1 ohm to the circuit, the current will have fallen from C = 200 amperes to $C_1 = \frac{100 - 96}{·02 + ·1} = 33·3$ amperes. On the other hand, in the case of a dead resistance $C = 200 = \frac{100}{R_1}$. $\therefore R_1 = ·5$ ohm. When the switch is opened so as to add ·1 ohm to the circuit, the current will in this case have only fallen from C = 200 amperes to $C_1 = \frac{100}{·5 + ·1} = 166·6$ amperes. In fact, the presence of a motor has much the same effect on the sparking as reducing the supply voltage to a mere fraction (in this example to $\frac{1}{3}$) of its actual value.

Exactly the same explanation, slightly complicated by the impossibility of directly adding or subtracting voltages not in phase with one another, holds in the case of an alternating motor. In the case mentioned in the question, the motoring current passing through the 60-kw. armature would probably be from three to four times the full-load current of the machine, as that would be about the amount required by a modern iron-type alternator to induce a back voltage almost equal to the supply voltage by means of armature reaction alone. In spite of this largely increased current, however, the fact that the circuit contains a motor would be sufficient to reduce the sparking to a quite small amount. The fact that the armature is of the iron type has only an indirect effect on the sparking, by keeping the motoring current down to a smaller figure than would be the case with a coreless armature.—Q.

Answer to No. 375 *(awarded* 5*s.).*—The fact that the machines were iron-cored would undoubtedly moderate the strength of the current flowing into the unexcited machine, but it is not usual to find a 30-ampere machine whose self-induction is sufficiently great to choke down a dead short-circuit current to about 10 or 15 amperes (which would be the largest magnitude of the current to produce a very small spark under the most favourable circumstances) at full voltage. The further explanation is more probably to be found in the fact that, as the supply was alternating, there must have been instants when the voltage was actually at zero before passing on to the next phase. By great good luck the operator broke circuit at one of these instants. As there was only a trifling voltage at the moment of breaking circuit, it was possible to put an effective air resistance in the circuit before the pressure of the other alternators (assisted by the increased voltage due to the self-induction of the unexcited machine on breaking circuit) was sufficient to increase the spark into an arc. This may be seen more clearly by noting that unless there is absolutely no voltage on a circuit, there will be formed, at the instant the extreme edge of the switch blade leaves the tip of the jaws, a small spark, due to the heating and volatilising effect of the current passing through the high resistance of the point of contact. If there is induction in the circuit this spark will be increased, because, owing to the increased resistance of the circuit due to diminution of sectional area at the switch blade, an E.M.F. will be set up tending to strengthen the current up to or beyond its original strength. But in the case that we are considering we may suppose that the E.M.F. of the main supply was dropping down towards its zero position, thus tending to reduce the current in the circuit at the moment. On the other hand, the induction of the machine was producing an E.M.F. opposing that of the supply, and an instant would arrive at which the two opposing E.M.F.'s balanced each other. If the operator pulled out at this instant he probably saved himself an attack of ophthalmia. J. A. S.

Answer to No. 375 (*awarded* 5*s.*).—The fact that the armature of the 60-kw. alternator was iron-cored would certainly tend to reduce the magnitude of the short circuit current, but it is very improbable that the choking effect would be so great as suggested. One of the usual tests of a modern iron-cored armature is to run it on a short-circuit in its normal field, and when this is done the short-circuit current generally amounts to three to four times the normal working current of the machine (see Mr. Eborall's Society of Arts Howard Lectures, 1901). As this experiment should produce approximately the same current in the armature as placing it across the live terminals of a similar machine, it follows that the diminutive spark observed could not be attributed to the choking effect of the 60-kw. armature. It might be suggested that the spark was extinguished or suppressed by the capacity of the concentric mains or any other capacity which might have been connected as a shunt across the terminals of the alternators, but although Mr. W. Duddell showed very conclusively in his paper and experiments before the Institution of Electrical Engineers last year that a medium capacity as a shunt to the terminals of a metal switch prevents the formation of an arc when the latter is opened, it is not likely that such a large power could be suppressed in this way, especially as the capacity of the mains would not be acting as a direct shunt to the arc, but in series with the resistance and self-induction of the armature in question. The most reasonable explanation seems to be the result of a coincidence—namely, that the exact moment at which the switch was opened (and it is most likely that it was opened at a very high speed by the frightened attendant) coincided with the period at which the alternating current in the armature was zero. As explained above, the current was probably a very large one *on the average*, but being alternating there were, of course, two periods in each cycle at which it was nil, and it is probable that the switch was opened when the current was at zero, or had only a small positive or negative value. It has often been noticed when an alternating-current circuit is opened quickly that sometimes the spark is smaller than the average, and the explanation seems to be that mentioned above.—T. R. D. KENNY.

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Question No. 376.—Discuss the advantages and disadvantages in the Lancashire and Galloway types of boilers of passing the flue gases first along the bottom of the boiler and then the sides, or *vice versâ*?

Answer to No. 376 (awarded 7s. 6d.).—There would seem to be very little to choose between the two methods of passing the flue gases; both are to be found in all parts of the country. Whatever difference there may be must be almost so small as not to be worth considering. In any case it is largely a matter of opinion; some engineers prefer one way, some another. Such advantages as either may claim can be stated as follows, the disadvantages of one being found in the advantages advanced for the other:

First along the Bottom and then along the Sides.—It is claimed by the advocates of this method that the gases, being at their hottest just as they leave the internal flues, will be able to impart considerable heat to a portion of the boiler (the bottom), in which the water is somewhat closely confined, and therefore the circulation will be improved in this part, and consequently there will be less chance for depositing mud. This portion of the boiler, moreover, receives no direct benefit from the fires, at least as regards the front part, which is immediately below the grate area, and therefore should properly receive the heat from the gases first.

First along the Sides and then along the Bottom.—In this method it is claimed that the gases being at their hottest, they can be utilised to better advantage by passing them first along the sides, as giving—approximately—say, twice the boiler-plate surface to absorb their heat over the former method. Having done so, they will now have less to part with, and can be again used to better advantage by giving them a smaller surface for the second journey. It may be also claimed for this method that the brickwork setting will be slightly cheaper, slightly simpler, and slightly stronger.

It will thus be seen how little there is to choose between the two methods. Such as they are, the advantages may, perhaps, be considered to rest with that in which the gases are first passed along the sides and then under the bottom. E. M. R.

Answer to No. 376 (awarded 7s. 6d.).—In looking at this question, we must remember that flame and heated gases always rise, and that, therefore, in passing through a tube or flue the hottest bodies, such as the flames, will always touch the top, consequently the hottest part of the flue will be the top. The lowest parts of the flue will be warmed by radiation only. The furnace is arranged with this fact in view, and water always lies on the top of the furnace in every kind of boiler. It is evident that the further the heated gases, etc., of the furnace go the more they become cool, and therefore we must make the best use of them as soon as possible. This is best done by putting them into contact with the coolest part of the water in the boiler; and we know that the coolest water is always at the bottom, therefore the bottom of the boiler is in a position to receive the most heat and to pass it on most advantageously to the water, because the heat of any part of the boiler itself never exceeds that of the water in contact with it, and a cold body can receive heat more rapidly and in greater quantity than a hot one. Therefore the heated gases and flames (if they are long enough, as they generally are) should be led from the furnace tubes underneath the boiler. This part of the flue should be made big enough to allow of ash and dust from the furnace settling there without being an obstruction to the draught, and it can now be divided, half going along one side of the boiler and half along the other, but the great disadvantage of this side flue is that the top of it and one side of it are only firebrick, and can therefore receive no heat usefully. However, the useful or boiler side of this flue is always curved (in section), and so it gets as much heat as possible under the circumstances. At the bottom of the inside of the boiler there is a large quantity of water ready to carry away heat it receives; but at the sides the water is hotter, there is not so great a volume, and it can more easily escape by reason of its position before it has received all the heat the furnace gases can communicate. This is not, however, in reality a loss, because other particles of water would quickly and continuously follow. The great disadvantage of the bottom or lower part of these boilers, is that the water at the bottom is necessarily cooled by being in contact with the bottom of the front part of the furnace flue, and this is cooled by the cold air going to the fire. This loss, however, occurs at the front end of the boiler, where the heating effect of the underneath flue is least because of the bifurcation to the side flues.

Another advantage of this arrangement—viz., passing the furnace gases underneath the boiler before going to the sides is that a greater and better circulation of the water is kept up inside the boiler, because at the back of the boiler where the flue turns down there is very great heat, so the water here rises rapidly from the bottom to the top, while at the front of the boiler—the coolest place—there is a downward flow. These convection currents are very useful, because they prevent the water from getting too quiescent, which is never advisable, and because they keep the quality of the water uniform. If the flue were led first round the sides and then underneath, the water might lie too quiet in the boiler, and the coolest water remain always at the bottom, while a considerable part of the heat of the furnace might be spent in warming the firebrick of the side flue to no useful purpose.

I therefore conclude that it is best to take the furnace gases underneath the boiler first and then along the sides, and I believe this is the most usual practice.—F. G. A.

COMPANIES' MEETINGS AND REPORTS.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION.

Mr. J. S. Raworth presided at the ordinary meeting of the shareholders held at the London offices, and in moving the adoption of the report, already published in this journal, said that in August last the supply of electric energy for lighting and power was begun, and the actual number of lamps connected with the mains were now equivalent to 5,760 of 8 c.p., and applications for 186 more was now being dealt with. Some of the manufacturers had been induced to adopt motors for driving their machinery. New generating machinery was being laid down, which would increase the available power by 800 h.p. On electric lighting account alone they had lost something like £300, but it would be wiped out in the present year and a good dividend earned. Under the Kidderminster and Stourport Tramway head they had to their credit £54,439 for the purchase of the tramways and electrical equipment, and £1,278 on parliamentary deposits in consols; national war loan £591 at cost price. The reserve fund, which stood at £550, would be increased by another £500, the total balance of profit being £2,108. This, on the whole, he thought satisfactory. They had obtained a parliamentary order for a light railway to Bewdley, and it was hoped that its construction would be begun during the present year. He moved the adoption of the report and accounts.

Mr. R. P. Sellon seconded, and the motion was carried.

WEST INDIA AND PANAMA TELEGRAPH.

At the meeting of the shareholders, held at Winchester House, **Mr. W. S. Andrews**, the chairman, in moving the adoption of the report, said the receipts from messages and subsidies amounted to £24,600, or £1,656 more than in the corresponding half of the preceding year, while the expenses (£20,963) were £470 less, leaving a balance of only £3 337, which, together with interest on investments and £954 brought forward, made a total of £6,671, insufficient to meet the cumulative dividends on first and second preference shares for the half-year, amounting to £11,770. The directors thought it well to carry forward the balance. It was not the first time they had been in arrears with the preference dividend, but it had been made up. The ordinary shares had received dividends since 1890, taken partly from the appreciation of their securities, which was now at an end. They were all aware of the deplorable condition of our West India Islands. For years the Company's receipts had been decreasing, the period synchronising with the activity of Continental countries in the matter of bounties. The sugar industry was practically extinct, and no other could possibly take its place. The only hope for the West Indies was the imposition of countervailing duties or the abolition of the bounty system. This Company depended for its revenue on the prosperity of the islands, and unless something were speedily done he could not see his way out of the difficulty. The reduction in rates so far had not brought an adequate increase in messages.

Mr. H. Holmes having seconded the motion, it was carried.

ELECTRICAL POWER DISTRIBUTION.

Directors: Emile Garcke, M.I.E.E. (chairman); C. Shirreff Hilton; John S. Raworth, M.I.C.E.; R. Percy Sellon, M.I.E.E.; Wm. L. Madgen, M.I.E.E. (managing director). Secretary: Geo. J. Somerville.

Report of the directors (with abstract of accounts) to be

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presented to the shareholders at the fourth ordinary general meeting of the Company to be held at Surrey House, Victoria-embankment, W.C., on Tuesday, June 4, 1901, at 12 noon :

The profits amount to £15,001. 2s. 9d., and, after deducting the proportion of general expenses chargeable to revenue, and the expenses incurred in connection with schemes not proceeded with and written off, and a sum of £1,271. 5s. 9d. held in reserve in respect of new schemes in course of development, there remains a net profit of £13,045. 11s. 2d., which the directors propose should be applied as follows: preliminary expenses written off, £826. 6s. 2d.; reduction of furniture account, £55. 15s. 2d.; payment of income tax, £513. 17s. 8d.; dividend at the rate of 5 per cent. per annum on ordinary shares for nine months or from the dates on which calls and instalments were paid, £1,320. 2s. 10d.—carried forward to next account, £10,329. 9s. 4d. The Company was incorporated on June 23, 1898, with a nominal capital of £20,200, divided into 2,000 ordinary shares of £10 each and 200 deferred shares of £1 each, and by special resolution dated April 19, 1900, the capital was increased to £300,000 by the creation of 12,980 ordinary shares of £10 each, and 15,000 preference shares of £10 each. The subscribed share capital is now £149,800 in ordinary shares of £10 each, and £200 in deferred shares of £1 each—total £150,000. There are at present unissued 15,000 preference shares of £10 each, which the directors propose to issue at an early date on terms to be announced. The total amount expended on Electric Power Acts and negotiations in connection with new schemes in course of development, less amount reserved, was £16,840. 13s. 6d., after writing off expenses incurred in respect of schemes not proceeded with, but including a portion of general expenses. The total expenditure under the head of investments was £31,730. 13s. The directors who retire this year are Mr. Emile Garcke and Mr. J. S. Raworth, and both are eligible for re-election. Mr. Ernest Wright, A.C.A., retires, and his firm, Messrs. Wright and Wake, offer themselves for election.

Dr. BALANCE-SHEET.	£	s.	d.
Capital authorised	300,000	0	0
Capital issued	74,114	0	0
Loans	28,500	0	0
Sundry creditors	4,678	5	8
Associated companies on account of contracts	2,991	10	11
Profit and loss account—ordinary share dividend, £1,320. 2s. 10d.; balance carried forward, £10,329. 9s. 4d.	11,649	12	2
	£121,933	8	9

Cr.	£	s.	d.
Expenditure on Power Bills and new schemes	16,840	13	6
Cash paid in respect of investments	31,730	13	0
Sundry debtors	69,152	12	8
Furniture and fittings; less amount written off (20 per cent.)	223	0	7
Cash at bank and in hand	3,986	9	0
	£121,933	8	9

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Proportion of expenditure on contracts and undertakings not proceeded with and written off	684	5	10
Reserve in respect of new schemes in course of development	1,271	5	9
Balance carried down	13,045	11	2
	£15,001	2	9
Preliminary expenses written off	826	6	2
Furniture and fittings—amount written off (20 per cent.)	55	15	2
Income tax	513	17	8
Proposed dividend on ordinary shares at 5 per cent., £1,320. 2s. 10d.; balance carried forward, £10,329. 9s. 4d.	11,649	12	2
	£13,045	11	2

Cr.	£	s.	d.
Profits on contracts and undertakings and sundries	15,001	2	9
	£15,001	2	9
Balance brought down	13,045	11	2
	£13,045	11	2

APPENDIX.

The attention of the Company has been particularly directed to economy in capital cost and administrative charges in connection with the electrical supply undertakings in which it is interested, and to developing the association with electrical traction and other allied interests so as to secure a comprehensive demand, a cheap and reliable supply to the public, and a satisfactory return upon the investment. The working agreement with the British Electric Traction Company, Limited, promises to be of much assistance in this direction, as it is enabling the electrical supply and the electrical traction undertakings in the same districts to be worked together to mutual advantage, and under the most favourable conditions in regard to operating expenses. The extent of country over which electrical energy can be the most cheaply distributed, and over which improved traffic facilities can be given by means of electrical traction, has largely increased during recent years. There are indications that comprehensive undertakings combining these services will equal in importance some of the largest national industries, and that the arrangements most satisfactory to the public are as little susceptible of local treatment within arbitrary boundaries as are the railway or telegraph systems of the country. The business undertaken by this Company in association with the British Electric Traction Company is directly in this line of development, and it is believed that the positions which the Company has secured will enable it to show satisfactory results from year to year while making those extensions which circumstances render desirable. The following are concise particulars of undertakings now in hand:

Banbury.—The Electrical Power Distribution Company has obtained the Banbury electric lighting provisional order intended to be transferred to the Banbury and District Electric Supply Company, Limited, which has been formed for the purpose of carrying out the undertaking. Present subscribed capital, £25,000.

County of Durham.—The County of Durham Electric Power Distribution Company, Limited, has been formed with a capital at present subscribed of £30,070, for the purpose of carrying out electrical supply undertakings in that county. Provisional orders under the Electric Lighting Acts, authorising retail supply to consumers for power, light, and other purposes, have been obtained for Gateshead, Jarrow, and Durham (City). Satisfactory progress has been made with the work, and it is expected that general supply will be commenced during the present year in Gateshead about Aug. 1, in Durham (City) about September, and in Jarrow about November. With a view to facilitating the operations of the above company, and those of the British Electric Traction Company, Limited, in the same area, the Electrical Power Distribution Company, in the last session of Parliament obtained an Electric Power Act, under the title of the County of Durham Electric Power Supply Act, 1900, by means of which electrical energy can be supplied in bulk under favourable conditions to retail undertakings, such as those above mentioned, to electric tramways and light railways, and to other authorised users for prescribed purposes within an area of about 250 square miles, bordering on the south side of the River Tyne, and comprising a large portion of the engineering and colliery districts of the county. The construction of the main power station at Gateshead has kept pace with the equipment of the local sections of the traction scheme for the county to which it is supplying current, and both of these undertakings have been successfully inaugurated this month.

County of Kent.—The Electrical Power Distribution Company has obtained the Sheerness Electric Lighting Provisional Order, 1900, and the Sevenoaks Electric Lighting Provisional Order, 1900, and it is intended to transfer these orders to the County of Kent Electrical Power Distribution Company, which has been formed with a capital at present subscribed of £25,000, for the purpose of carrying out such undertakings in the county. The British Electric Traction Company, Limited, is promoting a light railway order for Sheerness, which has been passed by the Commissioners, and it is intended that this line, when authorised and equipped, shall be worked in conjunction with the electric supply undertaking.

County of Northampton.—The Wellingborough electric lighting provisional order has been obtained by the Electrical Power Distribution Company, and it is intended to transfer it to the County of Northampton Electric Power and Traction Company, Limited, which has been formed with a capital at present subscribed of £25,000 to carry out this and other electrical undertakings in the county. The British Electric Traction Company, Limited, has obtained an Act authorising the construction of an electric tramroad system in Wellingborough, Rushden, and neighbouring districts, and with a view to economy in administration it is in contemplation to work the undertakings conjointly.

County of Surrey.—The County of Surrey Electrical Power Distribution Company, Limited, has been formed, with a capital at present subscribed of £25,070, and provisional orders under the Electric Lighting Acts have been obtained for the neighbouring districts of Sutton, Carshalton, and Wallington. It is expected that the supply will be commenced during the present year.

County of Sussex.—The provisional order under the Electric Lighting Acts for the borough of Lewes has been obtained for the County of Sussex Electrical Power Distribution Company, Limited, which has at present a subscribed capital of £20,070. The works are on the point of completion, and supply will commence next month.

North Metropolitan District.—The North Metropolitan Electrical Power Distribution Company, Limited, has been formed, with a capital at present subscribed of £25,070, for the purpose of carrying out electrical supply undertakings in this important district. Provisional orders under the Electric Lighting Acts authorising retail supply have been obtained for Barnet and Hertford, and negotiations are proceeding with other districts. In Barnet the supply was commenced in September of last year. In Hertford the undertaking is well advanced, and the supply will be ready for the autumn of the present year. With a view to the supply of electrical energy in the North Metropolitan districts under comprehensive and economical conditions, the Electrical Power Distribution Company in the last session of Parliament applied for and was granted the North Metropolitan Electric Power Supply Act, 1900, authorising the supply of electrical energy, under conditions similar to those of the County of Durham Act, within an area of about 325 square miles, including the great suburbs to the north of London, from Tottenham on the east to Harrow on the west, and the growing manufacturing districts along the River Lea. It covers the area within which the extensive North Metropolitan electric light railways are being promoted by the British Electric Traction Company, Limited, and allied interests.

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Penarth.—The Penarth Electric Lighting Company, Limited, with a present subscribed capital of £25,000, has the provisional order under the Electric Lighting Acts for Penarth, a growing residential district and seaside resort adjoining Cardiff. The works are in course of construction and the supply is expected to commence in the coming month.

Staines, Egham, and Chertsey.—The Electrical Power Distribution Company has obtained a provisional order under the Electric Lighting Acts for the neighbouring districts of Staines, Egham, and Chertsey, and it is intended to transfer it to the Thames Valley Electric Supply Company, Limited, which has been formed with a capital at present subscribed of £25,000 to carry out the undertaking.

Weston-super-Mare.—A provisional order under the Electric Lighting Acts has been obtained by the Weston-super-Mare and District Supply Company, Limited, which was formed for the purpose of carrying out the undertaking, and has a capital at present subscribed of £25,070. The works are now on the point of completion, and supply will be commenced immediately. In addition to the concession for the electrical supply, the Company has also obtained a provisional order for a system of electric tramways in the town, and with a view to producing the most satisfactory results it is intended that the two undertakings shall be worked together.

There are other provisional arrangements which have been made, and negotiations are pending in regard to a number of other undertakings, but it would be premature and inexpedient to describe them at this stage.

MEXICO ELECTRIC TRAMWAYS.

With the report of the directors of the Mexico Electric Tramways, Limited, for 1900 the accounts of the Compania de Ferrocarriles del Distrito Federal de Mexico, S.A., for the same period are given, the dollar being taken as equivalent to 2s., with a view to demonstrating the position approximately in British currency. The net balance to the credit of the profit and loss account at the close of the year was £26,966, which enabled the Board in Mexico to declare a dividend of 12½ per cent. on the ordinary share capital. This dividend, together with the interest received, has been duly credited to the revenue account of the Mexico Electric Tramways, Limited, which shows a credit balance of £24,545. A dividend of 6 per cent. on the preference shares has been declared, which will absorb £5,564, leaving a balance in hand of £18,980. The directors recommend a dividend of 5 per cent., amounting to £15,000, on the ordinary shares, leaving a balance of £5,980 to be carried forward. The past year's results have been materially prejudiced by the dislocation of traffic, due to the reconstruction of the system, and by the congestion caused by the introduction of an entirely new drainage system throughout the city. The country has, moreover, passed through a year of commercial depression.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Glasgow.—The Corporation invite tenders for the supply of electricity meters. Tenders by June 10. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for six specimen electric tramcars. Tenders by June 7. Details in our advertisement columns.

Islington.—The Lighting Committee invite tenders for free or assisted wiring. Tenders by June 11. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of branch rubber-covered cables. Tenders by June 10. Details in advertisement columns.

Edinburgh.—The Corporation invite tenders for ash-conveying plant, Dewar-place station. Tenders by June 15. Details in our advertisement columns.

Dundee.—The Town Council invite tenders for the overhead equipment of Seagate route. Tenders by June 5. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the wiring of the new Council offices. Tenders by June 5. Details in our advertisement columns.

West Stanley (Durham).—Tenders for electric lighting are invited on inspection for new Catholic church, West Stanley. Apply to Rev. J. Thompson. Tenders by June 1

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection of dry-back marine-type boilers. Tenders by June 8. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for the overhead equipment of about five miles of tramways and tramway poles. Tenders by June 7. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of electrical fittings for the lighting of their Queen's-road car-shed. Tenders by June 4. Details in our advertisement columns.

Huddersfield. — The Corporation invite tenders for five mechanical stokers, to be fixed to five 8ft. by 30ft. Lancashire boilers. Tenders by June 4. Details in our advertisement columns.

London, E.C.—The East Indian Railway Company invite tenders for electric overhead travelling cranes, etc. Specification may be seen at the Company's Offices, Nicholas-lane, London, E.C. Tenders by June 12.

Dublin.—The Lighting Committee invite tenders for the supply and erection of motors and motor-generators, accumulators, meters, and works wiring. Tenders by June 3. Details in our advertisement columns.

Islington.—The Lighting Committee invite tenders for the painting of the arc lamp columns and crutches, of which 398 are in use in the borough. Tenders by June 11. Details in our advertisement columns.

Peterborough.—The Corporation invite tenders for the supply and erection of one Lancashire boiler, 30ft. by 8ft., and one 120-kw. steam dynamo. Tenders by June 14. Details in our advertisement columns.

Colmenar Viejo.—Tenders are invited for installation and working for 20 years of electric lighting. The public lighting will require 150 16-c.p. lamps. Tenders to the Mayor of Colmenar Viejo, Province of Madrid, Spain.

Dublin.—The Lighting Committee invite tenders for the supply and erection of main switchboards, sub-station switchboards, transformers, arc lamps, and arc lamp pillars. Tenders by June 3. Details in our advertisement columns.

Exeter.—The Town Council invite tenders for erection of the buildings of their new electricity generating station. Specifications, etc., may be obtained from Mr. Donald Cameron, city engineer and surveyor. Tenders by June 14.

Salford.—The Corporation invite tenders for the supply and delivery of additional steel poles, cast-iron bases, etc. (Contract No. 16), in connection with the electric tramways. Tenders by June 3. Details in our advertisement columns.

Uxbridge.—The Uxbridge and District Electric Supply Company invite tenders for erection of a generating station on land adjoining the Waterloo-road. Specifications, etc., can be obtained from the Secretary's Office, 1, Vine-street. Tenders by June 4.

Aldershot.—The Urban District Council invite tenders for erection of buildings and shaft in connection with their electric lighting station. Specifications, etc., may be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., surveyor. Tenders by June 4.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the first portion of the Colinton Mains Fever Hospital, the number of lighting points being about 1,550. Tenders by June 12. Details in our advertisement columns.

Exeter.—The Council invite tenders for boiler-house equipment, pipes, etc., engine-room equipment, switchboards, connecting cables, coal bunkers and conveyors, and feed and condensing water tanks. Tenders by June 14. Details in our advertisement columns.

Wakefield.—The Corporation invite tenders for supplying and fixing a new armature to a steam alternator at the electricity works, Calder Vale, Wakefield. Specifications, etc., may be obtained on application to the City Electrical Engineer, at the Electricity Works. Tenders by June 4.

Doncaster.—The Corporation invite tenders for steel grooved girder tramway rails for eight miles of tramways in the borough of Doncaster and adjoining neighbourhood. Particulars may be obtained at the office of the borough surveyor, Mr. W. H. R. Crabtree, M.I.C.E., 3, Priory-place, Doncaster. Tenders by June 3.

Taunton.—The Corporation invite tenders for the construction, supply, and erection of one 250-kw. steam alternator, one 15-kw. motor-generator, switchboard extensions, one water-tube boiler, superheater, jet condenser, and air-pump, and sundry pipe extensions. Tenders by June 11. Details in our advertisement columns.

Burnley.—The Electricity Committee invite tenders for (A) five injectors, capable of dealing with 700 gallons per hour; (B) one feed pump, capable of dealing with 3,500 gallons per hour. Specifications, etc., may be obtained on application to Mr. Robt. Birkett, the borough electrical engineer, Aqueduct-street, Burnley. Tenders by June 10.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

York.—The North-Eastern Railway Company invite tenders for the following articles, in such quantities as they may require, during six months ending Dec. 31, 1901, delivered carriage paid at the telegraph stores at York: (1) telegraph apparatus; (2) telegraph wire and line stores. Particulars may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by June 10.

Dundee.—The Town Council invite tenders for steel fishbolts, with locknuts (about 186cwt.); steel tie-bars with nuts and washers (about 864cwt.; steel joint plates, with bolts and lock nuts (about 2 600 sets); and cast-steel points and crossings (about 435cwt). Specification, etc., may be obtained from Mr. W. Mackison, C.E., Municipal Offices, 91, Commercial-street, Dundee. Tenders by June 4.

Kearsley.—The Urban District Council invite tenders for the taking-up roadway and repaving, laying of rails, points, etc., and all labour required for the construction and completion of

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tramways from Market-street to Unity Brook and along Long-causeway at Kearsley. Specifications, etc., may be seen at the office of the Council's surveyor, Mr. Herbert Nuttall, A.M.I.C.E., 20, Market-street, Bury. Tenders by June 13.

London, S.W.—Tenders are invited for the supply of 13,400 tons of steel rails and 958 tons of fishplates for the Queensland Railways. Tenders will be received at the Queensland Government Office, 1, Victoria-street, London, S.W., until 2 p.m. on June 11, endorsed "Tender for Steel Rails and Fishplates," and accompanied by a preliminary deposit of 1 per cent. on the tender. Specifications, drawings, etc., may be obtained at the office of the Agent-General for Queensland.

Warrington.—The Corporation invite tenders for the supply, delivery, and erection of one water-tube boiler and pipework; supply, delivery, and erection of 500-kw. high-speed engine of the Willans type, with direct-coupled continuous dynamo; and supply, delivery, and laying of underground mains, stoneware conduits, etc. Specifications, etc., can be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Tenders by June 13.

Uganda.—The Crown Agents for the Colonies, acting on behalf of the Uganda Railway Committee, invite tenders for the supply of galvanised iron wire, specification and form of tender for which can be obtained on application to the Crown Agents, at whose office the drawing will be on view between the hours of 10 a.m. and 4 p.m. (Saturday, 10 to 2). Tenders to be delivered, addressed to the Crown Agents for the Colonies, Downing-street, S.W., and endorsed "Tender for Galvanised Iron Wire, Uganda Railway," not later than noon on June 11.

RESULTS OF TENDERS.

Manchester.—The Corporation have accepted the tender of the Electrical Company, Limited, 122-124, Charing Cross-road, W.C., for six three-phase generators of 2,500 h.p. each, and for sub-station motor-transformers.

Royal Yacht.—We learn from the General Electric Company that they have received an order from Messrs. Waring and Son, of Hammersmith, for special "Robertson" lamps for the King's dining saloon on the new royal yacht.

Stoke-upon-Trent.—The Guardians have accepted the tender of F. W. Smith and Co., Southport, at £401, for electric motors for driving new laundry machinery, also the wiring of laundry buildings, nurses' home, and farm buildings. Twenty tenders were received.

Brighton.—The Corporation have accepted the tender of Messrs. Redpath, Brown, and Co., Limited, of Edinburgh, at £15,978, for the erection of the iron and steel work required in the construction of an electrical power station at Southwick. Thirty-nine tenders were received, ranging from £15,909 to £52,500.

Todmorden.—The Fielden Joint Hospital Committee have accepted the tender of R. S. Blackburn, Hebden Bridge, for the erection and maintenance of telephonic communication between the Fielden joint hospital, the workhouse, and the Urban District Council offices at Hebden Bridge, and the Urban District Council offices at Mytholmroyd, and the house of the receiving officer at Hebden Bridge.

Poplar.—The Borough Council have accepted the tender of Mather and Platt, Limited, for the supply of 500-kw. generator, balancer, generator and booster, spare armature and switch gear, in accordance with specification, at £10,371; also the tender of Babcock and Wilcox, Limited, for the supply of two boilers, two chain-grate stokers, two superheaters, Green's economiser, water softener, and extension of coal bunkers, in accordance with specification, at £4,482.

Fulham.—The following tenders have been recommended for acceptance: Boult Bros., engine oils, £135. 9s.; J. Gibb and Co., asbestos packing, £57. 15s.; General Electric Company, incandescent lamps £43. 4s., arc lamps and accessories £147. 15s. 10d., fuse wire, tape, etc., £33. 3s. 2d.; City Glass Company, arc lamps, globes, etc., £13. 8s. 6d.; De Grelle, Houdret, and Co., carbons £45. 8s. 3d.; Electric and General Contracting Company, service boxes £635. 12s. 6d., compound £13. 2s. 6d.; Johnson and Phillips, cables, tents, etc., £381. 14s. 3d.

BUSINESS NOTES.

TRACTION.

Oldham.—Major Druitt, R.E., on behalf of the Board of Trade, has inspected two sections of the electric tramways.

Twickenham.—The District Council have dropped their opposition to the London United Tramways Bill upon terms.

Blackpool.—Major Druitt, Board of Trade inspector, has inspected the extension of the Corporation's tramways to Marton.

Hull.—On Whit Monday the traffic receipts from the Corporation tramways amounted to £465, as compared with £383 the corresponding day last year.

Brentford.—At the last meeting of the Town Council it was stated that it was the intention of the tramway company to commence running trams on July 1.

Ramsgate.—Another portion of the Isle of Thanet electric tramways was opened on Wednesday for traffic from the harbour along the West Cliff to Ellington Park.

Llanelly.—The tramway company have submitted their scheme for electric tramways to the Board of Trade, and a definite answer is expected within the next three or four days.

Middlesex.—The County Council have adopted the report of their Parliamentary Committee, slightly amended, in favour of the scheme of tramways from Tottenham to Staines.

Southampton.—The Board of Trade have sanctioned the proposed tramways loan of £80,000—£53,820 for permanent way, £7,230 for electrical equipment, and £18,950 for cars.

Wolverhampton.—The Town Council on Friday confirmed their resolution in committee with reference to the adoption of the Brown surface-contact system of traction for the tramways.

Bradford.—The work in connection with laying down the tramway from Bradford to Queensbury is now nearing completion, and it is thought the cars will be running to Queensbury next month.

King's Norton and Northfield Tramways.—The opposition to this Bill having been withdrawn, it has been referred to the consideration of the Committee on Unopposed Bills in the House of Commons.

Portsmouth.—It is anticipated that the consent of the Local Government Board to the borrowing of £600,000 for the purchase of the new electric trams in the town by the Corporation will be received within the next week or so.

Halifax.—It is noted with satisfaction that the receipts of the Northowram tramways have recently compared favourably with those taken on other routes. The takings on the section during the fine weather amounted to about 11½d. per car mile.

Ramsgate.—The Town Council having come to the conclusion that the explanation of the Isle of Thanet Electric Tramway Company with reference to the recent accidents on their system is not satisfactory, have decided to appeal to the Board of Trade.

Leeds.—The electric launch which was recently placed on the Waterloo Lake, Roundhay Park, by the Corporation was tested by Mr. John McEwan, Board of Trade surveyor, on Friday, and on Saturday the certificate of the Board of Trade was received.

Darlington.—The municipalisation of the tramways was considered at a General Purposes Committee meeting, when a motion that a special meeting of the Council be called to consider the purchase of the tramway system for £7,500 was ultimately carried.

Manchester.—Lieut.-Colonel von Donop, Board of Trade inspector, has inspected the permanent way of the Cheetham Hill route of the new municipal electric tramways system. Mr. Trotter inspected the electrical equipment. It has been definitely arranged that the electric tramcar service shall begin on June 6.

Wigan.—Tenders are to be obtained for rails, fishplates, other ironwork, setts, gravel broken stone, and cement for the proposed extension of tramways. The borough engineer has been instructed to complete the Martland Mill Bridge route, and separate tenders are to be obtained for the rails, etc., required for the work.

Merthyr Tydvil.—The Cabs Committee have received a reply from the Board of Trade to the effect that it was unable to delay the settlement of the proposed regulations for the electric railway until the 5th prox., and that the line would not be inspected by the Department unless there was some special reason for doing so.

Hammersmith.—At the fortnightly meeting of the Borough Council the clerk presented a letter from the tramways company, stating that the use of the gongs for the avoidance of danger had been approved by the Board of Trade, and the rate of speed in travel is in conformity with the regulations framed in connection therewith.

Aberdeen.—The Tramways Committee have approved a scheme of greatly extending the car service in the city. A letter has been received from the Board of Trade stating that they would not allow guard slips to be put up in connection with electric tramways, and that guard wires were necessary. Guard wires, it was explained, had been in use in Aberdeen for some time.

Bristol.—The cars run on Whit Monday last year numbered 120 and the passengers carried 154,628. On Monday last the cars run numbered 216 and the passengers carried 248,909, showing an increase of 94,281 over last year. This year the whole of the cars run are worked by electricity, whereas on the Bank Holiday of last year many of the cars were worked by horse power.

Paris-Bordeaux Automobile Race.—There were 90 entries for the motorcar racing contest between Paris and Bordeaux, England being represented by one 70-h.p. Napier car. The victory was accorded to Mr. Fournier, who rode a Morse machine, and who accomplished the journey of over 370 miles in 8 hours, 44 minutes, and 45 seconds. He thus maintained an average speed of five miles every eight minutes.

Newcastle.—A joint meeting of the sub-committee of the Tramways and Markets Committees has been held to reconsider the application from the Tramways Committee to acquire part of the pig market for car-sheds. The question of erecting car-sheds over the pig market, by means of a lift, was under consideration, and other plans were also discussed. The meeting stood adjourned for the Tramways Committee to submit a definite plan of their requirements.

Crewe.—The British Electric Traction Company some time ago sought and obtained from the Light Railway Commissioners an order to construct light railways in Crewe, but owing to the impracticable conditions imposed by the Corporation, the order was allowed to lapse. Last year the Corporation applied for a

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similar order for themselves. The London and North-Western Railway opposed, and the order was refused. On Saturday the Electric Traction Company gave notice of application for another order for Crewe.

Birstall.—It is understood that the District Council are in negotiation with the British Electric Traction Company with regard to that section of the tramlines which passes through the Council's district, and that in the course of a few days the result will be made known. With respect to the portion between Birstall and Gomersal notice to acquire has already been served on the tramways company, and similar notice will be given in August in relation to the small length of line between Smithies and the foundry at the junction of the cross-roads.

Sunderland.—It is stated that the Corporation tramways carried over 100,000 passengers on Whit Monday. This is a record for the town, the previous highest being 60,000 on Easter Monday. The first extension made upon the original scheme of tramways—that reaching from Roker-terrace to Sea-lane—has been inspected by Lieut.-Colonel von Donop, inspector to the Board of Trade. The section is about three quarters of a mile long, and, being an almost absolutely straight line and devoid of any serious gradient, does not present any special structural difficulties.

Lancaster.—At the last meeting of the Town Council the Tramways Committee reported that they had had an offer from a syndicate to purchase the right to construct electrical tramways in the borough, obtained from Parliament last year. The idea of the syndicate was to buy the tramway system between Lancaster and Morecambe, convert it to electrical traction, and then connect it with the proposed Lancaster route. The committee had refused the offer, and the Council confirmed the decision. A beginning with the actual work of laying down the new system in the borough would be made soon.

Pontefract.—A Bill has been introduced into the House of Lords by Lord Dudley, Under-Secretary of the Board of Trade, to confirm a provisional order authorising the United Kingdom Tramway Syndicate to construct tramways in the borough of Pontefract, the urban districts of Castleford, Featherstone, Normanton, and Whitwood, and the rural district of Pontefract, all in the county of the West Riding, York, and for other purposes. The order sets forth 20 sections of the tramway, and it is provided that the promoters shall cause an electric lamp of not less than 16 c.p. to be erected on the posts at every interior angle of the road of 120deg. or less, and at every stopping place on the said tramways.

Newport (Mon.).—A town's meeting has been held to consider the question of the proposed conversion of the tramways to electric traction. The Town Clerk said the amount involved in the Parliamentary Bill was divided—£90,000 for tramways, with extensions, and £40,000 for electrical purposes. The Mayor explained that at the last meeting of the Town Council tenders for electric traction and power station amounting to £50,000 were accepted. The whole scheme would cost £96,000. Eventually, a resolution that the Mayor and Corporation be asked to rescind the resolution carried at the last meeting of the Council was carried by a large majority. It is expected that a poll of the ratepayers will follow this action.

Metropolitan Railway Bill.—The Parliamentary Committee appointed to consider this Bill has issued a special report, in which they say that it is intended by the Bill to empower the Metropolitan Railway Company and the Harrow and Uxbridge Railway Company to make a deviation railway and other works, and to abandon portions of authorised railways which will be thereby rendered unnecessary, and to release a portion of the money deposited with the High Court of Chancery in respect of the abandoned portions of railway; and that it is proposed by the Bill to revise and extend the period limited by former Acts for the compulsory purchase of lands and for the completion of the railways and other works thereby authorised.

Sheffield.—On Saturday night a fitter's labourer named Joseph Hand was knocked down and killed by an electric car which ran right over him. It was some 20 minutes before his body was recovered from beneath the car, and at the inquest on Tuesday the question of the delay in extricating the body was raised. The jury returned a verdict of accidental death, the foreman remarking that he thought it would be wise for the Corporation to provide some means of lifting cars without such delay. If a man's foot had been under the car there would have been a similar delay, there being no appliances on the car. It was finally agreed to add a recommendation from the jury, to the effect that "jacks" should be stationed at frequent intervals along each tramway route.

Glasgow.—On behalf of the Board of Trade, Colonel Yorke has inspected the permanent way of the electric tramway routes between St. Vincent-place and Maryhill and St. Vincent-place and Kelvinside. The electric cars are expected to be running on these routes in the course of a few days, after which the horse car traffic will practically be confined to the southern and eastern districts of the city, in which, however, the electric cars are already partially in operation. The total receipts of the Corporation tramways for the year ending this week amount to £485 000, as against £464,786 for the previous year, giving an increase of over £20 000. Of that increase about half is accounted for since the exhibition opened and the electric cars began to run, the increase at the end of April being about £10,000.

West Ham.—The idea of enlarging the present power station at Abbey Mills in connection with the proposed tramways has been abandoned in favour of erecting entirely new premises on the site of the old sewage pumping station at Canning Town. The equipment of the new station will comprise three sets of engines and dynamos, with a total capacity of 1,500 kw. for tramway purposes; seven sets, with a capacity of 4,800 kw. for lighting and other purposes; 16 boilers, five condensers, two economisers, and accessories. Altogether the new station will possess a capacity of 4,800 kw. The electrical engineer (Mr. James K. Bock) in his report, submitted to the Council, on the power to be installed for tramways, suggests that it would be well to provide sufficient power to supply 100 motorcars at one time.

West Cumberland Tramways Bill.—The House of Commons Select Committee presided over by Mr. Seale Hayne has passed the preamble of this Bill, the only opposition before the committee coming from Cleator Moor. Under this Bill it is proposed to raise £400,000 by shares and £100,000 by borrowing for the purpose of constructing tramways and to supply electricity for all public and private purposes within certain limits. The proposed tramway commences at Cleator Moor, runs through Whitehaven to Workington, Low Seaton, Maryport, and terminates at Silloth, being 31 miles in length. The line would serve 15 important villages and five important towns, the latter having a population of 68,000, and the whole district 120,000. The estimated cost of the line and generating station is £361,000. With respect to the opposition of Cleator Moor, their only real objection was in respect of a bridge, which they said the promoters should be compelled to widen if they were making their tramway, but the committee decided that the bridge in question was wide enough for the purpose.

Warrington.—At the monthly meeting of the Rural District Council the promoters of the South Lancashire tramways scheme wrote stating that they are now in a position to agree to undertake the supply of electricity in bulk to the Council for the purpose of electric lighting, power, etc., in the district of Burtonwood. The proposals of the company, briefly, are that the Council should obtain their own electric lighting order and provide a network of distributing mains in the district named, together with the sub-station for receiving the supply of electricity in bulk. The Council would thus become their own undertakers under the Electric Lighting Act, and would by this arrangement be relieved from a large capital outlay for a generating station. The company's generating station would be situate at Atherton, and mains would be laid to the district free of charge. It was stated that the opinion at Burtonwood was that they would rather carry the electric lighting scheme out themselves, and it was decided that the matter should be in abeyance pending a further expression of opinion from Burtonwood on the subject.

Cardiff.—At a meeting of the Tramways Committee on Friday the sub-committee reported in detail on their inspection of different types of electric cars in different parts of the country. The sub-committee stated that owing to the exceptional features arising both in the service required and on some of the routes over which the cars would have to work at least three types would be necessary—single deck bogie cars, double deck bogie cars, and double deck four-wheel cars. The committee recommended that the Splott route should terminate at Custom House-street instead of running the single deck cars through to Grangetown, where double-deck cars could be very easily used. The single-deck car recommended would have a carrying capacity of 31 passengers, and the double-deck bogie cars a carrying capacity of 68 passengers, having accommodation for 30 passengers inside and 38 outside. Lath garden seats instead of the knifeboard or longitudinal seats, a double staircase, and two motors as propelling power were also recommended. The recommendations were adopted, and the engineer was instructed to prepare specifications, so that tenders might be invited as soon as possible.

Blackburn.—As stated in our last issue, the annual report on the working of the Corporation tramways, as presented to the Tramways Committee, shows a loss of £3,776 on the year's working. The total receipts from both electric and steam traction amount to £36,972 odd, while the working expenses amount to £28,947 odd, leaving a balance of £8 024 odd. Taking into account the capital charges on loans to the figure of £11,801 odd, there is a deficit of £3 776 odd. Throughout the past year the work of the electric equipment of the lines and the relaying of the permanent way have been pushed on as fast as material could be delivered, and it is anticipated that the cemetery section will be ready for electric traction by the end of June and the Church section by the end of July. In October last the Darwen section was opened for electric traction, and has worked satisfactorily, and shown a considerable increase in receipts over the corresponding period of the previous year. Referring to the financial position, the report states that the electric car expenses are higher than what they will be when all the sections are working, on account of sundry expenses incurred in handling the new cars as they are delivered, and this amount can only be placed against the revenue. The receipts per mile on all sections are not as high as was expected, partly owing to the large amount of mileage run in the early hours of the morning for experiment. An increase of fares is, therefore, recommended. There are at the present time 5·22 miles of electric tramways in operation and 5·5 miles of steam.

Belgium.—The sixteenth annual report has been issued of the Société Nationale des Chemins de Fer Vicinaux, which was founded in 1884, under the auspices of the Belgian Government, for endowing with railways, generally light, and of metre (3ft. 3⅜in.) gauge, districts which would not in the ordinary way receive the benefits of railway communication for many a year to come; but, through the beneficent action of the society, the railways are made and stocked by means of capital subscribed,

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in varying but defined proportions, by the Government, the provinces, the communes through which they pass, and companies or individuals interested in them. Although a few lines in outlying districts did not pay their way at first, and some of them even incurred a considerable loss, provided for by general and special reserve funds, such loss is now almost entirely made good, and only two of the 104 lines conceded, representing a collective length of 1,481 miles, show a slight balance on the wrong side. To the report is appended a graphic diagram showing at a glance the progress of the society's operations since its formation, with the remarkable success achieved. After the first year's working the curve of the annual receipts is almost a straight line, the figure having increased from £3,505 in 1885 to £393,660 last year. The curve of the lengths worked, also varying but slightly from a straight line, shows an increase from 36 miles in 1885 to 1,143 miles last year. The curve of the lengths of lines conceded shows greater variation, as also does that of the capital subscribed, for each line has its separate capital, attaining last year the total of £4,964,360. Of the 79 lines that have been worked for more than a year, 40 yield a dividend higher than that guaranteed; 10 more than 3 per cent.; 11 more than 2½ per cent.; and six more than 2 per cent.

London Underground Railways.—The Joint Committee of the two Houses of Parliament appointed to consider the routes proposed in various underground railway Bills now before Parliament resumed their enquiry on Friday. On behalf of inhabitants of Hampstead, counsel removed an impression that there was no opposition to the Charing Cross, Euston, and Hampstead line. Mr. Balfour Browne, K.C., opened the case for the King's-road Railway. From Eel Brook-common at Fulham the line would proceed through a densely-populated district, of which King's-road was the main artery, and would terminate at Victoria Station, where the line would get into touch with more than half the railways of London. It was stated in evidence that the line would be two miles and six furlongs, and there would be stations at Wandsworth Bridge-road, Grosvenor-street, and the bottom of Sloane-street. The size of the proposed tube was 11ft. 6in., and there would be two classes of fares at a uniform rate. Mr. Balfour Browne next stated the case for the Piccadilly and City line, which, starting from an end-on junction with the North-Eastern London line at Cannon-street and interchanging traffic there with the District Railway, would proceed, with stations at Ludgate-circus, the Law Courts, and Wellington-street, Strand, to Charing Cross, and finally to Piccadilly, where it was proposed to make an end-on junction with the Piccadilly and Brompton line. If, however, the promoters of the latter line objected to this junction, then by means of an interchange station the Piccadilly and City passengers could have connection with the Hammersmith and Charing Cross line. Sir Douglas Fox described the route with its various connections and subways, and pointed out how St. Paul's Cathedral had been carefully avoided by taking the line under Carter-lane. The congested space in front of the Mansion House had also been avoided. The tube contemplated would be 13ft., but the promoters proposed powers for 13ft. 6in. Counsel then opened the case for the West and South London Junction line. The sections of the line proposed include a line from Bishop's-road, Paddington, to the Marble Arch. Another section would continue the line to Victoria, arrangements having been made with the Office of Woods and Forests to run under the park by the side of Park-lane. A third section passed from Victoria under Vauxhall Bridge-road to the river, and thence by the Oval to a terminus in Camberwell New-road, where a generating station would be established. Subways at various points would give passengers connections with other lines, and thereby establish useful communication between the north-west and south-east of London. The connections of the proposed line with 17 other lines existing and proposed, having been explained, Sir Douglas Fox, on behalf of the North-West London Company, stated the objections to the proposed line crossing under the projected North-Western line near the Marble Arch. If the promoters would raise their level and join end-on with his company, his directors would be prepared to enter into an arrangement with them. The Committee adjourned to June 11.

LIGHTING AND GENERAL.

Croydon.—A main is to be laid at a cost of £1,200 to supply current to 17 houses in the Pampisford-road district.

Kyle.—Mr. Kerr, architect to the Guardians, has been asked to report upon an installation of electric lighting for the house.

Share Market.—Nothing much was doing in electric securities during the week beyond British Westinghouse preference and Metropolitans.

Submarines.—The Russian Government are building an electrically-driven submarine boat at Kronstadt, which is to be finished by the end of June.

Liverpool.—Mr. H. P. Boulnois has held the enquiry into the application of the City Council for sanction to borrow £300,000 for the purposes of electric lighting.

Canterbury.—Mr. F. H. Tulloch has held an enquiry into the Town Council's application for sanction to borrow £17,000 for the purposes of electric lighting.

Blyth.—A commencement has been made with the power station buildings of the electricity works for the Northern Counties Electricity Supply Company.

Poplar.—The loyal burgesses are clamouring for current at 3d. per unit, and are threatening that if their wish be not complied with new customers will become scarce.

Dalmeny.—The electric light is about to be installed at Lord Rosebery's residence, Barnbougle Castle, Dalmeny, by Messrs. Anderson and Munro's Edinburgh branch.

Personal.—Mr. E. T. Williams, assistant borough electrical engineer, King's Lynn, has been appointed to the position of engineer-in-charge at the Belfast Corporation electricity works.

Gloucester.—Alderman Fielding has been added to the Works Sub-Committee of the Electricity Supply Committee. Mr. Bache is obtaining estimates for the cable to be purchased for supplying the hospital.

British Thomson-Houston Co.—This firm have just issued a new list of alternate-current fan motors, which should find a ready sale while the hot weather lasts. We notice that they are designed for a frequency of 60.

Stock Exchange.—The Committee of the Stock Exchange have ordered the Aron Electricity Meter, Limited, 125,000 ordinary shares of £1 each, fully paid, Nos. 1 to 125,000, to be quoted in the official list.

Edinburgh.—At the last meeting of the sub-committee of the Electric Lighting Committee of the Town Council it was reported that the applications for the electric light during the past year were equal to 194,000 8-c.p. lamps.

Taunton.—Colonel W. R. Slacke has held an enquiry into the Town Council's application for sanction to borrow £21,000 for electric lighting purposes and £4,500 for the erection of a refuse destructor near their sewage outfall works.

Southwark.—The City of London Electric Lighting Company, Limited, intend to apply for a provisional order empowering them to supply electric energy for all purposes throughout the whole area of the metropolitan borough of Southwark.

Hoylake.—The Hoylake and West Kirby District Council have decided to light by electricity the public lamps in the streets in which electric mains are laid. We note that the supply will be available for consumers within the next few days.

Boating Accident.—The employés of Messrs. Callender's telegraph works on the 26th inst. held a club regatta off Belvedere, and we very much regret to learn that, during a heavy squall, two men, named Moir and Cobb, were drowned owing to their boat being upset.

Bridlington.—The Town Council on Wednesday adopted a resolution stating that the present is not an opportune time to carry out the Bridlington Electric Lighting Order, 1900, and that the carrying out of the order be postponed, the town clerk being instructed to apply to the Board of Trade for an extension of the period of two years.

Greenwich.—The Guardians have decided to light the schools at Halfway-street, Sidcup, by electricity, and an estimate is being prepared of the cost. The Borough Council on Wednesday passed a resolution disapproving of a provisional order being granted to the City of London Electric Lighting Company to supply electric energy for all purposes in the borough.

A Large Order.—Messrs. Ernest Scott and Mountain, Limited, of Close Works, Newcastle-on-Tyne, have, we are informed, secured the contract for the electrical equipment of the Port Talbot Steel and Iron Company's steel-rolling mills which are now in course of erection. This is probably the first new mill in which a complete installation of electrically-driven machinery has been adopted.

Penzance.—The following report was adopted at Wednesday's meeting of the Town Council: "The Electric Lighting Committee had before them a letter from Edmundson's Electricity Corporation, Limited, asking to be allowed to carry out the electric lighting order in case the Council do not see their way to carry it out, and recommend that they be asked to state the terms on which they would do so."

London Gazette.—The promoters of the City and North-East Suburban Electric Railway Company intend to petition for additional provision to authorise alteration of levels of a portion of the proposed railway and the use of land at Low Leyton for the construction of a generating station. The Ambleside Urban District Council propose to transfer their electric lighting order to the Windermere and District Electricity Supply Company, Limited.

Lancaster.—At Wednesday's meeting of the Town Council a resolution to pay £20 to Mr. Alan Fraser, late borough electrician, was defeated. It will be remembered that Mr. Fraser went out to the war as a yeoman, with the consent of the Corporation, who allowed him £1 a week during his absence. While he was away they appointed a new electrical engineer in reference to a scheme of electrical tramways. Mr. Fraser came home at his own expense, obtained a better position elsewhere, and then asked the Council to refund him part of his return fare from South Africa, which it is alleged the War Office made him pay. The Council refused on the ground that they never asked Mr. Fraser to return.

Jamesville Triplex Electric Pump.—The Jamesville Ironworks Company, of Jamesville, Pa., U.S.A., has sent us a copy of their pump circular. In it special reference is made to electric pumps for mine work, and the advantage of electric transmission is pointed out. Small pumps can be so easily erected and moved when they are electrically driven. The pumps made by the above firm are of the three-throw type. The motor is placed on the same bed-plate, with its axle extended on both sides, so that there is a double drive. A pinion, one on each end of the shaft, then gears into two large gear wheels placed one on each end of the pump axle with its three cranks. This firm standardises its pumps according to the lift required, this ranging from 350ft. up to 1,200ft.

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Runcorn.—We regret to hear that on Saturday morning a fire occurred at the Wigg Chemical Works, Runcorn, belonging to the United Alkali Company, and damage was done, it is reported, to the extent of £25,000. There were several explosions, but no persons were injured.

Notting Hill.—The Notting Hill Electric Lighting Company's Bill seeking powers to provide additional station accommodation to meet "the demands for the supply of electrical energy within their area of supply," has passed the Unopposed Bill Committee of the House of Commons.

Provisional Orders.—Bills to confirm certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, relating to the electric lighting of Birstall, Skipton, and Honley, have passed committee, and in due course will be reported for third reading.

Ashton-under-Lyne.—The Town Council have issued the statutory notice that they intend, in accordance with the provisions of the regulations made by the Board of Trade on Sept. 11, 1897, to apply to the Board of Trade for permission to alter the standard pressure at which energy is to be supplied.

Newark.—An enquiry is to be held into the Urban District Council's application for power to borrow £30,000 for electric light. In the meantime the Electric Lighting Committee have been instructed to consider the possibility of obtaining electricity in bulk, within a reasonable time, from the company whose Bill is now before Parliament.

Light Cure.—Mr. Alfred Harmsworth has given £10 000 to the London Hospital, Whitechapel, to endow one of the three lamps started there for the light cure of lupus. The authorities of the hospital hope that this very generous act will be followed, and that the other two lamps, one of which was presented to the hospital by Queen Alexandra, may be similarly endowed, as each lamp costs the hospital £400 a year.

Bristol.—Mr. Bird having resigned the post of station superintendent, on his appointment to the managership of the Guernsey Electric Supply Company, it has been decided to promote Mr. J. H. Bolman, B.Sc., to the vacant post. Extensions of the mains to St. Stephen's-street, Canon's Marsh, and at Redland have been sanctioned. An application for an extension in Silverthorpe-lane stands deferred.

Chichester.—The Corporation have followed with great interest the working of the electric lighting at Windsor, and have just received a report stating that the deduction to be drawn from the same was that Chichester would do well to embark on a like undertaking, taking care, however, that it was retained in the hands of the Corporation, and that the expenditure on the works was not so lavish as in the case at Windsor.

Mansfield.—The Electric Lighting Committee having decided to proceed with the electric lighting works and not to accept the offer of the Derbyshire and Notts Electric Power Syndicate to take the whole of the energy from them, preferring to erect their own generating station and lay their own mains. Specifications have been approved and the engineer has been authorised to ask for tenders, as the committee are most anxious to push on with the local scheme as quickly as possible.

Radstock.—The Urban District Council have adopted a report stating that the Lighting Committee had considered Mr. Preece's report upon an electric lighting scheme for Radstock and Midsomer Norton, and had decided to defer the matter to a future meeting of the committee, the surveyor in the meantime to make enquiries and to report further as to the relative cost of pumping at the proposed sewage works by electrical and other power, and also to report generally upon the electric lighting.

Barnet.—At the last meeting of the Urban District Council the following letter was read from the North Metropolitan Electrical Power Company, Limited: "We duly received your letter of the 8th inst. enquiring the terms upon which we should be prepared to light the new area, and having carefully considered the matter, beg to say that at present we should much prefer not to make any extensions in the directions indicated until the business has been further developed in the district we are now dealing with."

Boiler Certificates.—It has been arranged that the Parliamentary Committee to consider the Bill to grant certificates to persons in charge of steam-engines and boilers, second reading of which was agreed to earlier in the session, shall consist of the following persons and a motion to the effect is to be made at the reassembling of the House: Mr. W. W. Allan, Mr. Baldwin, Sir J. Brunner, Mr. Crean, Mr. Galloway, Sir A. Hickman, Mr. Jacoby, Mr. Nannetti, Colonel Pilkington, Sir F. Powell, Mr. Renshaw, Colonel Royds, Mr. Tomlinson, Mr. J. Wilson (Durham), and Sir T. Wrightson.

Tenbridge.—The adjourned enquiry by the Local Government Board into the Urban District Council's application to borrow £20,400 for electric lighting purposes was concluded at the Central Hall on Friday. Mr. Reader Harris, K.C., M.P., again appeared for the Council, and Mr. Atherley Jones, K.C., M.P. (instructed by Messrs. Freer, Morgan, and Brown), for the opposition on the part of the ratepayers. There was again a good attendance, incinding Councillor W. Baldwin, Councillor F. East, J.P., Councillor R. W. Annison, Councillor G. Dadson, Councillor I. Race, Mr. C. E. Warner, Mr. J. Lee, and others.

Warwick.—The Board of Trade have granted a provisional order to the British Electric Traction Company, Limited, for the supply of electricity within the borough of Warwick. The order provides that the local authority may acquire the undertaking of the company for the supply of this area within six months after the expiration of a period of 28 or 35 years from the commencement of the order on giving two years' notice. A special power is also granted to the company to enable it at any time within one year from the commencement of this order to transfer the undertaking to the Leamington and Warwick Tramways and Omnibus Company, Limited.

Weston-super-Mare.—Mr. B. Heap (chairman of the Urban District Council) and Mr. J. E. Norman (vice-chairman) last Friday switched on the current at the Weston-super-Mare and District Electric Supply Company's station. It appears that upon taking over the Council's provisional order for electric lighting, the company had undertaken to supply the compulsory area defined therein within 15 months. This period has been slightly exceeded, but the company have extended their mains considerably beyond the limits of the prescribed area. The applications number 95, with a consumption of from 4,000 to 5,000 lamps. Mr. S. G. Leech is the resident manager-engineer, and Mr W. C. C. Hawtayne the engineer representing the Council. The tramway will be supplied from the same building.

Wimbledon.—The statement of accounts of the Electric Lighting Committee just issued is considered eminently satisfactory. The accounts for the year ended March 31, 1901, show that the existing debt at that time was £65,000; the expenditure on repayment had been: principal, £1 551. and interest, £1 483; and working expenses were £6,338—total expenditure, £9,373. The revenue from private consumers was £5 479; from public lighting, £4 028 a total of £9 508; leaving a balance of profit for the first time of £134. 9s. 7d. The engineer has been authorised to carry out cable extensions in the following roads at an estimated cost of £105: Woodside, Spencer-hill, Queen's-road. The estimate of capital expenditure for the 12 months ending March 31, 1902, is £7 500 and application is to be made for sanction to the borrowing of this amount.

French Manners.—From the Paris chief telephone exchange comes the following story, which, if true, is typical of the excitable and self important personages whose rudeness towards ladies may be observed daily at any Paris tramway or railway terminus: A well-dressed man called and asked which office he was connected with He was shown into the room of the lady superintendent, and immediately made a violent assault upon her, boxing her ears with closed fists, while he exclaimed, "So you are one who makes a fool of me whenever I ring you up." The lady screamed loudly for help, and the police had to be called in to remove him to the lock-up, where he stated that he had been so incensed at the muddle the telephone clerks made of his calls that he determined to teach some of them the lesson that he was not to be played with.

Blackburn.—Mr. A. S. Giles, the borough electrical engineer, has just issued his annual report on the working of the electricity department during the past year. The receipts are stated at £14 465. 3s. 5d., against £11,843. 10s. in the previous year, an increase of 22 per cent., while the expenses have been £9,383. 1s. 10s., against £7,135. 0s. 2d., leaving a gross profit of £5,082. 1s. 7d., against £4,078. After paying the interest and sinking fund charges there is a balance in hand of £273. 7s. 8d., against £19. 1s. last year. The cost of generating in the works has been reduced from 1·65d. per unit last year to 1·32d., and the total costs, including management and distribution to the consumers, from 2·07d. per unit to 1 78d. There is an equivalent of 56 524 lamps of 8 c.p. connected to the mains, an increase of 10 524 over the previous 12 months. During the year applications were received for supply to 54 additional motors, which now total 94, or an aggregate of 280 b.h.p. The number of consumers taking the supply for all purposes is 670, an increase of 66 over last year, and the average price obtained per unit sold is 2·7d. The total output from the works for the year is 1,159,861 Board of Trade units sold, an increase of about 53 per cent. over last year's production, and during the year two additional generators have been put down of 256 kw. each, which brings up the capacity of the works to 3 280 h.p. The maximum load on the works at any one time was 1.112 kw. on March 23 last. Mr. Giles advises a uniform charge of 2s. per quarter for all meters up to 50 amperes. He says the number of meters in service is 692, costing about £3,114. The market price to-day for a meter up to 50 amperes is £4. 10s. The present rentals are 2s. 6d. per quarter each up to 25 amperes, and 5s. per quarter for one of 50 amperes capacity.

Islington.—At last Friday's meeting of the Borough Council a report was received from the Electric Lighting Committee stating that they had had under consideration the difficulties which confront them in connecting consumers in streets where supply mains are laid owing to the restriction contained in Standing Order No. 12, that "no contract shall be entered into or liability incurred for works proposed to be paid for out of capital until the consent of the sanctioning authority to the borrowing has been obtained." They recommended that Standing Order No. 12 be altered by the addition of the following words: "Except in the case of low-tension distributors and services required to connect consumers of electricity with the Council's mains which may be laid, after being sanctioned by the Council, as and when authorised by the Lighting Committee." This was passed subject to the condition that the Lighting Committee submit quarterly to the Finance Committee a statement of the amount so expended, with plans showing where the work has been carried out. The Council also agreed to a report of the Lighting Committee stating that the late Vestry authorised extensions of mains in Hornsey-road, and that the cost of such mains was included in a loan, sanction to which has been granted

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by the London County Council. As some technical questions connected with the system of laying the mains were under consideration by the Board of Trade, and time must necessarily elapse before any definite conclusion is arrived at, the committee thought this work should be proceeded with, and with that view they had obtained an estimate from the electrical engineer of the cost, calculated on the same basis as was used in preparing the estimates for the original loan, which amounts to £10,530.

London County Council.—In connection with the Holborn-to-Strand improvement the Council is acquiring from the Metropolitan Electric Supply Company, Limited, their station buildings, machinery, and works in Sardinia-street. Section 55 of the London County Council (Improvements) Act, 1899, requires the Council to convey to the company a new site, to pay "a sum equal to the costs and expense of erecting and fitting up a new generating station upon the new site with new plant of a capacity to generate and supply electrical energy to an output of not less than 4,000 kw.," and to fulfil other conditions. The company contended that the sum to be paid to them ought to include the value of spare or stand-by plant, and that the normal capacity of the entire plant ought to be not less than 5,000 kw.; but the Improvements Committee were advised that there was no obligation upon the Council to pay the cost of erecting and fitting up a new station with plant of a capacity to generate a supply, under ordinary circumstances, of more than 4 000 kw. Accordingly an action against the company was commenced by the Council in the Chancery Division for a declaration as to the rights of the parties under the Act; and Mr. Justice Farwell decided in favour of the Council's contention. The company appealed against this decision. Lords Justices Collins and Stirling, who heard the appeal, disagreed with the judgment of Mr. Justice Farwell, and decided that it was open for the arbitrator to say whether or not any spare or stand-by plant was necessary. The appeal was accordingly allowed. Notice of appeal is now to be given against the decision of the Court of Appeal in the action by the Council against the Metropolitan Electric Supply Company, Limited. Notices under Electric Lighting Acts and Orders have been approved of as follows: the Central Electric Supply Company, under the company's Act of 1899, to lay extra high-tension mains from the company's generating station along Lodge-place, Grove-road, Rossmore-road, Harewood-avenue, Marylebone-road, Gloucester-place, Portman-square, Lower Seymour-street, James-street, Oxford-street, and along Wigmore-street, Cavendish-square, Margaret-street, Regent-street, and Great Portland-street; the County of London and Brush Provincial Electric Lighting Company, under the County of London (Northern Extensions) Order, 1897, to construct a transformer box in Cross-street, Hatton-garden; the London Electric Supply Corporation, under its order of 1889, to construct an underground converter box in Manning-street, Bermondsey, and under the same order to lay trunk and high-tension distributing mains across Waterloo-road and along Exton-street; the Metropolitan Electric Supply Company, under the West London Order, 1889, to lay low-tension mains along portions of Mortimer-street and Great Portland-street, and also to lay high-tension mains along and across Marlborough-hill, and along Circus-road and Lennard-place, and under the Paddington Order, 1890, to lay high-tension mains along and across Shirland-road; the St. James and Pall Mall Electric Light Company, under the St. James Order, 1890, to lay extra high-tension mains along Oxford-street, Argyll street and place, Carnaby-street, Ganton-street, and Marshall-street to the company's station; the Westminster Electric Supply Corporation, under the Westminster Order, 1889, to lay extra high-tension mains along Robert-street, Gilbert-street, Providence-court, North Audley-street, Green-street, Park-lane, Hamilton-place, Hyde Park-corner, Grosvenor place and gardens, Ebury-street, Belgrave-road, Eccleston-place, Charlwood-street, Vincent-square (two sides), Carey-street, Regent-place, Horseferry-road, and Millbank-street, and to construct four underground chambers; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along Park-street, Albert road and terrace, and Savernake-road, and along Charlotte-street and Stephen-street.

LIGHT RAILWAYS.

An enquiry has been held into the proposed Wales and Laughton light railway order.

We understand that the provisional order granted by the Light Railway Commissioners for extensions of the Barnsley and district light railway has been confirmed by the Board of Trade.

The promoters of the proposed light railway to the Lizard propose to work the railway by electricity instead of steam, an offer having been made to provide the greater part of the money required to construct the line on condition that it was worked electrically, and that level crossings were substituted for bridges.

The Middlesex County Council are about to apply for four orders, involving the construction of about 75 miles of light railways, at an estimated cost of £25,000 per mile. Application is also to be made (1) for the construction of a light railway from Holmfirth to Southowram, near Halifax, for goods traffic only, of which Mr. Myers Beswicg, of Leeds and Westminster, is the engineer for the scheme, and Messrs. Land and Foster, Halifax, the solicitors; (2) for the construction of two lines in the parishes of Melton Bromeswell, Sutton, Shottisham, Hollesley, Alderton, and Bawdsey, to be called the Woodbridge District and Bawdsey Light Railway; and (3) of a line in Woolwich, Greenwich, Eltham, Charlton, and Kidbrook.

The fourth annual statement just issued by the Commissioners shows that since the date of the last report the Treasury have conditionally agreed to make the following advances in respect of light railways authorised by orders confirmed by the Board of Trade: Leek, Caldon Low, and Hartington (Waterhouses to Hulme End section), £5,000, in addition to £10,000 previously promised; Tanat Valley, £10,000, in addition to £18,000 previously promised; Welshpool and Llanfair, £7,500, in addition to £7,000 previously promised; Wick and Lybster, £5,000 as a free grant and £3,000 as a loan without interest, in addition to £20,000 previously promised. The Treasury have also conditionally agreed to advance sums in respect of certain orders approved by the Light Railway Commissioners, but not yet submitted to the Board of Trade for confirmation—viz., Cromarty and Dingwall, £25,000 as a free grant and £12,500 as a loan without interest; Elsenham, Thaxted, and Bardfield, £3,250, in addition to £16,000 previously promised.

Fifty-six applications for orders to authorise light railways were made in the year 1896-7; 65 in the year 1897-8; 94 in the year 1898-9; 67 in the year 1899-1900; and 27 in the month of November, 19,000. The Commissioners' report deals with 126 orders (in respect of 133 applications) which they have submitted to the Board of Trade for confirmation. On Dec. 31, 1899, 18 orders were before the Board of Trade for consideration. Of these, 13 were confirmed by the Board during the year under report, and five were held over for various reasons, one of them having since been confirmed. In the course of the year the Light Railway Commissioners submitted 40 fresh orders to the Board for confirmation. Objections to the confirmation of the orders were lodged with the Board of Trade in most instances, and in each case a day was appointed for the consideration of the order, and an opportunity of being heard was given to objectors. The Board of Trade also considered each order with special reference to the points mentioned in Section 9 of the Light Railways Act, and made various amendments in the orders. Sixteen of such orders, in addition to 13 previously mentioned, were confirmed by the Board of Trade during the year. The remaining orders—24 in number—were still under consideration on Dec. 31 last, but of these 10 have since been confirmed.

The orders dealt with by the Board of Trade during the year 1900 are recapitulated as follows; (*a*) Orders under consideration on Dec. 31, 1899—*Kelvedon, Tiptree, and Tollesbury (held over at request of promoters); Derby and Ashbourne (under consideration); Abergavenny and Monmouth (held over at request of promoters); Redditch and District, Callington, Basingstoke and Alton (Amendment), Dudley and District (Extensions) and Gosforth and Ponteland; South Staffordshire (confirmed), Cheltenham and District (confirmed), North Lindsey (confirmed), North Lincolnshire (confirmed), Isle of Thanet (Extensions) (confirmed), Essington and Ashmore (confirmed), Rhyl and Prestatyn (confirmed), and Mid-Suffolk (confirmed); Aldershot and Farnborough (consideration deferred pending the completion of negotiations between the promoters and the War Office); Waltham Cross and Enfield (consideration deferred pending the submission of the Middlesex light railways order now before the Light Railway Commissioners). (*b*) Orders submitted for confirmation during the 12 months ended Dec. 31, 1900: East Anglian (consideration deferred pending result of proceedings on Lowestoft Corporation Bill in Parliament); Cheltenham and District (Extension), Bishop's Waltham, Bexhill and St. Leonards, Highbridge, Wedmore, and Cheddar, Robertsbridge and Pevensey, South Staffordshire (Extensions), Bere Alston and Calstock, Lastingham and Rosedale, North Wales Narrow-Gauge Railways (Beddgelert Light Railways Extension), Bourne Valley, Barnsley and District, Gateshead and District, Peterborough and District, Bromsgrove, Rhyl and Prestatyn (Extensions), and Wotton-under-Edge (confirmed); *Ormskirk and Southport, *Long Melford and Hadleigh, *Maidstone and Faversham Junction, Spen Valley (Extensions), *Brackenhill, *West Hartlepool (Deviation, etc.), and Spen Valley (under consideration); Colne and Trawden, Barrowford, Nelson, and Leighton Buzzard and Hitchin (waiting action on the part of promoters); Nuneaton and District and *Oakington and Cottenham (waiting action on the part of promoters): Aldershot and Farnborough (Extension) (consideration deferred, pending the completion of negotiations between promoters and the War Office); *Sheerness and District and *Morley and District (with counsel for settlement); Dartford District (action deferred, pending result of negotiations between promoters and certain objectors); East and West Yorkshire Union, Tickhill, *Nidd Valley, Bridgwater, Stowey, and Stogursey, Loughborough and District, and *Cleobury Mortimer and Ditton Priors (time for lodging objections not yet expired. * Since confirmed.

The orders confirmed since the passing of the Light Railways Act, are as follows: 1897 (1 to 4) Basingstoke and Alton, East

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and West Yorkshire Union, Potteries, Hadlow. 1898 (5 to 30)—Wrington Vale, Flamborough and Bridlington, Crowland and District, Lizard, Lauder, Forsinard Melvich and Port Skerra, Gifford and Garvald, West Highland Railway (Loch Fyne), Bridlington and North Frodingham, Caledonian Railway (Leadhills and Wanlockhead), Carmyllie, Great Western Railway (Pewsey and Salisbury), West Hartlepool, Isle of Thanet, Dornoch, North Sunderland, Vale of Rheidol (Aberayron Extension), Goole and Marshland, Pewsey and Salisbury (Devizes Branch), Amesbury and Military Camp (L. and S.W. Railway), North Holderness, Gower, Dudley and District, Bankfoot, St. George and Hanham, Middleton. 1899 (31 to 65)—Tanat Valley, Flamborough and Bridlington (Amendment), Barking and Beckton, South Norfolk, Didcot and Watlington, Grimsby and Saltfleetby, Leek, Caldon Low and Hartington, North Shields, Tynemouth and District, Kinver, Ventnor Inclined, Liverpool and Prescot, Isle of Axholme, Sheppey, London United, Merthyr Tydfil, West Manchester, Llandudno and Colwyn Bay, Axminster and Lyme Regis, Corringham, Chatham and District, Poole and District, Penzance, Newlyn and West Cornwall, Trent Valley, Portsdown and Horndean, Fraserburgh and St. Combs, Welshpool and Llanfair, Southend-on-Sea and District, Glasgow and South-Western Railway (Maidens and Dunure), Didcot and Watlington (Extensions), Coggeshall, Bradford and Leeds, Doncaster Corporation, Wick and Lybster, Cranbrook and Tenterden, Glasgow and South-Western Railway (Cairn Valley). 1900 (66-94)—Basingstoke and Alton (Amendment), North Lincolnshire, North Lindsey, Essington and Ashmore, Redditch and District, Isle of Thanet (Extensions), Dudley and District (Extensions), Rhyl and Prestatyn, Mid-Suffolk, Callington, Bexhill and St. Leonards, Cheltenham and District, Cheltenham and District (Extensions), Robertsbridge and Pevensey, Highbridge, Wedmore, and Cheddar, Bere Alston and Calstock, Lastingham and Rosedale, North Wales Narrow-Gauge Railways (Beddgelert Light Railway Extension), Barnsley and District, South Staffordshire, Gateshead and District, South Staffordshire (Extensions), Bromsgrove, Peterborough and District, Bourne Valley, Bishop's Waltham, Gosforth and Ponteland, Wotton-under-Edge, Rhyl and Prestatyn (Extensions). 1901 (95 to 105)—Oakington and Cottenham, Long Melford and Hadleigh, Sheerness and District, West Hartlepool (Deviation, etc.), Ormskirk and Southport, Kelvedon, Tiptree, and Tollesbury, Morley and District, Maidstone and Faversham Junction, Brackenhill, Cleobury Mortimer and Ditton Priors, Nidd Valley.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Birkdale District Electric Supply Company, Limited.—Capital, £30,000. Object: to carry on in the United Kingdom and elsewhere the business of electrical engineers and contractors, suppliers of electricity, carriers of passengers and goods, electricians, etc.

Straker Steam Vehicle Company, Limited.—Capital, £12 000. Object: to acquire from S. S. Straker the benefit of certain existing inventions belonging to him in connection with steam-motor vehicles, and to carry on the business of mechanical and electrical engineers, etc.

Lewis Lighting System, Limited.—Capital, £15,000. Object: to adopt an agreement with E. Dalton; to acquire and turn to account any patents, inventions, licenses, concessions, and the like relating to improvements in the production of acetylene gas, and to carry on the business of electricians, engineers, lampmakers, etc.

Fuller, Macleod, and Co., Limited.—Capital, £10,000. Object: to acquire the business carried on at 9, Red Lion-court, E.C., by J. L. Fuller, as Fuller and Co., and to carry on the business of merchants, factors, dealers in electrical accessories and equipment, dynamos, motors, electrical engineers, makers of electrical and general engineering appliances, etc.

Eagle Engineering and Motor Company, Limited.—Capital, £6,000. Object: to adopt an agreement with R. Jackson of the one part and J. Kenworthy and J. B. Bindloss, jun., for the company of the other part, and to carry on the business of engineers, electricians, wheelwrights, tube makers, screw, bolt, and nut manufacturers, motorcar makers, etc.

Millington, Everitt, and Co., Limited.—Capital, £3,000. Object: to acquire from F. Millington the benefit of certain existing inventions, and to carry on the business of electricians, suppliers of electricity, manufacturers of and dealers in electrical, galvanic and magnetic apparatus, electrical and general engineers, cycle and motorcar manufacturers, etc.

Dolter Electric Traction Company, Limited.—Capital, £100,000. Object: to acquire inventions, licenses, concessions, etc., relating to the production, treatment, storage, application, distribution, and use of electricity, in particular to acquire from the Société d'Exploration des Brevets Dolter, of 12, Rue la Fayette, Paris, the benefit of certain patents and patent rights in respect of certain inventions relating to electric traction, or apparatus therefor, and to carry on the business of an electric traction and supply company, etc.

PROVISIONAL PATENTS, 1901.

MAY 13.

9911. Improvements in or in connection with direct-acting engines applicable for coal cutting, mining, drilling, tunnelling, stamping ore, pile driving, and the like. Sir Thomas Wrightson, Bart., M.P., and John Morison, 24, Southampton-buildings, Chancery-lane, London.

MAY 18.

10349. Method of and apparatus for mitigating the danger, with the object of preventing the loss of life, that is attendant upon the rush of steam from a burst or broken steam-pipe, particularly such as the high-tension engines of battleships, cruisers, liners, etc., are liable to. Charles Mackintosh, 159, Euston-road, London.

MAY 20.

10377. Main controlling electric switch. Sarah Dixon and Son, Limited, Boar-lane, Leeds.

10434. A process of increasing and decreasing the internal resistance of vacuum tubes. Alfred Ernest Dean, 73, Hatton-garden, London.

10459. Improvements in storage batteries. Vincent Groby Apple, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 21.

10480. Improvements relating to telephonic systems. Arthur Henry Hickley, 10 St. George's-crescent, Liverpool.

10482. A cell for electrolysis. Arthur Alexander Govan, 15, Renfield-street, Glasgow.

10505. Improvements in storage batteries. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10506. Improvements in magnetic separating apparatus. The Edison Ore-Milling Syndicate Limited, 188, Fleet-street, London. (Thomas Alva Edison, United States.) (Complete specification.)

10599. A new or improved telephone receiver holder. George S. Meyer, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 8, 1900, being date of application in United States.)

MAY 22.

10562. Improvements in dynamos and electric motors. Stainer Hutchins, 57, Barton-arcade, Manchester.

10569. Improvements in means or apparatus for preventing contact of telephone and telegraph wires with the trolley wires of electric tramway installations. Walter William McLauchlan, 62, Market-street, Manchester.

10571. Improvements in junction boxes for electric wire and like installations. George Hubert Woods, 55, Market-street, Manchester.

10587. Improvements in electrical lampholders. George Sperryn and William Henry Wood, 104, Colmore-row, Birmingham.

10609. Electromagnetic electric railway-track switch and means for controlling and operating same. Philip Benjamin Williams, 31, Cannon-street, London.

10623. An improvement in telephone apparatus. Arthur Harold Nicholson and the New Phonopore Telephone Company, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 15.

1900.

3343. Telegraphic transmitting, receiving, and translating arrangements. Muirhead.

3535. Electricity meters and electric clocks. Hookham.

9339. Multiplex telephony. Evans. (Faller.)

9631. Detective lock or seal for gas and electric meters, electrical demand indicators, and fuse boxes, or for any other uses or purposes to which same may be applicable. Bastian.

9744. Electric signalling apparatus. Lea and Taylor.

11054. Electrically-operated cloth-cutting machines. Garland.

11207. Distribution of electricity. Andrews.

11287. Conduits for electric conductors. Jones.

11941. Regulating appliances in connection with electric motors for turret turning, gun training, and analogous purposes. Scott.

19425. Electric coherers. Ducretet.

23240. Gear cases for electric cars. Cox, Smith, and Smith.

1901.

5077. Devices for X-rays. De Mare.

5220. Electric surgical dilators. Mosher. (Date applied for under International Convention, Aug. 25, 1900.)

5700. Electric clocks. Pöschl and Gaütsch.

8102. Switch systems for telephone circuits. Cerebotani and Moradelli.

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7492. Winding for electromagnetic inductive apparatus. Wait. (Date applied for under International Convention, Jan. 12, 1901.)

8162. Electrical lamps. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

8196. Sockets or holders for incandescent electric lamps. Uytenbogaart.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	May 25	685	672	+ 13	—	—
Birmingham Trams.	,, 25	4,884	4 553	+ 331	87,668	—
Blackburn Corp'rat'n	,, 24	515	507	+ 8	9,367	8,395*b*
Blackpool Corporatn.	,, 23	437	353	+ 84	3,470	2,815
Blackpool-Fleetwood	,, 25	432	414	+ 18	5,131	5 524
Bolton Corporation..	,, 26	1,440	1,361	+ 79	28,549	19,545
Bradford City Trams	,, 26	930	527	+ 403	12,529	8,094
Bristol Tramways Co.	,, 24	4,681	3,169	+1,512	—	—
Carlisle Tr'mw'ys Co	,, 25	191	—	—	2,870	—
Central London Ry.	,, 25	6,165	—	—	130 100	—
City & South London	,, 26	1,838	1,355	+ 483	41,471	26,320
Cork E. T. and L. Co.	,, 23	621	456	+ 165	8,215	7 136
Darwen Corporation	,, 24	222	160	+ 62	3,613	3,048
Dover Tramways ...	—	—	—	—	—	—
Dublin & Lucan E.R	,. 25	124	111	+ 13	1,831	1,695
Dublin U.T., elec. cars	,, 24	3,853	3,494	+ 359	—	—
Dublin S.D. Electric	,, 24	966	823	+ 143	—	—
Dundee Tram Co. ...	,, 22	720	423	+ 297	—	—
Glasgow Corporation	,, 27 1	1,835	9,623	+2,112	—	—
Halifax Corporation	—	—	—	—	—	—
Huddersfield Corp'n.	—	—	—	—	—	—
Hull Corporat'n E.S.	,, 25	1,589	1,257	+ 332	69 392	34,674
Liverpool Corporat'n	,, 18	9 495	7,954	+1,541	164,587	140.379
Liverpool Overhead	,, 26	1,565	1,429	+ 136	32,376	29,657
Portsmouth Corpn...	,, 25	543	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 26	3,571	—	—	—	—
Southampton Trams	,, 25	797	488	+ 309	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—
Wolverhampt'nC'p'n	—	—	—	—	—	—

b Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £242 decrease.

Barcelona Ensanche y Gracia, £67 decrease. Barcelona, £257 increase.

Brisbane. £338 increase.

Buenos Ayres and Belgrano Electric, £562 increase.

Calcutta, £155 increase.

Cape Town (month of February), receipts, £13,463; expenditure, £6,004.

Mexico Electric (month of April), receipts, £17,500; expenditure, £10,000.

Perth Electric, £257 increase.

Port Elizabeth (month of February), receipts, £3,043; expenditure, £1,803.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¾-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Electric Works, Ordinary, 80,001-95,000	1	—	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	—	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	—	85-90
British Insulated Wire, Ord., 1-70,000	5	—	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼ xd
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2¼
—— 4½ per cent. Debenture Stock	100	..	103-108
—— 4½ per cent. 2nd Debenture Stock	100	—	101-104
Callender's Cable, Debentures	100	—	109-113
—— Ordinary	5	—	14½-15½
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	2	—	2¾-4
—— 5 per cent. Debentures	—	—	101-104
Edison and Swan United, Ordinary	2	—	1-1¼
—— 5 per cent. Debentures	5	—	2¾-3¼
—— 4 per cent. Deb. Stock, Red.	100	—	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	—	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1¾-2⅛
—— 7 per cent. Cumulative Pref.	2	—	2¼-2
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	101-104
Giffre Electro-Chemical and Power, Ord., 20,001-180,000	1	—	0-¼
W. T. Henley's Telegraph Works, Ordinary	5	—	15½-16½
—— 5 per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-80,000	5	—	10-11
—— 6 per cent. Cum. Pref., 80,001-60,000	5	—	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	—	70-75
Bournemouth and Poole, Ordinary	10	—	11½-12½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7⅜-6½
—— 7 per cent. Preference	5	—	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	7-7½ xd
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	5-6¼
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	—	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	—	101-103
County of London and Brush Provincial, Ordinary	10	—	8-9
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	5¼-5¾
—— 6 per cent. Cum. Pref.	5	—	5¼-6
—— 4½ per cent. First Mort. Deb.	100	—	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	..	4¾-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	—	11-12
—— 4 per cent. Debenture Stock, Red.	100	..	102-105
Kensington and Knightsbridge and Notting Hill	100	—	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	3	—	1¾-1¾
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	13-14
—— ,, 85,001-98,769	5	—	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15¼-16¼
Oriental, 1879	1	—	1¼-1⅜
—— £5 Shares	5	—	6¼-6¾ xd
—— £4½ Shares, New	4½	—	5¼-6
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	—	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	—	80-90
South London, Ordinary	5	—	2¼-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14¼-15½
—— 7 per cent. Pref.	5	—	8¼-9¼
—— 3½ per cent. Deb.	100	—	93-101
Westminster, Ordinary	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9¼-10
—— Pref. Half-Shares	5	—	4¼-5
—— ,, ,, deferred	5	—	4¼-5¼
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	113-118
City and South London, Consolidated Ordinary	100	—	51-56
—— Ordinary	10	—	4¾-5¼
—— 4 per cent. Debenture Stock	100	—	111-116 xd
—— 5 per cent. Pref. Stock '91	100	—	132-137
—— ,, ,, ,, '96	100	—	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
—— Ordinary, 1-50,000	—	..	7¾-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	102-104
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	3¾-4
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	124-129
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	—	2¼-2½
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	—	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	—	6¾-7
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	—	9¼-10 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	..	99-101 p.c
British Electric Traction, Ord., 1-800,000 & 60,001-90,000	10	—	14½-15½
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	..	1¼-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	100	—	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	—	1⅛-1¼
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	98-103
Imperial Tramways, Ordinary	all	..	22-23¼
—— 6 per cent. Cum. Pref.	all	—	14¼-15¼
—— 4½ per cent. Deb. Stock	100	—	112-114
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	—	103-105
New General Traction, Ordinary	5	—	3¼-3¾
—— 6 per cent. Cum. Pref.	10	—	4¼-5 xd
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10¾-10¾
—— 5 per cent. Cum. Pref.	10	—	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	105-107 xd
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	—	1
—— £51,132 6 per cent. Preference	6s.	—	5/16
—— £50,000 ,, ,,	1	—	1
—— £500,000 4½ per cent. Debenture Stock	33½	—	33½
Telephones.—			
National Telephone, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. First Pref.	10	—	11¼-12¼
—— 6 per cent. Cum. Second Pref.	10	—	11¼-12¼
—— 5 per cent. Non. Cum. Third Pref.	5	—	4¾-4¾
—— per cent. Deb. Stock, Red.	100	—	96-98
—— 3½ per cent. Deb. Stock, Red.	100	—	87-90
Oriental Telephone and Electric Company	1	—	¾-1 pd

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NOTES.

Incorporated Gas Institute.—The thirty-eighth annual general meeting of this institute is fixed to be held at the Royal United Service Institution, Whitehall, London, on the 11th, 12th, and 13th inst., under the presidency of Mr. T. Ormiston Paterson, M.I.C.E. On the first day the proceedings will open at 10.30 a.m., and on the two subsequent days at 10 a.m. respectively.

Oil-Fields in Texas.—The recent development of the oil-fields in Jefferson County, Texas, has, according to an American contemporary, resulted in marked prosperity for other interests. The Houston Electric Street Railway, for instance, is now burning oil from the fields near the town of Beaumont, and, it is said, will thus save £1,300 per annum in their fuel bill. The price obtained for this Beaumont oil is just over 2s. per barrel.

American Municipal Electricians. — We are informed that the sixth annual convention of the International Association of Municipal Electricians of New York will be held this year in the Natural Food Company's Conventional Hall, Niagara Falls, on Sept. 2, 3, and 4. From present appearances this promises to be one of the best meetings ever held by the association, both as regards attendance and subjects to be brought before the convention. Full particulars may be had on application to Mr. F. C. Mason, 16, Smith-street, Brooklyn, N.Y.

Personal.—We note that it is in recognition of his numerous scientific works, as well as of his inventions, that Dr. Karl Auer von Welsbach has been made a baron by the Emperor of Austria. In this country Dr. Welsbach is best known in connection with the incandescent light which bears his name, but it is said that he is now seeking to do for electricity what he has already accomplished in respect of gas. The baron, who is still a young man, being only 42 years of age, comes of an inventive stock, and his father, who founded the State printing office in Vienna, was also an inventor in typography and xylopyrography.

German Visit to the States.—According to a note in *Electricity*, a party of engineers and other experts connected with German street railways will arrive in New York this week for the purpose of studying the different systems of electric tramways in vogue in America. It is stated that the German engineers will not be empowered to close any contracts for material, equipment, etc., with American manufacturers, their sole object being to gather data for submission to their respective executive officers. The result anticipated from this course is that substantial orders will be placed with United States firms. It is of interest to note that this is the first visit of German electrical experts to America.

The "Henry Angel Memorial."—A movement is on foot among the former students and colleagues of the late scientist, Prof. Henry Angel, to perpetuate his memory by founding a prize or scholarship to his name at the City of London College. For many years Prof. Angel taught steam, applied mechanics, and practical plane and solid geometry with signal success both at this college and elsewhere, and in spite of natural infirmities he laboured so unceasingly as to gain the highest esteem of all his pupils. It is felt that there are many members of the profession who would be glad to associate themselves with the movement, and subscriptions may be sent to Mr. P. J. Gillbard, hon. secretary of the fund, City of London College, White-street, E.C.

Determination of the Boiling Point of Liquid Hydrogen.—An abstract of a paper by Mr. James Dewar describing a method of determining the boiling point of liquid hydrogen by hydrogen and helium gas thermometers appears in the June number of the *Journal* of the Chemical Society. In this case the author states that a constant-volume thermometer, charged with hydrogen or helium, has been used. It is shown by a number of experiments that either a simple or a compound gas at an initial pressure somewhat less than one atmosphere may be relied on to determine temperatures down to its own boiling point in the constant-volume gas thermometer. The mean values of separate determinations give −182·5deg. as the boiling point of oxygen, and −252·5deg. as that of hydrogen. The latter is lower than the value −238·4deg. previously obtained with a platinum-resistance thermometer.

Institution "Journal."—The April issue of the *Journal* of the Institution of Electrical Engineers contains the following papers with the discussions thereon: "The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure," by Mr. J. B. C. Kershaw; "Capacity in Alternate-Current Working," by Mr. W. M. Mordey; "The Electrical Power Bills, 1900; Before and After," by Mr. W. L. Madgen; "The Dublin Corporation Electric Light Scheme," by Mr. R. Hammond (Dublin Section); "Electrically-Driven Machine Tools and their Advantages for Use in Engineering Workshops," by Mr. G. Ralph (Newcastle Section); and "A Method of Compensating Voltmeters for Voltage Drop in Long Feeders," by Mr. M. B. Field (Glasgow Section). The volume concludes with an original communication from Mr. A. Russell, entitled "Note on Resonance with Alternating Currents."

Cold Splicing of Electric Cables.—A new device for splicing electrical conductors without the outside application of heat has recently made its appearance on the American market. The new method, which has been introduced by the Morris Electric Company, is to remove the insulation for a short distance from the ends of the cable or wire, and then insert the ends in a short sleeve of copper of high conductivity. In describing this invention the *Street Railway Review* says the joint is then compressed into a solid mass, the external crevices of the cable being filled with a metal of the sleeve, making an air-proof and moisture-proof splice. The surface of contact between the cable and the sleeve is about nine times the sectional area of the cable, thus ensuring a joint of low resistance. The whole operation is done cold, and completed in a few seconds, and, it is reported, the joint is even stronger than the cable itself. These machines, we understand, are coming to be extensively used both in the States and abroad.

Wireless Telegraphy in the United States Navy.—The question of the introduction of wireless telegraphy into the United States navy has recently been occupying the attention of a specially appointed Board, who have investigated the matter, and made, among others, the following recommendations: that the use of homing pigeons be discontinued as soon as wireless telegraphy is introduced into the navy; that pending such action, no new pigeon cotes be established; and that wireless telegraphy be adopted by the navy for the transmission of messages between distant points. In the opinion of the Board, the successful operation of any system of wireless telegraphy demands a high degree of special electrical training, and they therefore suggest the establishment of two stations sufficiently far removed from each other for the training of both officers and men. This requirement, it is thought, would be best met by having stations at the Naval Academy, Annapolis, and the Navy Yard, Washington.

Apparatus for Decomposition Voltages.—In a recent paper under this title Mr. Wilder D. Bancroft

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describes a modified form of Le Blanc's method, by means of which the conditions under which metals can be separated, the existence of a complex ion, the conditions for a crystalline deposit, etc., can be easily investigated. From an abstract of the paper in the *Journal* of the Chemical Society we gather that in this arrangement a mil-ammeter is interposed in the main circuit containing the electrolytic cell, and the electrodes are connected with a high-resistance voltmeter having a contact key in this circuit. The voltmeter should be placed in series with another high resistance, and under these circumstances the resistance of the solution can be neglected. The electrodes are platinum wires, and the cell may be in the form of a beaker or a U-tube. The measurements made are potential differences, and not E.M.F.'s of polarisation. The value of the decomposition voltage can be arrived at by extrapolation to the point of zero current. The measurements are probably correct to about 1/50 volt. The results obtained with solutions of zinc sulphate and sulphuric acid agree well with those found by Le Blanc.

Proposed Electrical Museum.—The Council of the Institution of Electrical Engineers have at present under consideration the formation of a museum for objects or apparatus not now in commercial use, but possessing interest in connection with electrical science and its application. Probably many members have in their possession apparatus or specimens of the types required, and it is felt that there is considerable danger that in the course of time they may become dispersed and entirely lost sight, unless steps be taken to guard against such a contingency. To prevent the irretrievable loss to the profession of the many objects of historical interest that are still in existence, the Council invite members and their friends to-operate either in the collection or in the tabulation of such apparatus as may be available. The authorities at the South Kensington Museum have promised to receive such of the objects as may appear to them to be of sufficient public interest as a loan collection from the Institution until the Institution is in a position to exhibit them in a home of its own. It is particularly requested, however, that objects offered to the Institution should not be forwarded until intimation is sent that the Council is in a position to receive them.

Glasgow Tramway Accidents.—We notice that the starting of the electric trams on the main streets of Glasgow has been followed, as it always has been in other cases, by an increase in the number of accidents to passengers on the cars and to the general public in the streets. It is a curious thing that the greater speed should upset, as it does, the experience of years with respect to crossing streets. For instance, in Glasgow they have had electric cars running on one route for the last two years, and the people who use that route have become quite accustomed to the speed of the cars. As soon, however, as a new route is opened, a new set of inhabitants has to get used to the fact that the cars are running faster than when pulled by horses, and it is again shown that a certain number of accidents are required to enforce ordinary care. We notice, too, that a large number of the accidents in Glasgow were brought about by the passengers getting off the cars at full speed without making due allowance for the same. Up to the present, however, we are pleased to note that the Glasgow papers have not written the "scare-headed" articles on the subject which we have often seen in the local papers of other towns when electric tramways have been opened. The decrease in the number of accidents per week will, of course, take place as the people become more careful in crossing the streets and getting off the cars.

Electric Omnibuses.—Our readers will remember that at the meeting of the British Association at Bradford last year Mr. J. G. W. Aldridge described an electric omnibus which had been devised in Paris, and which took its power from two trolley wires suspended on one side of the street along which the omnibuses ran. In this case there was a most ingenious arrangement by which the collectors on the trolley wires were made to automatically run at the same speed as the 'bus. The connecting cord then between the 'bus and the collectors was not required to transmit any mechanical stresses, and could be paid out and wound in to permit of the omnibus running at a considerable distance from the line. We note in the current issue of the *Electrical Review* of New York that a Mr. A. B. Upham, of Tremont-building, Boston, has been working at the same problem, but up to the present his solution seems to us to be much more crude than that described by Mr. Aldridge. In Mr. Upham's scheme horizontal trolleys are used to bear against the trolley wires. While the supports of these two trolley poles could be fixed at a considerable height above the omnibus, there would not even then be the clear headway between the omnibus and the trolley wires which is required to enable vehicles to pass on the inside of the electric 'bus. Again, we think the inventor would find there was considerable trouble in working the horizontal trolley.

The Bowman Lindsay Monument.—The committee entrusted with the selection of the monument which is to be erected to mark the grave of James Bowman Lindsay, whose fame as a pioneer in electrical science is generally acknowledged among electricians, have decided upon the design to be adopted. The monument consists of a lofty column of grey granite, mounted on a graded base, with simple classical ornamentation. The total height will be 19ft. 3in., and the width 4ft. Surmounting the pillar is a bronze hand holding a thunderbolt, typifying man controlling electric energy. The front of the monument bears an inscription testifying to Lindsay's services as "a pioneer in electrical science." The inscription also embodies the following passage: "He devised an electric telegraph in 1832, suggested welding by electricity, produced a continuous electric light in 1835, proposed a submarine Transatlantic telegraph in 1843, and accomplished wireless telegraphy through water in 1853." In accordance with a suggestion thrown out by Sir John Long some time ago, passages from Bowman Lindsay's own writings are engraved on both the south and north side of the monument. It is thought that the appearance of the monument will be much improved by the placing of a granite kerb around the grave, and subscriptions for that purpose and for the completion of the work will be received by Mr. A. H. Millar, *Dundee Advertiser* Office, Dundee.

Mr. Edison and the General Electric Company.—The retirement of Mr. Thomas Edison from the directorate of the General Electric Company is regarded in the States from different points of view. The New York *Journal*, for example, refers to Mr. Edison as being "thrust from the directorate," and expresses the opinion that it is the wish of the capitalists behind the company and its officers to "dissociate from it not only Edison's name, but his personality." Mr. Edison's case is that he sent in his resignation two years ago, but it was not accepted or acted upon. A few weeks ago there was a pressing call for his attendance at a meeting of the company, and he responded at great personal inconvenience to himself. It was on this occasion that he urged that his resignation from the Board be accepted. The result was the dropping of his name, and it is said in some quarters that Mr. Edison's relations with the General Electric Company are

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now, as they ever have been, entirely cordial. His retirement from the directorate is put down solely to the fact that he cannot afford the time necessary to attend to the duties of the position. In the American technical Press the fact that Mr. H. P. Fish, who has been elected a director in the place of Mr. Edison, is the newly-elected president of the American Bell Telephone Company and the American Telephone and Telegraph Company, is regarded as a sign of closer friendship between the three companies.

Telephonic Communication on Tramways.—We have not heard of any device in use in this country by which those in a tramway office can open up a telephonic communication with the conductor of a car out on the road. The *Street Railway Review*, however, gives a description of a system, devised by the engineers for the Massachusetts electric companies, which is said to accomplish this purpose. The essential feature of the invention would appear to be a series of semaphores, one of which is placed near every telephone instrument along the line. From a diagram given in our contemporary, we gather that when a dispatcher in the office desires to speak with a conductor on any particular car, he closes a switch which causes to be exposed at each instrument on the line a red semaphore with the word "phone" painted on it. As the conductors of the several cars on the road reach these signals they immediately call the dispatcher on the telephone, and the signals are left in the "calling" position until the particular conductor required has responded. The dispatcher then switches the signals back, and they return to "clear" at once. Of course, it might very possibly happen with this system that two or three conductors that were not wanted would answer the call, but the dispatcher, by keeping careful track of his cars, can set the signals when he knows the desired car is nearing an instrument. No batteries are used in this device, as the signals are operated by current taken from the tramway circuit.

Illumination of Different Kinds of Glass.—In the *Journal* of the Chemical Society for June will be found an abstract of an interesting paper on this subject by Mr. Walthère Spring. Ruby glass, the author states, is made by the addition of traces of gold chloride to an ordinary fused glass. The glass so obtained is at first colourless, and only assumes a ruby colour during subsequent prolonged heating. When an intensely luminous electric beam is passed tangentially through a small cylinder of the colourless gold glass, practically no internal illumination is visible. In the case of the ruby glass, however, a yellowish-brown luminous trace is produced, probably due to reflection from minute particles of metallic gold. The intensity of colour of the ruby glass depends on the time of its reheating, and determines the intensity of illumination necessary to produce a visible trace. The deeper the colour of the glass, the less illumination is required. In the colourless glass the gold probably exists in a state of extreme sub-division, and the reheating which produces the ruby colour brings about a coarser colloidal aggregation similar to that which takes place in gelatino-bromide plates during maturation. Red glass coloured by copper and yellow glass coloured by silver show respectively dull brown and greyish luminous traces, due to the finely-divided metals. Glasses coloured by silicates of iron, chromium, manganese, and cobalt show only a faint luminous trace, and, allowing for the presence of small air-bubbles, are optically "void." Glasses which are colourless of themselves show a faint bluish trace, and are yellow when viewed through a great length. They thus resemble media containing an extremely minute turbidity. Glass decolorised by manganese compounds shows an intensely green fluorescence, the luminous trace being green when the incident light is either violet or blue, but suppressed when it is green, yellow, or red. Glasses containing iron alone or manganese alone are not fluorescent.

Electric Lighthouse.—The first installation of the electric light for lighthouse purposes in Australia was made so far back as 1883, yet even now it is looked upon as one of the grandest examples of electric lighting of which the Southern Hemisphere can boast. The Macquarie lighthouse, at the entrance to Port Jackson, indeed, is itself one of the finest in the world, and by its presence the entrance to Sydney Harbour is made perfectly safe, except during the most violent weather. We gather from a note in the *Journal* of the Society of Arts that the light is of the first order, sixteen-sided, dioptric, holophotal, revolving white light of the system of Fresnel. A flash of eight seconds every minute is obtained, and although it is stated to have a range of 25 miles seward, this is by no means the limit of distance at which the flash can be distinctly discerned. The whole apparatus is carried on a round pedestal, which offers the great advantage of enabling the keeper to enter without interfering with the rotation of the arrangement. A duplicate set of apparatus for using the electric light is also set up in this lighthouse, and, as an additional precaution, arrangements are made to burn either gas or paraffin oil. Again, the electric light may be exhibited at full power or half power at will. Although the Australian coast is remarkably free from dangers to navigation, lighthouses have been erected at every available point on the coast. The whole of the New South Wales coast is efficiently lighted, but it is expected that under the rule of the Federal Government still further improvements in this direction will be effected.

Engineers and Contractors.—It frequently happens that the interests of a consulting engineer and the interests of the contractors who work under him are not the same, although, of course, in the long run they both work with the same object—*i.e.*, to give the utmost satisfaction at the least cost. The question then arises as to how far the consulting engineer who has to advise a corporation, and to superintend the carrying out of large works, is right when he ignores the tender of a contractor whose work he is not acquainted with, or who has not, in his opinion, the experience to enable him to carry out the work. In this last case our sympathies lie with the consulting engineer, and we think that he should be sufficiently straightforward and have sufficient influence with his corporation to refuse the lowest tender if in his honest opinion the firm who have sent it in have not the requisite experience. Otherwise, if the work is allowed to proceed, the contractor obtains his experience at the expense of the corporation, and it may result that in the long run the corporation receives an article which is worth, as an investment, much less than would have been the case if another tender had been accepted even at a higher price. In the other instance—*i.e.*, that in which a consulting engineer passes by a low tender because he has no personal knowledge of the work carried out by the firm in question—we strongly support the grievance of the contractor. If tenders are advertised for, and a contracting firm goes to a great expense in sending in a tender with all the requisite drawings, it is not at all just that the tender should be refused because the consulting engineer has not taken the trouble to look up work which has been done by the firm for other towns or in other countries. We regret that this has been done in this country, and without doubt it will be done again; but, in our opinion, the only fair course for a consulting engineer to take if he means to only give the work to

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certain firms who have carried out contracts for him before, is to advertise the fact on advertising the tender.

Lancashire Motor Trials.—The third series of trials of motor vehicles for heavy traffic organised by the Liverpool Self-Propelled Traffic Association, which is the local centre of the Automobile Club, direct attention to the important question of road haulage by motors. The first two trials under their auspices, it will be remembered, resulted in various improvements being effected, and as two years have elapsed since the last trial was made, a great difference was to be observed both in design and equipment among the entries for the trials which have been in progress during this week. These trials commenced last Monday with hill-climbing feats at Everton-brow, and manœuvring at Prince's Dock. On the following day the motor vehicles travelled with merchandise to Manchester *viâ* Warrington, and on the Wednesday they returned to Liverpool *viâ* Bolton. On Thursday the programme consisted of a run to Blackburn *viâ* Chorley, and the trials conclude to-day with the return journey *viâ* Preston. Thirteen vehicles are entered, and these are divided into four classes, carrying loads varying from 1½ to 5 tons. The firms represented are the Thorneycroft Steam-Wagon Company, Limited, the Lancashire Steam-Motor Company, Geo. F. Milnes and Co., Limited, C. and A. Musker, Limited, Mann's Patent Steam Cart and Wagon Company, Limited, T. Coulthard and Co., Limited, the Mechanical Transport Company, and Simpson and Bibby. The first days of the trials were marked by the entire absence of the breakdowns which were only too common at the earlier trials in the past few years. In the manœuvring tests within confined spaces all the vehicles behaved splendidly, and in the hill-climbing ordeals the results were also very gratifying, one of the wagons making the ascent in good style with a cargo weighing about seven tons. With regard to the long-distance runs, the motors behaved very creditably, and the results obtained may be regarded as highly satisfactory. Great interest is being shown in the tests, and several representatives of Government departments are watching the results.

Development in the Teaching of Physics.—Practical work is the all-important factor in the study of physics, and we are pleased to note that the development in the equipment of laboratories, etc., for the use of students receiving instructions in physics in the polytechnics has been exceedingly satisfactory within recent years. From an account of the progress made since the formation of the Technical Education Board, given in the *Technical Education Gazette*, it would appear that up to 1893 very little provision was made for practical work in the teaching of physics, the whole instruction being practically confined to lectures. Liberal grants, however, have from time to time been made for the equipment of laboratories and lecture rooms in the various institutions, with the result that at the present not only is there an enormous increase in the number of students receiving instruction in physics, but over 90 per cent. of these perform indlvidnal practical work having a definite relation to the theoretical instruction. As an example of this we may mention the well-equipped new laboratories of the South-Western Polytechnic, which were recently opened by Sir Wm. Preece. Among the other institutions which have been largely developed within the last few years are the Regent-street Polytechnic, the Birkbeck Institution, the City of London College, the Borough Polytechnic, the Woolwich Polytechnic, the Northern Polytechnic, and the Battersea Polytechnic. An important scheme is now under consideration for increasing the accommodation at the Northampton Institute. Every year marks a distinct increase in the number of students attending for instruction in physics and electrical engineering, the number attending these departments at the institutions referred to above being over 2,000 for the present session. A marked improvement is also to be noticed in institutions of lower rank than the polytechnics which are aided by the Board. Here also grants have been made for the equipment of laboratories, more efficient teachers have been appointed, and the instruction and conditions of working have improved considerably. In the secondary day schools aided by the Board much attention has been given to the rational teaching of elementary physics in connection with the general scheme of science teaching.

Development of Water Power in Canada.—A water-power development possessing some interesting features, and now being installed at Milleroches, Ont., is described in the *Canadian Engineer*. This company will take water from the Cornwall Canal, one of the St. Lawrence system of waterways, through a very short headrace, and will discharge directly into an old channel of the river itself. According to present proposals, the first development will provide for 4,000 h.p., under a head varying from 20ft. to 30ft. About 1,000 h.p. will be installed at once and used for lighting the Cornwall Canal and opening its locks, under contract with the Dominion Government. Power will also be transmitted to Cornwall, Ont., six miles distant. The benefit of such a supply to this place will be readily conceived when it is stated that it is solely a manufacturing town, the principal industries being the manufacture of cotton goods, woollen goods, and paper. Owing to the construction of a dam by the Government a few years back, the difference between the water in the canal and the water in the river at low water is nearly 38ft., and it is at this point that the present water-power development is being installed. A regulating weir was built here by the Government for regulating the height of water in the canal, which is kept at a minimum depth of 14ft. From the channel leading to this weir water will be taken in a headrace about 200ft. long, and after passing through the turbines will discharge into the bed of the old river channel laid dry by the building of the dam. Turning to the electrical equipment of the station, the generators to be installed are of the rotating-field type, of 750 kw. capacity, designed to deliver three-phase currents at 2,200 volts. There are two exciters, each of 50 kw. capacity, and either one is sufficient to excite the four generators which will make up the ultimate capacity of the station. The switchboard is to be of blue Vermont marble on an angle-iron frame, and provides for control of exciters separately or in multiple. Lead-covered cables will lead from the switchboard to the wire-tower on the second floor, in which will be located the station lightning arresters. The step-up transformers are to be installed on the first floor of the wire-tower, where the potential will be raised from 2,200 volts to 11,000 volts. The circuit wires fan out in both directions from the tower. Both the lighting and power lines are supported by cedar poles, spaced about 100ft. apart, every fourth pole bearing an alternating enclosed arc lamp. The three-phase 10,000-volt line is tapped at each lock for connection to a transformer, which steps the voltage down from 11,000 volts to 220 volts, the lock master's cabin serving as a small sub-station from which is distributed all the current for power service at the locks. The arc lighting and power cables for crossing from side to side of the lock terminate at the switchboard in the terminal or cabinet houses. The locks are provided with from six to thirteen lights, and motors are used for handling the sluice gates and for opening and closing the lock gates, as well as for control of the weir gates by

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which the levels of the different sections of the canal are regulated. The use of electric light and power thus makes the canals quite as serviceable by night as by day, and practically doubles their capacity, besides handling the traffic more rapidly, permitting the boats to make more trips in a season, which tends to reduce the cost of transportation.

Glasgow Electricity Charges.—Subject to confirmation by the Town Council, the Glasgow Electricity Committee have fixed upon a scale of charges for electric current. Mr. W. A. Chamen, the Corporation electrical engineer, has prepared a report on the subject for the consideration of the Town Council, in which he states that the sum required in connection with the electric lighting undertaking for the year ending May 31, 1902, will be at least £92,000. The difficulty has been to decide on a scale of charges which would result in an increased revenue for next year. With this end in view the committee have arrived at these conclusions: (1) that it is unsound policy to reduce the initial price to one-hour consumers below the present rate of 6d. per unit, though they do not wish to increase it; and (2) that they will be more certain to obtain a largely-increased revenue through encouraging the sale of electricity to long-hour consumers by reducing the price to them. What are known as the "one-hour-and-under" consumers have cost £164,780 in capital expenditure to produce a revenue of only £6,208, or 3 7 per cent., while the consumers over one hour and upwards (excluding domestic, theatres, churches, and power), some 1,845 in number, have cost about £478,578 in capital expenditure, and produce a revenue of £46,154, or 9 6 per cent. The addition of short-hour consumers, therefore, is regarded as an increasing loss to the Corporation, even at the price of 6d. per unit. The actual average cost of about 6,000,000 units sold to private consumers during the past year is estimated at about 3 18d. per unit. If, with the estimated expenditure of £92,000 for this year, only the same quantity of electricity be sold, the average cost would be 3·68d. per unit. But should the sale of electricity increase by 50 per cent., as it has done for the past two years, the only additional cost would be for coal, and that would only be, at the most, some £6,000 for the extra 3,000,000 units, or a total expenditure of, say, £98,000 fer the 9,000,000 units, which would represent an average cost of 2·61d. per unit. With these facts before them, therefore, the committee considered that every effort should be made to sell 9,000,000 units during the year, and to this end that the price should be 6d. per unit for the first 365 hours of maximum demand, and 1d. for any further quantity, and that the rates for domestic consumers, theatres, halls, etc., should be 3½d. per unit; for churches, 3d. per unit; and for power, 1½d. per unit. The revenue produced on 6,000,000 units would be only about £72,000, but if, as anticipated, the output sold be increased to 9,000,000 units, and the proportions of the various class of consumers remain as at present, the revenue produced would be about £104,000, while, as before stated, the expenses would be about £98,000, leaving a balance of £6,000 to the good, and giving an average revenue of 2·77d. per unit sold. There can be no doubt that the policy of the committee as recommended by Mr. Chamen is the right one, as the reduction of the charge to long-hour consumers is sure in the long run to result in the more rapid growth of the undertaking, and consequently the swelling of the revenue. Any alteration in price on the wrong side would be sure to shake the confidence of the public, and would certainly not tend to an increase in the number of consumers of the right kind. In his report to the Town Council, Mr. Chamen gives it as his opinion that if the recommendation of the committee be accepted, there is no doubt whatever that the whole capital expended will be fully productive very soon, and in this view we entirely agree.

City and Guilds of London Institute.—We have before us the annual report of the council of the City and Guilds of London Institute as presented to the members at the general meeting held last month. The report opens with the statement (previously announced in this journal) that his Majesty the King has graciously consented to become patron of the institute, of which, as Prince of Wales, he has been president since 1881. On April 11 last year a petition was presented to her late Majesty the Queen in council for a charter of incorporation of the institute, which was granted. In the early part of last year the institute was offered 15 nominations to commissions in the army for students of the institute's colleges—10 in the Royal Artillery, and five in the infantry. An unaccountable delay occurred before any of the candidates were called up by the War Office for medical examination, until in August, before all the commissions were filled up, an intimation was received that a sufficient supply of officers had been obtained, and that it had, therefore, become necessary to close the offer to the technical colleges. Commissions in the army were, however, awarded to the following nine gentlemen who had been nominated—viz, Messrs. E. S. Allsup, T. C. Cunningham, D. G. W. Hume, F. G. Maunde-Thompson, H. R Scarlett, J. H. Stone, J. B. W. Stroud, C. E. Vines—all in the Royal Artillery—and W. L. Carter in the infantry, who has since resigned. In connection with the Central Technical College, the announcement is made that Prof. Henrici has been elected dean of the college for the session 1900-1. A table is given showing the course of instruction at the college, from which it appears that there has been a gradual increase in the number of students from year to year. In the year under review there were 281 students as against 245 in the year 1898-9, showing an increase of 36. At the close of the last session the diploma of associate of the institute was awarded to 46 matriculated third-year students. With regard to the Technical College at Finsbury, the council report that there was a satisfactory increase in the total number of students attending the college during the session ending in July, but attention is drawn to the fact that this was entirely due to an unusual increase in the number taking the electrical course, which increased from 64 to 101 in the course of the year. With this, however, there has been a slight falling off in both the mechanical and chemical departments. The fluctuation in the number of electrical students is also to be noticed at the Central Technical College, although not to the same extent. The council regard this state of things as being in all probability due to the varying prospects in public estimation of the electrical industries The rapid development of electric traction in this country during the past two or three years has no doubt attracted an increasing number of students to the electrical departments, and very possibly at the expense of the others. At the close of the session certificates were awarded to 56 students, as against 38 in the previous year; 9 in mechanical engineering, 29 in electrical engineering, and 18 in chemistry. There was a small increase in the number of students entering the South London Technical Art School last session over that of the previous session, and the work done continues to be of an earnest and satisfactory kind. In the technological examinations department there has been a further growth in the work of the department during the past session, and in the other branches of the institute similar progress is reported.

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TYNEMOUTH ELECTRICITY WORKS.

Tynemouth, which has been for years the health resort of Newcastle-on-Tyne, will this summer have the additional attraction of electric light in its main streets, and also of electric traction to enable visitors to get to Whitley and Cullercoats easily. The electric lighting is in the hands of the Corporation, and from the same works a supply of electrical energy is given to the tramways, which are being worked by a company. The area of the borough of Tynemouth is much more extensive than would be expected from those who have only gone to Tynemouth for pleasure, as it includes a large part of what would be thought to be North Shields. The population of the borough is about 50,000.

MR C. TURNBULL, BOROUGH ELECTRICAL ENGINEER OF TYNEMOUTH.

JACOB DAGLISH, ESQ., MAYOR OF TYNEMOUTH.

R. IRVIN, ESQ., CHAIRMAN OF THE TYNEMOUTH ELECTRICITY WORKS COMMITTEE.

The electric lighting provisional order was obtained by the Corporation in 1891, but no steps were taken to put the powers of the order into force until 1895. The Corporation then circularised the inhabitants to know how many would take the electric light if a supply were given. The results of this enquiry were as unsatisfactory as similar enquiries have been in other towns. The inhabitants refused to give answers which they thought would commit them to take the supply. In consequence of this, the matter was again shelved until 1897, when Mr E. M. Lacey (of the firm of Messrs. Lacey, Clirehugh, and Sillar) was retained to advise the Corporation. The question of electric traction was then under consideration, and under his advice a combined station for supplying electric light and electric energy for the tramways was laid down.

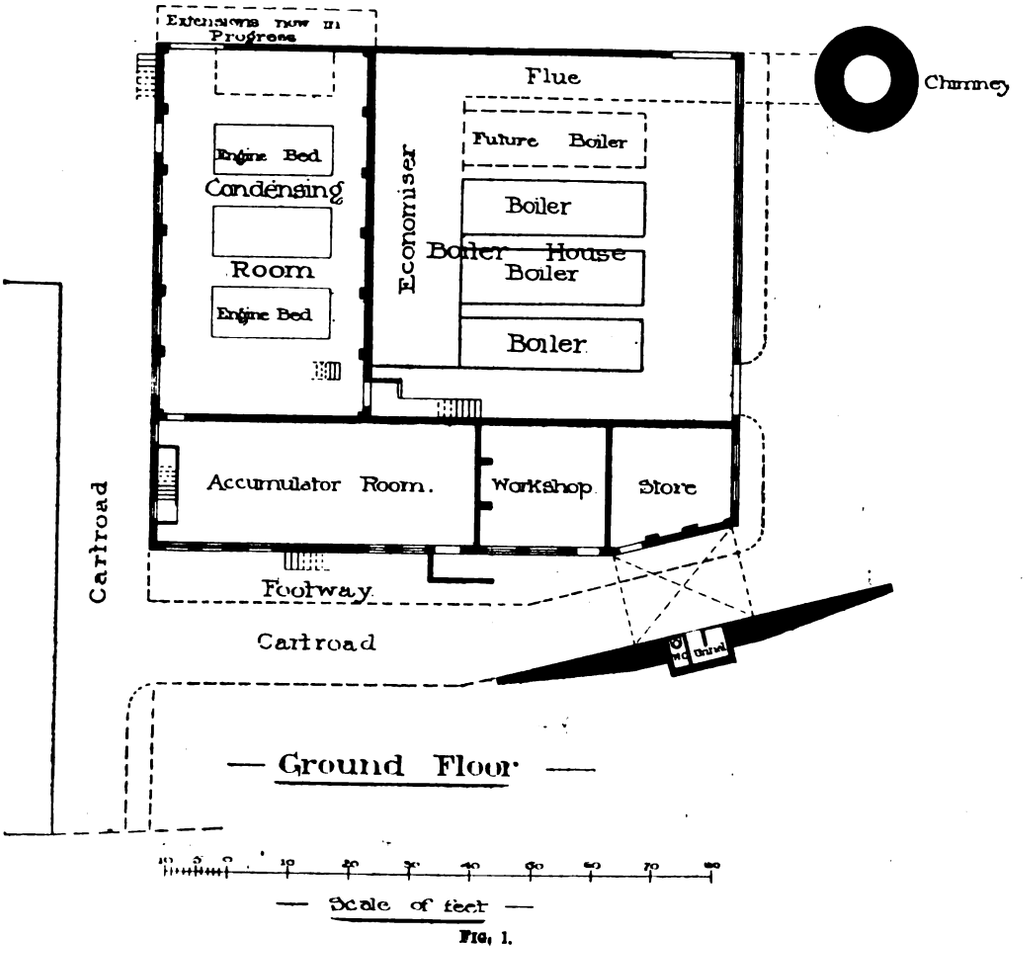

FIG. 1.

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As a result of the combination, Mr. Lacey was enabled to increase the size of the plant provided in the first instance. A good site was obtained, practically in the centre of the area to be supplied, from which distribution by means of direct currents could be conveniently carried out. The site is situated in Pow Dene, which is only a short distance from the Tynemouth goods station, from which coal is obtained. The consulting engineers and Mr. John T. Smillie, the borough surveyor, have made most excellent use of the characteristics of the site selected. The area which is at the bottom of the Dene adjoins on to the road which leads up the side of the Dene into the main Tynemouth road. The works being at a considerably lower level than this road, arrangements have been made to enable the coal to be brought in at a high level and shot directly into the coal bunkers over the boiler-room, which holds 300 tons of coal. In Figs. 1 and 2 we give the first-floor and ground-floor plan of the works, and in Fig. 3 is shown the front elevation of the works and offices. The bridge, which is seen at the right hand of the illustration, is used for bringing in the coal, and it will be seen how much higher this is than the level of the boiler-house floor.

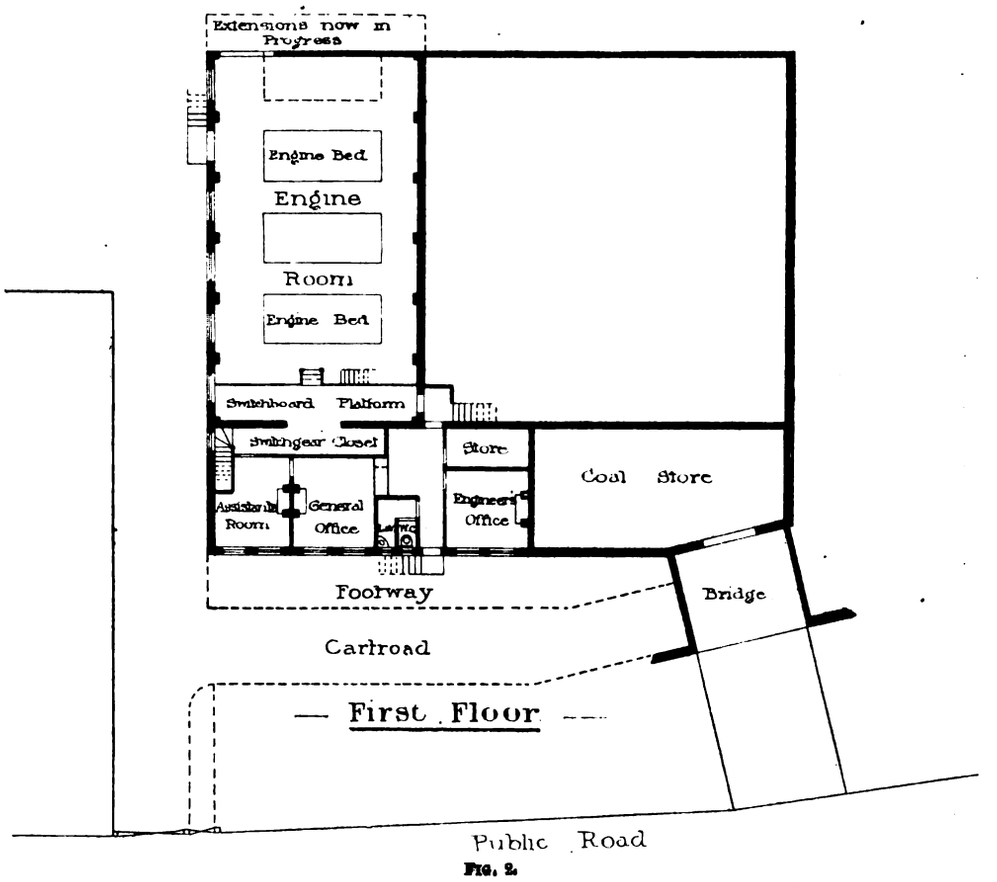

FIG. 2.

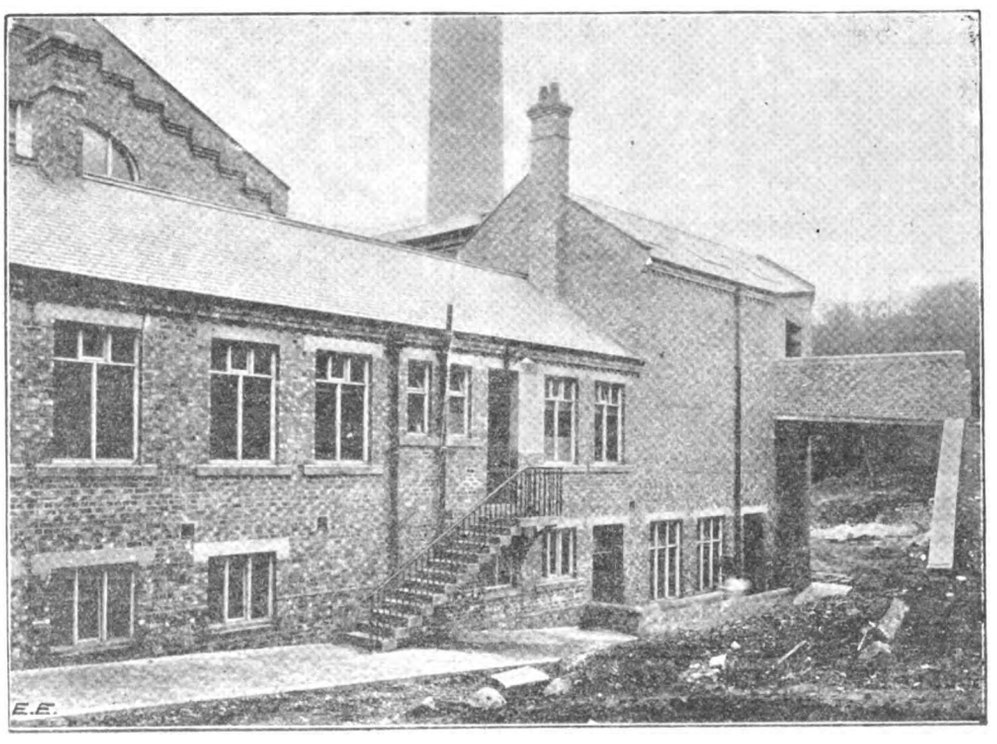

FIG. 3.—View of the Offices and Boiler-House of the Tynemouth Electricity Works.

In planning the buildings it was sought to make supervision over each department as easy as possible. Upon the lowest and at the same level are the boiler-house, the room for condensing plant, the accumulator room, the workshop,

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and store. At a higher level, over the condensing plant room, is the engine-room, and at a height of 2ft. 6in. above that and over the accumulator-room are the offices. The switchboard platform and the offices are on the same level. The offices are approached by an outside stair, the object in placing it outside being to preserve an unbroken area in the accumulator-room. The buildings are entirely of brick, the engine-room being glazed from floor to roof with glazed brickwork. The whole of the floors, excepting those in the offices, which are of wood, are of cement concrete, the surface of the engine-room floor being finished with tiles. The chimney shaft is circular in plan, and is 150ft. in length above the ground level, the foundation being carried 20ft. below. The internal diameter is 8ft, and it is intended to serve the proposed refuse destructor as well as the electrical plant. These buildings were all designed by Mr. Smillie, who also superintended their erection.

The steam-raising plant now installed consists of three Lancashire boilers, which were supplied by Messrs. Yates and Thom. These boilers (Fig. 4) are each 30ft. long and 8ft. 6in. diameter. They are designed for a working pressure of 150lb. per square inch, and are guaranteed to evaporate 8,000lb. of water per hour. These boilers are fired by means of Proctor sprinkling stokers, which can be seen in Fig. 3. The main coal bunker is situated at the farther end of the boiler-house, and runs transversely across it, as can be seen in the above-mentioned illustration. The coal from this main bunker runs by gravity into a conveyor placed under it. This conveyor delivers into the second conveyor, which is seen in the front of the boilers over the stoker hoppers. These two conveyors were supplied by Messrs. Graham, Morton, and Co., of Leeds, and are each driven by electric motors made by the Clayton Engineering Company. The great reduction in speed required is obtained by worm gearing, while the thrust of the worm is taken on ball bearings. The stokers are also driven by an electric motor. At the back of each of the boilers are placed Musgrave superheaters, which are designed to give a superheat of

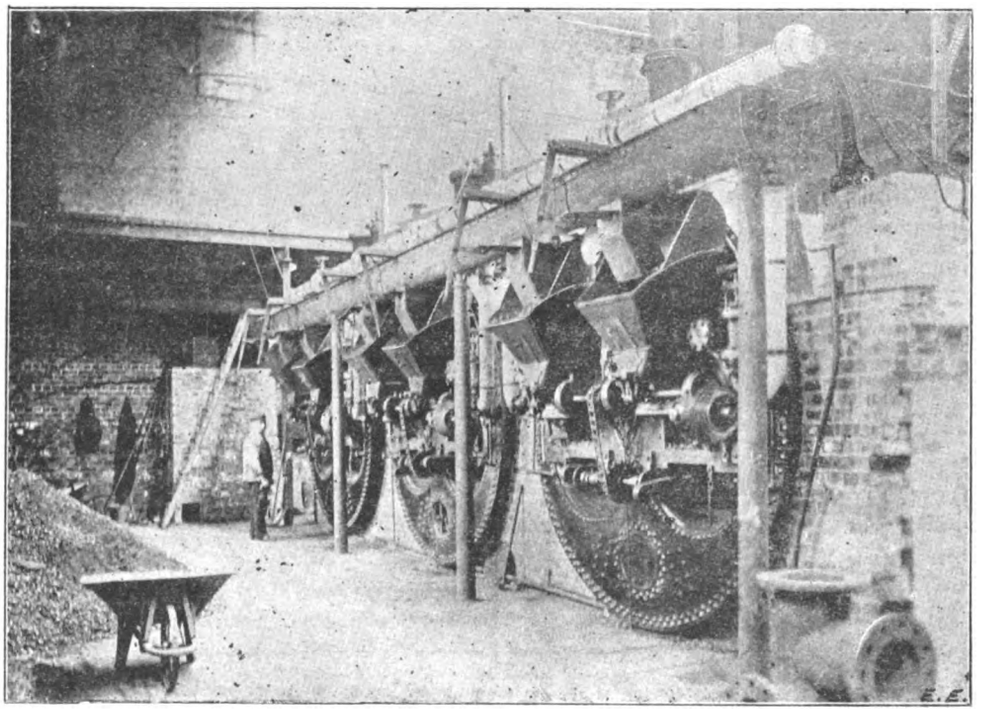

FIG. 4.—Yates and Thom Boilers and Proctor Stokers in the Tynemouth Electricity Works.

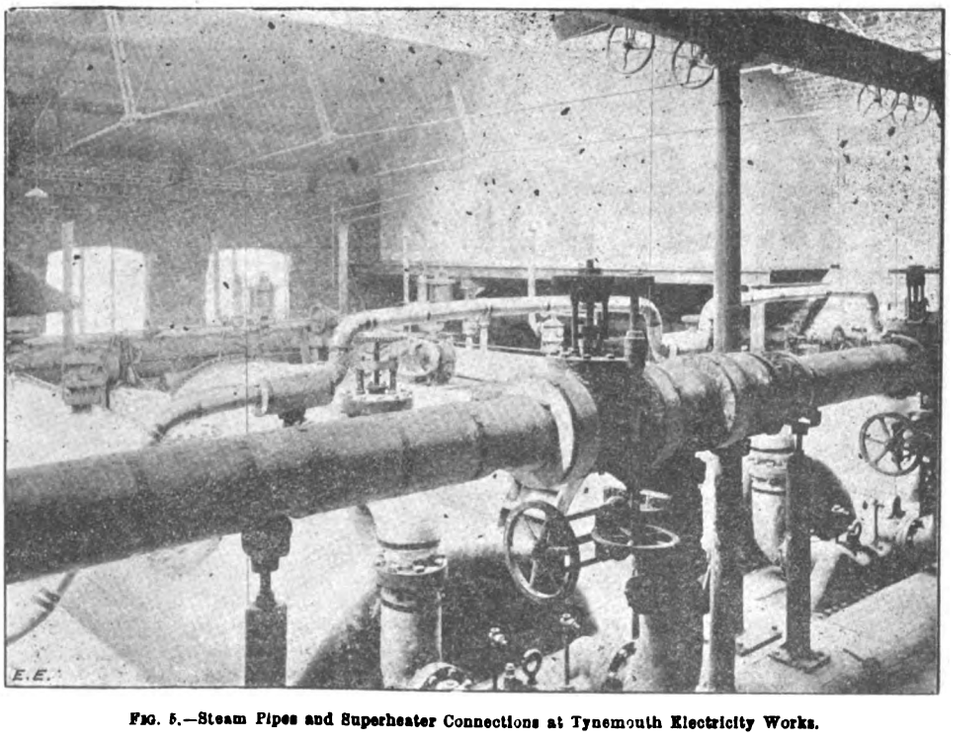

FIG. 5.—Steam Pipes and Superheater Connections at Tynemouth Electricity Works.

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20deg. to 150deg. at the stop valve of the engine. The connections to these superheaters can be seen in Fig. 5. In each case a by-pass is arranged, so that the whole of the steam given off by a boiler need not be passed through a superheater. In this way the degree of superheat can be varied. The boilers are fed on a system which allows a complete duplication, so that the breakdown of one part of the feed pipes, or of one feed pump or one injector, will not interrupt the supply of feed water. Two electrically-driven three-throw pumps, by Messrs. Goddard, Massey, and Warner, have been supplied, each capable of delivering 2,500 gallons of water per hour against the full boiler pressure. These electrically-driven pumps are controlled on the series-parallel system, so that their speed can be varied from full to one-quarter of full speed in easy steps. In this way a continuous feed at all loads can conveniently be obtained. In Fig. 6 is shown a section through the station from which a general run in the levels of the steam-pipes can be gathered. The main ring is 9in. in diameter, and is equipped with Hopkinson valves, so that any length can be isolated for repairs.

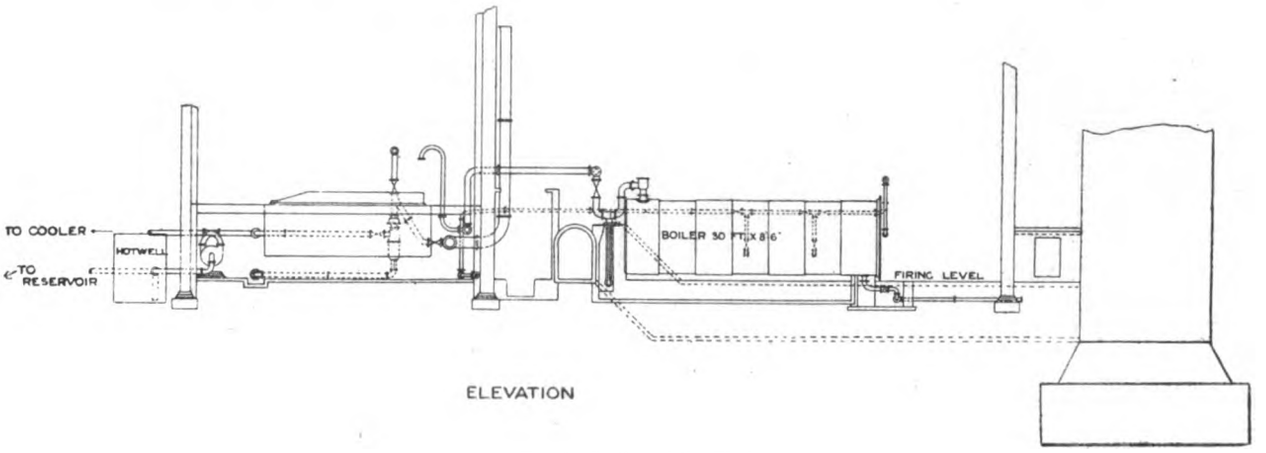

FIG. 6.—Section of the Works.

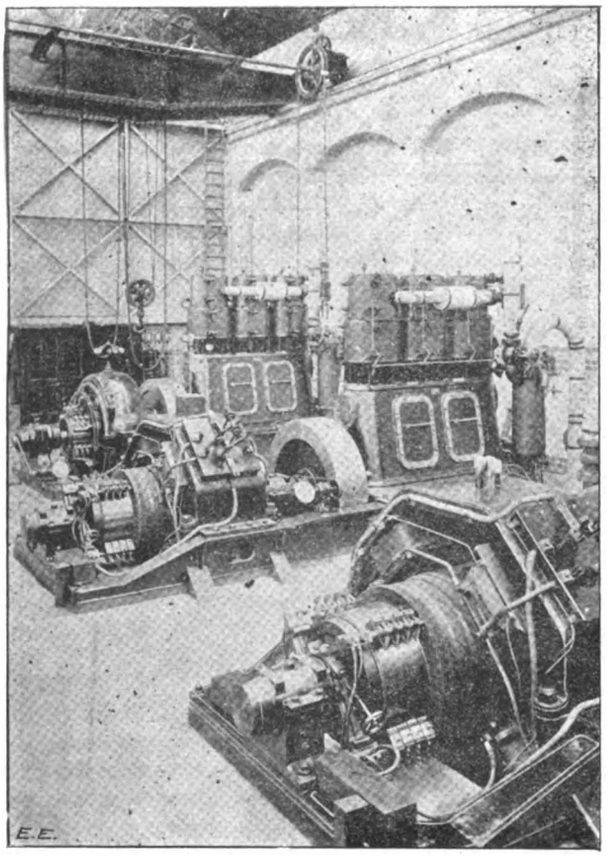

FIG. 7.—View of the Tynemouth Generating Plant.

The engine-room plant consists at present of three Belliss engines, each capable of giving 300 i.h.p. at 420 revolutions per minute. The engines are of the six-cylinder compound type, driving on to three cranks spaced at 120deg. apart. The governing of these engines is so arranged that in the event of a sudden heavy load high-pressure steam is admitted into the low-pressure cylinders, in which case the engines are able to give 360 i.h.p. In Figs. 7 and 8 a general view of this engine-room can be obtained. The first two engines from the switchboard end of the building are directly coupled to two dynamos, supplied by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne. These are of the four-pole Lundell type, made as described in our last issue, and are nominally 180-kw. machines. They are specified to give 360 amperes at any voltage from 445 up to 500 when working on the shunt, or up to 550 volts when the series coils are in circuit. From the results obtained on trial, however, we gather that these dynamos are very considerably under-rated, as they are capable of giving much higher loads than mentioned above under the specified conditions. These two machines are normally intended to take the lighting load, but throw-over switches placed on the machines, as seen in Fig. 7, enable them to be quickly transferred to the traction side of the station. A spare armature has also been supplied for these two machines. The third dynamo, which under ordinary conditions will take the traction load, is of the Westinghouse type, and was supplied by the British Westinghouse Co. This dynamo is seen in the foreground of Fig. 8. It is of the six-pole type, and is nominally of 190 kw., being able to give 380 amperes at from 490 to 550 volts. The regulation of the compounding of this machine is effected by means of a variable shunt across the series coil. In laying down all the above plant, Mr. C. Turnbull, the borough electrical engineer, was careful to get the foundations excellently level to start with, so that practically no grouting was required.

The exhaust from the engines can either be taken into a main exhaust pipe to atmosphere, or condensed in Ledward ejector condensers. One of these ejector condensers is supplied for each engine. The water coming away from the same is led to a hot-well, and from thence is forced up to the top of a cooling tower supplied by the Klein Engineering Company. This tower occupies a space 35ft. by 24ft., the top of the chimney is 60ft. high, and the water inlet is placed 25ft. up. The capacity of this water-cooling tower is guaranteed by the makers to be such as to be able to cool the water from engines developing 1,000 h.p. Two electrically-driven centrifugal pumps are used in connection with the condensing plant, the one for circulating the water to the condensers, and the other for raising the hot water to the top of the cooling tower. Each of these centrifugal pumps is driven by a Royce motor. The pumps are placed in the basement. In Fig. 9 we show the circulating pump, and also the automatic controlling gear for stopping the lifting pump when the water in the hot-well falls below a predetermined level. This automatic gear consists of a rocking lever, along which a heavy weight can roll. This rocking lever is seen in the illustration behind and just above the coupling of the circulating pump. The axis of the lever is taken through the engine-house wall, and on it is then connected another lever, terminating in a float in the hot-well. In the

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position shown in the illustration the motor is not connected. When, however, the water in the hot-well rises, the lever will rock until the rolling weight, seen to the left, is raised above the axis of rotation of the lever. The weight then runs down and closes the switch quickly by means of the vertical connecting rod seen in the illustration. The switch gear is placed on the engine-floor level to one side of the water-level gauge.

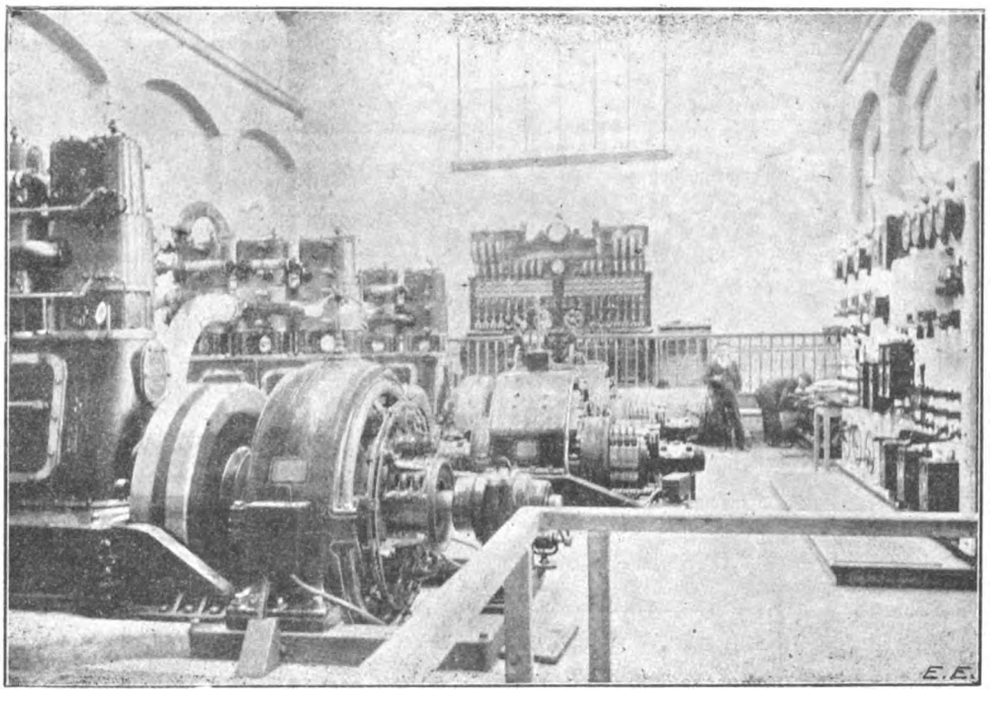

FIG. 8.—General View of the Tynemouth Engine-Room.

space would be advantageous. The main fuses come rather close to the main switch and omnibus bars, and may cause trouble in the event of a short-circuit on the mains. The instruments are all of the edgewise type, so arranged that they can be conveniently read from the engine-room floor level. The traction switchboard is of the Westinghouse standard type (as will be seen from the illustration, Fig. 12), while Fig. 13 gives the connections used in this

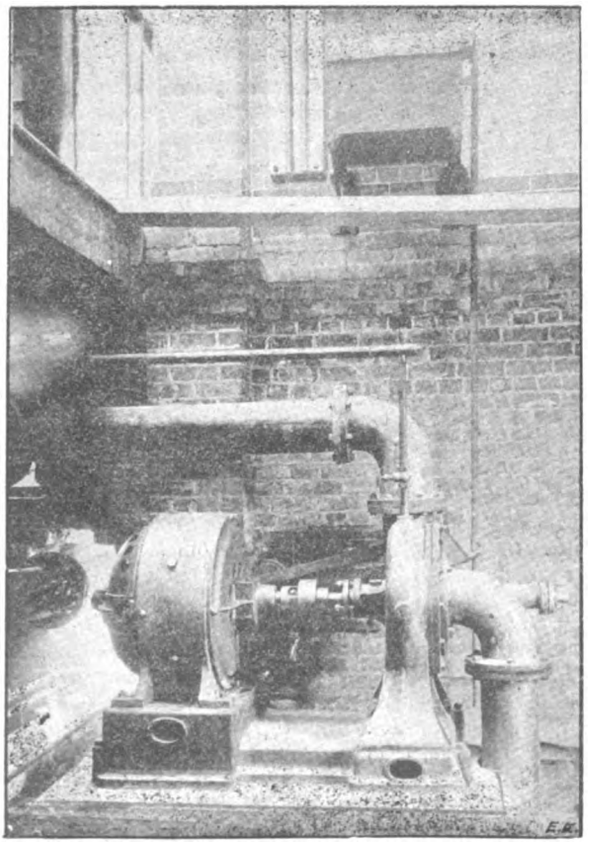

FIG. 9.—Electrically-Driven Circulating Pump and Automatic Contact for Lifting Pump.

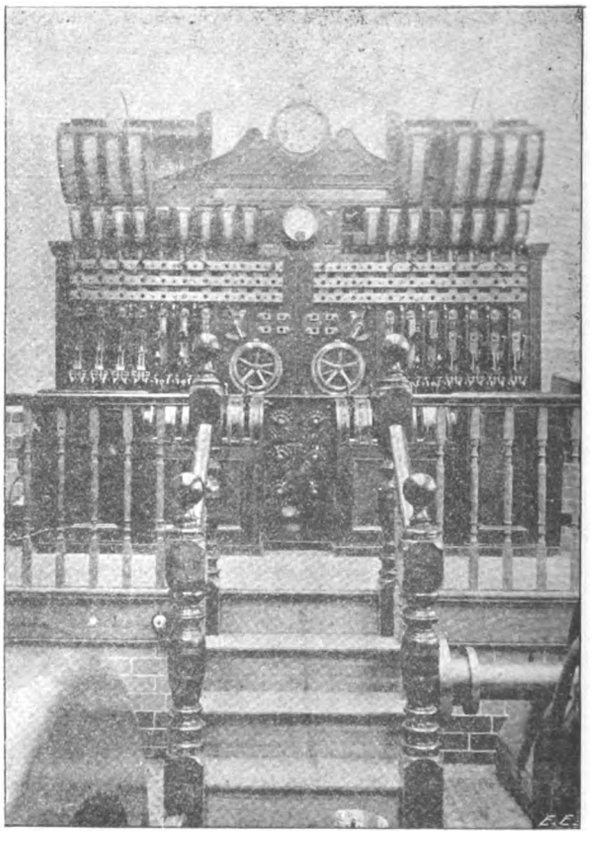

FIG. 10.—The Lighting Switchboard at Tynemouth.

The lighting switchboard is shown in Fig. 10, while Fig. 11 is a diagram of connections used. This board was manufactured and supplied by Mr. Bertram Thomas, of Manchester, and it will be seen that a very compact board has been obtained—in fact, we think that a little more case. The tramway company takes its supply from terminals behind this board.

The accumulators are of the Pritchetts and Gold standard type. There are 252 cells altogether, with a normal discharge of 60 amperes for 10 hours, or 250 amperes

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for one hour. They are fixed in lead boxes in a well-lighted accumulator-room.

The mains were all supplied and laid by Messrs. Siemens Bros. and Co., and are of their armoured type, laid direct in the ground. When putting the cables down, however, pipes were laid in certain places, through which additional feeders can be drawn in at a later date. Four feeders have at present been laid. The first of these goes to the east end of Front-street, at Tynemouth, where it is terminated in a feeder pillar opposite the Tynemouth Priory; the next feeder terminates at the junction of Albion-street and Church-street; the third feeder at the junction of Saville-street and Bedford-street; while the fourth feeder is arranged to supply the riverside premises. All the best residential streets and business thoroughfares have already been supplied with distributing cables. In some cases what we believe is a novel procedure is adopted, as instead of running the cables down each side of a resi-

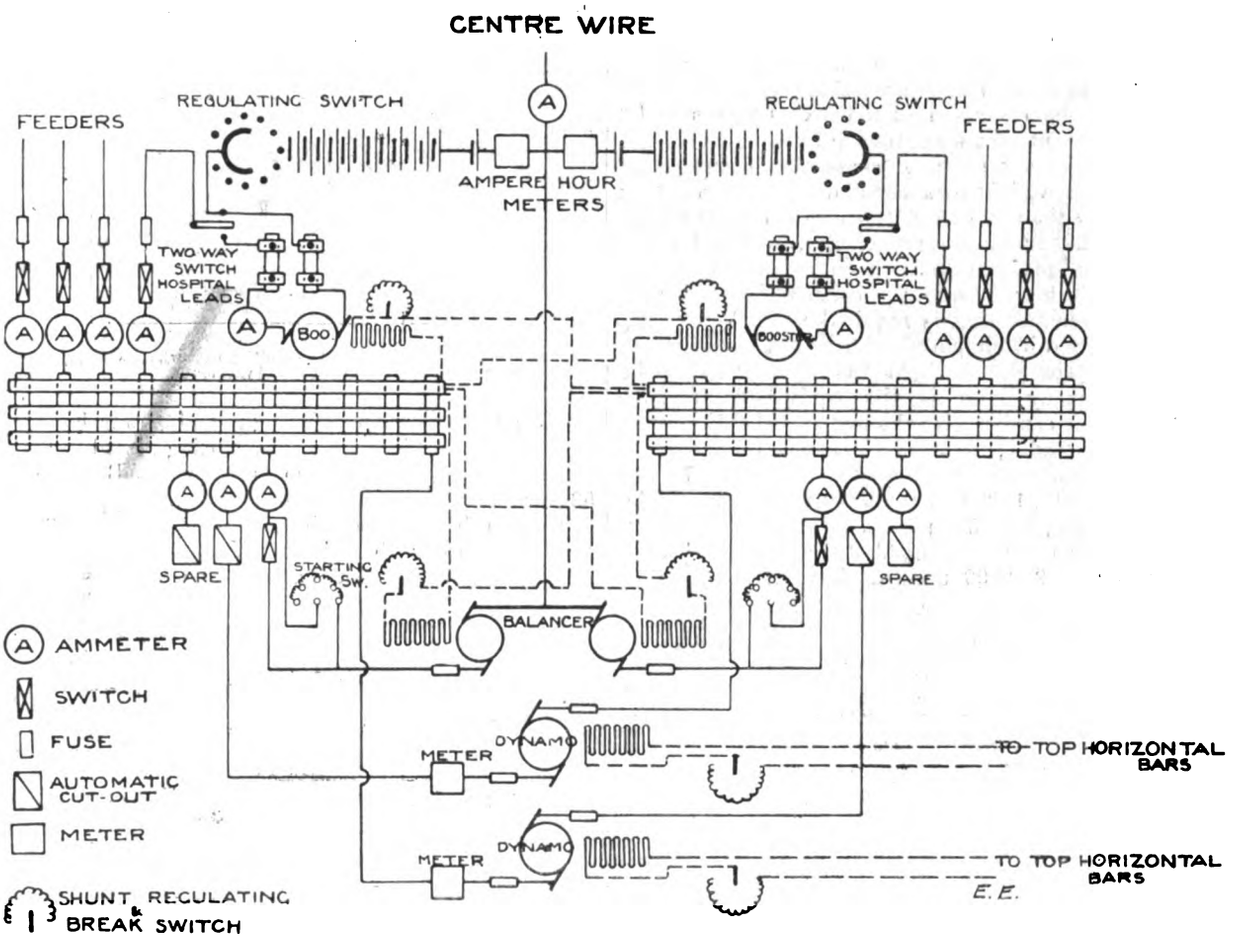

FIG. 11.—Diagram of Lighting Switchboard.

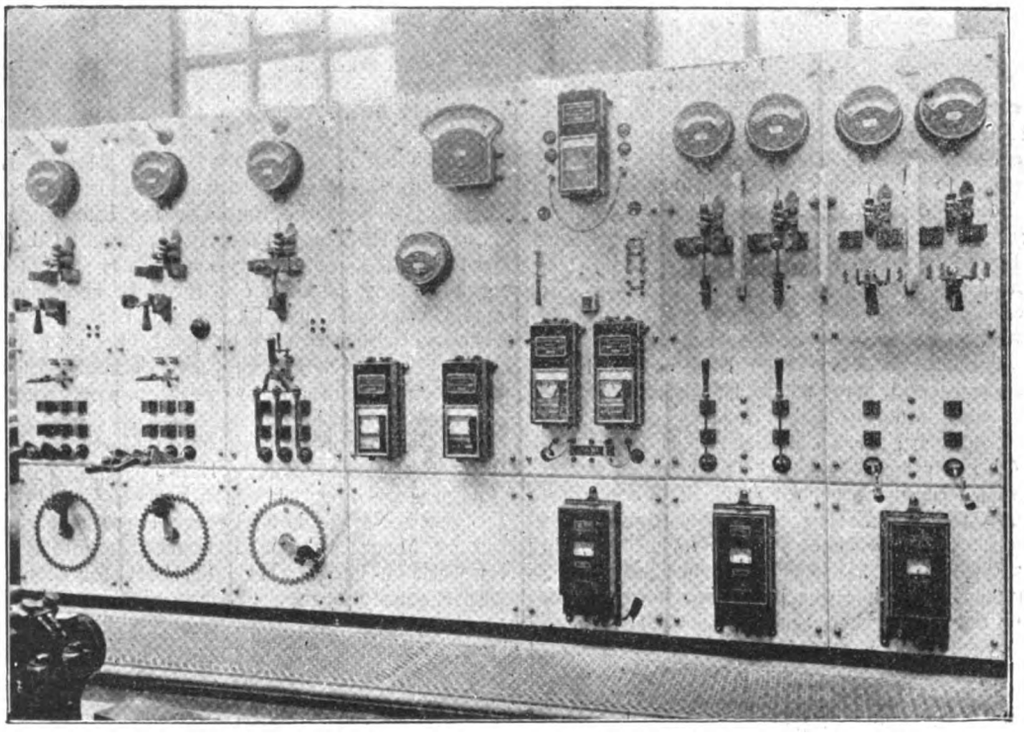

FIG. 12.—View of the Westinghouse Traction Board.

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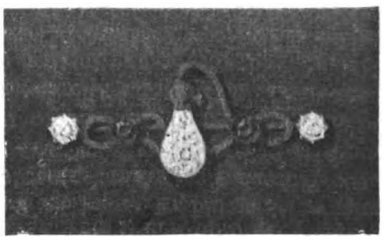
dential street, a single cable is laid in the back lane between two such streets. Mr. Turnbull informs us that he finds it cheaper to make the connections from such cables than from cables in the main street, and that it saves in cost in the first instance. Also it is more convenient to have the meter in the kitchen than in the front of the house. As regards the middle-wire connection, this is earthed at the station through a fuse in parallel with a suitable resistance. This resistance is to be composed of a bank of lamps. Mr. Turnbull informs us that when testing for lengths on the main, he arranges a temporary connection between the positive and negative 'bus bars at mid-day or on a Sunday; he then connects the one end of the one-half of the main battery to earth through a galvanometer, so that he gets the record of the total leak to earth on the whole system. Having obtained this, and also the earth leakage on each side of the system, all that is required to be known can be readily obtained by simple addition and subtraction.

The demand for electric light has been found to be good; thus already there is the equivalent of some 8,000 8-c.p. lamps connected to the mains, and this number will soon be exceeded, as a good demand for motors is arising. The consumers are charged at the rate of 7d. per unit for the first 100 hours' use per quarter of the maximum demand, and 2d. per unit for all above this. The tramway company are charged at the rate of 1½d. per unit for the first 200,000 units used per annum, with a minimum payment guaranteed of £1,100 per annum. For any excess of current used over the above quantity per annum, a reduction is given in the following way: for the next 50,000 units, 1·4d.; for the next 50,000 units, 1·3d., and so on until 400,000 units per annum is reached, after which the fixed charge will be 1d. per unit. At present some 12 arc lights only have been fixed as a kind of experiment in street-lighting. These lamps are of the Siemens type.

The Corporation, to encourage consumers, have entered into an arrangement with the Northern Electric and Engineering Company, a local firm, to do free wiring at the following rates: for one fitting with one lamp and switch, 3d. per lamp per quarter; for an additional point on the same switch, 4d.; for an additional lamp on a fitting without a separate switch, 3d. per quarter. The consumer can hire-purchase the installation by paying double the rent for 4½ years, or 1½ times such rent for 6½ years. Up to the present date there has been such a demand for ordinary consumers that it has not been possible to push this system very much, but there is every reason to believe that it will prove to be a useful means of attracting consumers.

The official opening of the works took place on April 3 last, but at that date they had been running for about six weeks. The ceremony was of a semi-private nature, as it was not considered advisable to have too many people about when some of the machinery was, of necessity, running for the trams. The Mayoress of Tynemouth (Mrs. Jacob Doglish) started the engine, and was presented by the Chairman of the Electricity Committee with a diamond brooch in commemoration of the occasion. This brooch was designed, to the instruction of the engineer, in the form of an electric lamp (diamonds) in a gold holder, and was very effective.



The Brooch presented to the Mayoress when switching on the light at Tynemouth.

The extensive demand for light and power has already necessitated orders for more plant being placed. Thus the consulting engineers inform us that a Bellias-Siemens 520-kw. steam dynamo is now on order. The boiler plant is also to be increased by another 30ft. by 8ft. 6in. Lancashire boiler by Messrs. Yates and Thom. The condenser and pipework for the new plant extensions will be carried out by Messrs. Hedley and Boyd, of North Shields.

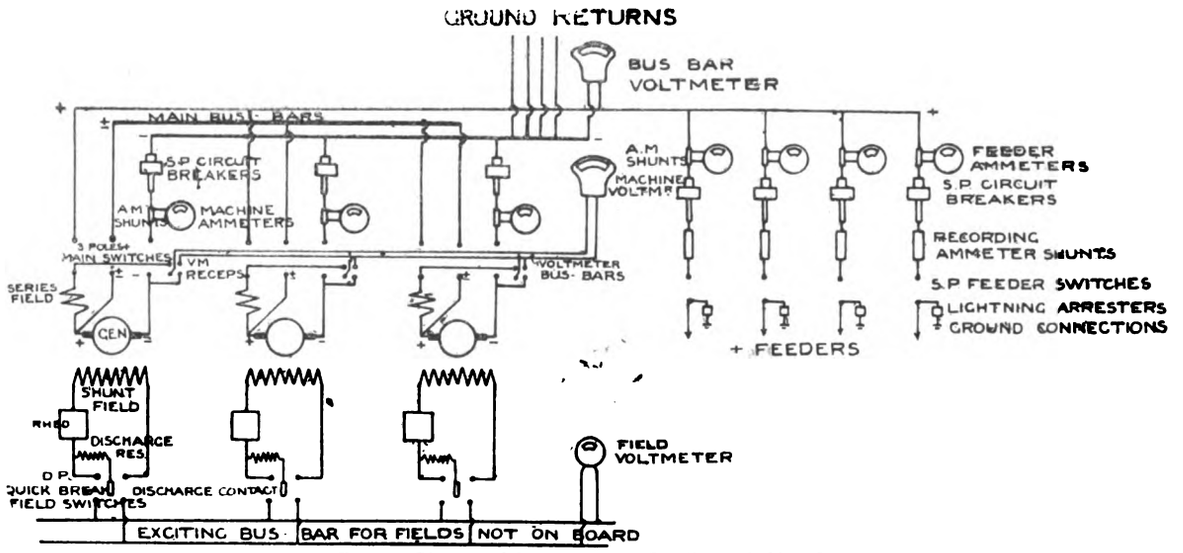


FIG. 13.—Diagram of Connections for Traction Switchboard.

In conclusion, we have to thank Messrs. Lacey, Clirehugh, and Sillar, the consulting engineers, and Mr. J. F. Smillie, the borough engineer, for kindly placing information and drawings at our disposal, while Mr. C. Turnbull was most kind in showing us round the station and explaining the many details of interest in connection with the same. We think that Tynemouth has an electric lighting station of which it may be justly proud, and which will enable electricity to be supplied at rates satisfactory both to the consumers and to the ratepayers, who guaranteed the requisite capital.

Mr. C. Turnbull, the borough electrical engineer, was educated at Fettes College, Edinburgh, and afterwards had a business training. He then went to the Durham College of Science, Newcastle-on-Tyne. He served his apprenticeship at Messrs. C. A. Parsons, Steam-Turbine Works, Newcastle-on-Tyne. He left them for the Scarborough electric supply station. Before coming to Tynemouth he was for some time with the National Electric Wiring Company as district manager.

Liverpool.—Another electric wire accident occurred in Liverpool last week. While a car was turning a sharp curve leading from Tithebarn-street into Moorfields the trolley jumped the wires, and becoming entangled with the overhead arrangements, brought down a number of wires on top of the car. There were no personal injuries.

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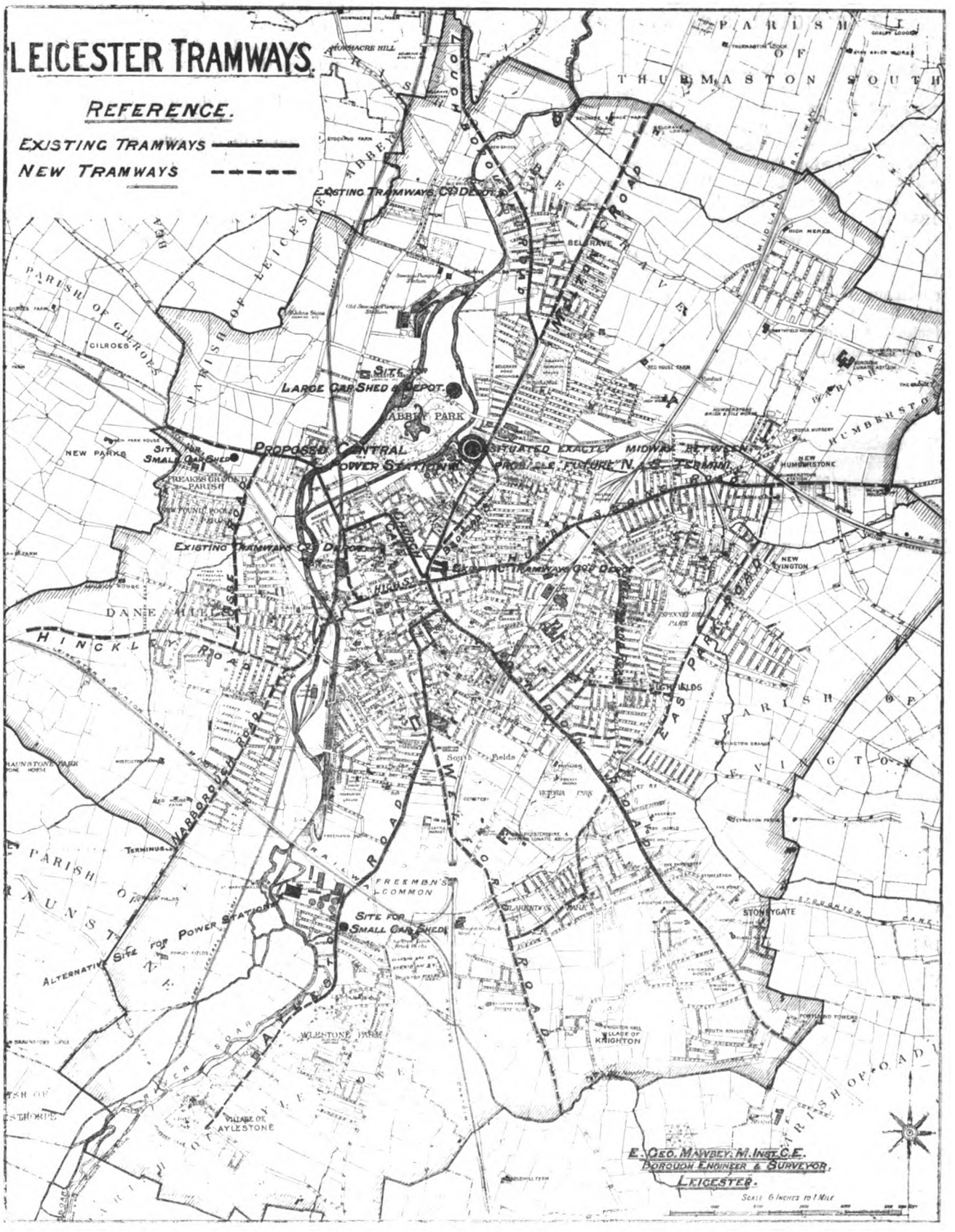
LEICESTER TRAMWAYS.

Through the kindness of Mr. E. G. Mawbey, M.I.C.E., the borough surveyor of Leicester, we are able to produce this week a map which shows clearly the routes of the proposed electric tramways in Leicester. On this map the existing tramways are shown by thick black lines, while the dotted lines indicate the proposed extensions. The boundary of the borough of Leicester is indicated by a black line which is shaded on the inside. On this map is also shown the positions of the two sites for the generating works. The first of these is indicated by the black concentric circle near the upper part of the map. It is this site which is recommended by Mr. E. Manville, of the firm of Kincaid, Waller, and Manville, the consulting engineer to the Leicester Corporation. It will be seen from an inspection of the map that the position of this site is a fairly central one, also as practically all the extensions are being made to the north of the town, it tends to become more central. It is also close to those routes on which the heaviest traffic will occur. The other site, which is shown in the lower part of the map, is situated at the gasworks. It will be seen that this is some considerable distance from the centre of the town. Mr. Manville has advised the Corporation that a direct-current


LEICESTER TRAMWAYS.
REFERENCE.
EXISTING TRAMWAYS
NEW TRAMWAYS
EXISTING TRAMWAYS C.D.E. OF 5
SITE FOR LARGE CAR SHED & DEPOT.
ABBEY PARK
PROPOSED CENTRAL POWER STATION
SITUATED EXACTLY MIDWAY BETWEEN PRESENT & FUTURE N. & S. TERMINI
SITE FOR SMALL CAR SHED
EXISTING TRAMWAYS C.D.E. OF 5
EXISTING TRAMWAYS C.D.E. OF 5
HINCKLEY ROAD
WARREN HILL ROAD
SITE FOR POWER STATION
ALTERNATIVE SITE FOR POWER STATION
SITE FOR SMALL CAR SHED
FREEMEN'S COMMON
VILLAGE OF AYLESTONE
VILLAGE OF KNIGHTON
E. GEO. MAWBEY, M. INST. C.E.
BOROUGH ENGINEER & SURVEYOR,
LEICESTER.
SCALE 6 INCHES TO 1 MILE

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supply at about 500 volts could be given to all the tramways if the first site were used, whereas if the tramway generating plant is placed at the gasworks a polyphase high-tension transmission scheme would be required.

THE COMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

Among the establishments to be visited in Berlin by the Institution of Electrical Engineers the world-renowned works of Messrs. Siemens and Halske are of the first importance. Probably no better proof of the phenomenal progress made in electro-technical science can be obtained than by following the remarkable growth of this firm, which was established by Werner Siemens and T. G. Halske over 50 years ago. At the World's Fair in London, 1851, the improvements made by the firm on the Morse telegraph were rewarded by the council medal, which was conferred on but a few exhibitors. From that time the business of Messrs. Siemens and Halske, owing to the enormous development of electricity, grew steadily, and the firm found it necessary to establish new branch factories in different parts of the city and suburbs.

At present the works of Messrs. Siemens and Halske consist of the following establishments at and near Berlin: (1) the Berlin works in the Markgrafenstrasse, telephones, telegraphs, measuring instruments, etc.; (2) the dynamo works at Charlottenburg; (3) the cable works at the Nonnendamm, between Charlottenburg and Spandau; (4) the incandescent lamp factory at Charlottenburg, Helmholtzstrasse; (5) the block works (railway safety appliances) at Charlottenburg, Helmholtzstrasse, now in course of construction, to be opened in August, 1901.

The Berlin Works of Messrs. Siemens and Halske.

A bird's-eye view of these works is shown in Fig. 1. The building in the Markgrafenstrasse (Fig. 2), which was purchased over 50 years ago by Messrs. Siemens and Halske, has up to the present day been intimately connected with the development and growth of the concern. It is still considered the centre of the whole works, even though other large factories have been established by the firm. But the reader must not suppose that this building, similar to palatial factories, now built with long stretched fronts, high, broad windows, splendid façades, and elaborate decorations, in its whole external appearance gives a picture of the size and extent of the whole plant. The house which one enters is not modern, but it has something not possessed by new establishments—namely, a historical importance.

It is not our purpose to enter in detail on the gradual rise of the parent building, for it can be of but little interest to the reader to learn how from time to time the neighbouring buildings were purchased and connected with the above-named centre, or that even in neighbouring streets a number of factories and workshops, as, for example, the huge works in the Lindenstrasse or the screw factory in the Markgrafenstrasse were established. Yet all these extensions for a length of time could not satisfy the growing demands for more room, and so a large building is now being erected at the Ascanischeplatz intended for the "Central-Abteilung," the managing department of the firm, and for the electric railway department, both of which have remained till now in the parent building. It can be well understood that with the increasing growth of the Berlin works its enlargement could not be uniform, and the sketch (Fig. 3) showing the extended factory yard also indicates how gradually one factory building has been added to the other. Originally the two side buildings in the foreground were used for factory purposes. Later on the five-storeyed factory building in the left background was added, becoming the home of the first cable-works in Germany, in conjunction with the opposite building. The two side buildings in the background were next added, and finally the connecting cross building, which fronts upon the Charlottenstrasse. From a practical point of view, the engineer will hardly look at this narrow yard with an admiring eye, but when he considers the past, and looks from the designing table and out of the workshop beyond to the past history of electro-technical science, if he comprehends the present time in its whole fulness and realises the importance of technics in modern political economy, he will bring his mind to bear on the thought that this plain, narrow piece of earth, this simple factory yard, crowded with wagons and goods, is the point of departure of a great deal of the progress in modern electricity.

We will not attempt to make a description of the different lines of manufacture carried on, as the Berlin works devote themselves exclusively to the production of small and fine apparatus in the line of the mechanic, an account of which would be of little interest to the reader. In its place will be given a short account of the different factories which comprise the Berlin works. At first, telegraphy should be mentioned as the oldest business of the house. This department comprises a number of sections. Many of these form factories in themselves, as, for example, the making

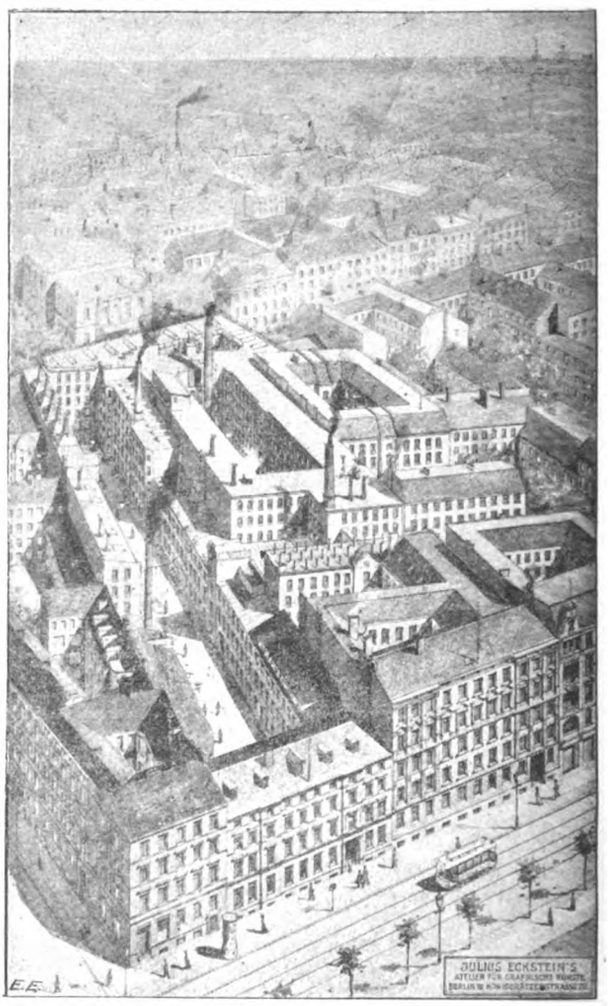

Fig 1.—Bird's-eye View of the Berlin Work.

of the Morse apparatus, of the printing, telegraph, and railway signalling apparatus. The same can be said of the manufacture of measuring and controlling instruments, as also of the department of accessories for telegraphic plants of every kind. In order to give an idea of the extent of the whole operations, it may be mentioned that in the telegraph and telephone departments about 5,000 different kinds of articles are made. The second main section of the Berlin works comprises the telephone department, which produces microphones, telephones, annunciators, and, finally, the well-known telephone apparatus of the firm's make. The latter have attained an exceptional importance, and were awarded with a "grand prix" at the Paris Exhibition in 1900. Further, the section of measuring instruments deserves to be mentioned. Its importance may be recognised by the fact that the measuring instruments of Siemens and Halske—as, for instance, the Universal galvanometer—have found their way to all parts of the world. What distinguishes this

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department from all others is the fact that it requires not only the skilled hand of the mechanic, but also the scientific training required for the examination of instruments. The workshops where the latter are made also contain adjusting rooms, where the instruments are most carefully examined and calibrated. The fourth factory belonging to the Berlin works is the one devoted to railway safety appliances, whose construction frequently serve as models for others, and have also rendered possible,

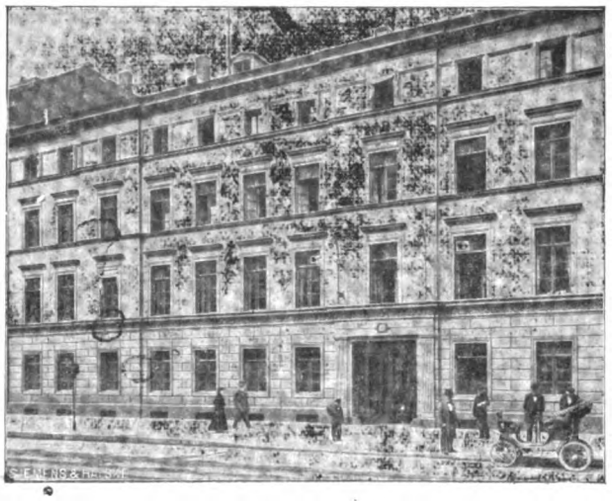

FIG. 2.—Front View of the Berlin Works, Markgrafenstrasse.

regular, and safe the fastest train service. Now, this department, owing to want of room, will be transferred to Charlottenburg. The fifth section, the manufactory of water-meters, has nothing to do with electricity, but is intimately connected with the name of Siemens, as William Siemens was the inventor of the water-meter. The sixth and youngest department is one for the manufacture of articles of precision. This section, however, is not, like the others, divided according to the articles manufactured, but

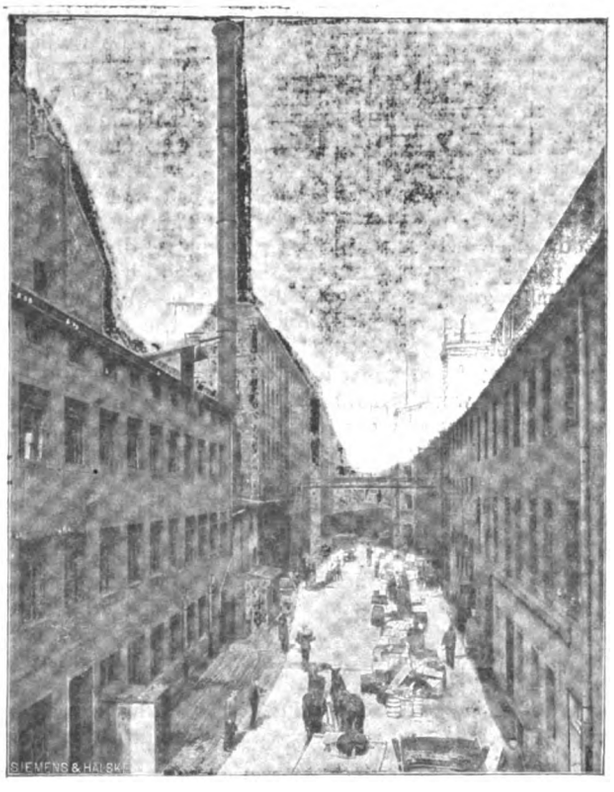

FIG. 3.—Factory Yard.

makes them all. It is well known that the firm from its very early beginning has aimed to make apparatus perfect to the smallest detail. Formerly this could only be attained by the carefully trained and skilled mechanic, but such a division of labour was not only expensive, but also unprofitable and took much time.

In the course of the last decade of the nineteenth century a new method for the making of metallic parts was developed, the whole work consisting of a series of the simplest steps, a machine constructed especially for this purpose being used for every step in the manufacture. The machine executes the work with great exactness, and therefore, with its aid, every part of the article to be made can be produced in large quantities and at a cheap price, as the machine needs only careful supervision by an experienced workman. Yet this achievement in the construction of machines has only gradually and recently been attained, and for this reason the firm formerly did not give up hand work. Only when it became thoroughly convinced that apparatus manufactured by means of special machines had become so developed that they would satisfy the high demands of the house as to quality, it was decided to introduce this method of manufacture, and the Berlin works arranged accordingly.

(To be continued.)

OPENING OF THE PERTH ELECTRICITY WORKS.

The formal opening of the Perth electricity undertaking took place on Saturday, June 1, when a large company was invited by the Corporation to witness the proceedings. The Town Council was strongly represented both by present and past members, and the guests included Sir Robert Pullar and Mr. John A. Dewar, M.P., the latter of whom, while acting as Lord Provost, took a lively interest in the Corporation electric lighting scheme at the time it was in its earlier stages. The company was photographed before the opening ceremony took place, and on this having been done Lord Provost Macgregor was presented with a gold key by Mr. W. C. C. Hawtayne, the consulting engineer for the work. After acknowledging Mr. Hawtayne's gift in a suitable manner, the Provost opened the gates and admitted the company into the engine-room. When a short time had been allowed for inspection of the engines, the Lord Provost turned on steam to one of the two 200-kw. sets, and Sir Robert Pullar turned on steam to the other set. This part of the opening ceremony having been gone through, the Provost requested Mrs. Wright, the wife of the convener of the Electric Lighting Committee, to switch on the light in the station, which that lady at once performed, amid cheers from the company. Mr. Callender here presented Mrs. Wright, on behalf of the contractors, with a handsome gold bracelet in a suitably-inscribed morocco case. Ex-Bailie Wright having thanked the contractors, Councillor Grieve, sub-convener of the Lighting Committee, switched on the light to the arc lamps in the streets of the town, and also to a number of private installations which are now connected up to the town supply. After a further inspection of the station, the company sat down to a cake and wine banquet, presided over by the Lord Provost, with ex-Bailies Wright and Mr. John Bigg, town clerk, acting as croupiers.

After the loyal toasts had been honoured, Bailie WOOD proposed the toast of "The Engineers and Contractors." In proposing this toast he paid a high tribute to Mr. Hawtayne for the manner in which he had performed his part of the undertaking, and also complimented the various contractors for the expeditious way in which they had carried out the work. The Council were fortunate, he said, in having Mr. Lambert appointed as resident engineer, and they looked to him to make the electric undertaking a great commercial success.

Mr. HAWTAYNE and Mr. CALLENDER having suitably replied,

Sir ROBERT PULLAR proposed "The Town Council." He was sure that the Town Council had been wisely expending the money of the ratepayers, as they had often done on previous undertakings, and he felt certain that the electric light would be a great pleasure and comfort to the citizens who adopted it.

Lord Provost MACGREGOR, replying on behalf of the Council, thanked them for the assistance they had always given to him. It was very arduous work, and growing more arduous every day.

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Mr. DEWAR, in proposing "The Committee," referred to the amount of hard work which had been done by the gentlemen who were specially in charge of the electric lighting movement. He gave some interesting information regarding the amount of money spent by the city of Perth in the last 10 years or so. This amounted to about a quarter of a million of money in capital expenditure, most of which had been spent on productive work, and would yield a return to the community. He recalled the long period during which their principal effort as a Town Council was to keep others out. This "hold-the-fort" policy was pursued until ultimately they had to procure a provisional order and to proceed to lay down an electric lighting plant for themselves. He hoped the Corporation would soon have the tramways under their control, operated as an electrical system from the station now opened.

The toast of "The Committee" having been duly honoured, the LORD PROVOST, in the name of the Town Council and friends, presented ex-Baillie Wright, the convener, with a handsome silver salver, suitably inscribed, and a purse of sovereigns as a memento of the occasion.

Ex-Baillie WRIGHT replied on behalf of the committee, and thanked the subscribers for their gifts.

The toasts of "The Ladies" and "The Lord Provost" having been proposed and responded to, the proceedings terminated.

ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

Official Opening of Headquarters.

Lord Kelvin, the honorary colonel Electrical Engineers (R.E.) Volunteers, presided last Saturday at the formal opening of the drill hall, which has been erected in Regency-street, Westminster, for the sole use of the corps.

Major R. S. ERSKINE, O.C.E.E. (R.E.) Vols, gave a brief sketch of the history of the corps, which emanated from a proposal by the late Dr. J. Hopkinson, in consequence of which the Institution of Electrical Engineers appointed a committee and invited applications. In 1897 Major Hopkinson began to form the corps, and the strength was 120 in 1898 with an efficiency of 115, which figures rose in the next year to 219 and 210 respectively, and in 1900, including the South African contingent, to 380 and 352. The present strength is 494, including the second South African contingent. The limit is 580. It was first proposed to instal the headquarters at Woolwich, and an office was taken at 13, Victoria-street. The 1st Middlesex Regiment greatly assisted with regard to drill and lent their headquarters, Sergeant-Major Stephenson inspecting the men. Assistance was also given by the London Scottish and Fusiliers, and Dr. Bateman, surgeon-captain London Irish Volunteers, gave his services in inspecting the applicants in town. The corps had now their own medical officer, and men would be inspected at headquarters. Owing to the great difficulty of working the corps from an office only, and to the difficulty of getting the said South African detachment together owing to objections by other tenants, it became necessary to look about for a building of their own. The estimated cost of the present building was £7,000; the War Department allowed a loan of £6,000 and also another of £1,000 to be borrowed privately. They would, however, not grant this loan of £6,000 until after completion of the building. A guarantee of the officers, backed by other guarantors, finally secured the capital required. Mr. Sydney Morse had acted as the corps legal adviser free of charge. Mr. Weyman was the architect of the building.

Captain E. Hopkinson, on behalf of himself and Mrs. J. Hopkinson, presented a large portrait of Dr. John Hopkinson. Subsequently Lord Kelvin asked Mrs. J. Hopkinson to formally declare the building open. Both Lord Kelvin and Colonel Crompton then referred feelingly to the eminent services of Dr. Hopkinson as the founder of the corps, and Colonel Crompton gave an account—and a most favourable one—of the doings of the said detachment in South Africa.

Major Erskine stated it was the intention of presenting Mrs. Hopkinson with a silver model of the searchlight, but the presentation had to be postponed, as the model was not quite ready yet.

The building consists of a very large and lofty hall, well lighted from above, spacious offices, and a number of recreation and lecture rooms. A small Morris tube is fitted up in the basement. The headquarters will be open every evening to members of the corps for instruction and recreation, and will no doubt be greatly conducive of quickly bringing the number up to the full establishment.

ELECTRIFICATION OF THE DISTRICT RAILWAY.

A special general meeting of the proprietors of the Metropolitan District Railway Company was held yesterday at the Westminster Palace Hotel for the purpose of considering additional provisions in the Bill promoted by the company for the conversion of their system to electric traction, and of adopting a provisional agreement between the railway company and the Metropolitan District Electric Traction Company, Limited. The object of the additional provisions and agreement is to render unnecessary those clauses of the Bill as deposited in Parliament by which powers were sought to raise new first debenture stock, to cancel certain authorised capital, and to reduce the dividend on the preference stock. From the remarks of Mr. Forbes, the chairman of the railway company, who presided over yesterday's meeting, we gather that the combination which has been formed, with Mr. Yerkes at its head, in order to carry out the electrification of the District Railway have taken up about half of the ordinary stock of the railway company, and are ready to find the money to provide the machinery for the conversion of the railway from steam to electric traction. The chairman impressed upon the meeting the fact that these gentlemen are quite willing to stake their fortunes and their reputations on this undertaking, and, what is more, they have given tangible security. The agreement between the railway company and the traction company has been the source of very great deliberation, and as it now stands it may be divided into two parts. First, with regard to the proposed generating station in Lots-road, Chelsea—this will be erected by the traction company at a cost not exceeding £400,000, and on completion will be hired to the railway company for 999 years at a rental based on 5 per cent. of the outlay per annum. With regard to this work, the chairman stated that it will be carried out, not under a lump sum contract with any particular firm, but by placing contracts with different firms best fitted to deal with the particular class of work in hand. This will ensure the work being done at the lowest possible cost, and the shareholders will have a voice in determining what the cost price shall be. With regard to the electrification and equipment of the railway for working by electric power, this part of the contract differs from that relating to the generating station. Under the agreement the work is to be carried out by the traction company, payment being made by the railway company in £500,000 ordinary stock and £166,000 4 per cent. debenture stock. The half a million of ordinary stock, the chairman explained, will be taken up by the American combination at the normal price of 25, and the 4 per cent. debenture stock at par. One point of particular interest is that the traction company assert that they will carry out the conversion of the system without interfering at all with the regularity of a single train in the ordinary service. The chairman's statement as to the proposals of the Board brought several shareholders on their legs. Some wanted to know what benefit they were going to derive from the conversion of the line to electric traction; others, why the Americans had elected to come over here and invest their money in the concern. Mr. Forbes's reply, that he supposed it was because the Americans had such a lot of money that they did not know what to do with it, was not generally accepted. He emphasised the fact that these American gentlemen had undertaken to do a thing which this company might very well have done for themselves years ago had they had the necessary knowledge and the necessary courage to carry out the scheme. This was a very momentous and important question, and he deplored the

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fact the attendance of shareholders that day was so limited. Mr. Perks, M.P. (whose name has been associated with that of Mr. Yerkes in certain quarters in connection with this undertaking), took this opportunity of stating that he has not got one single pennyworth of interest, either professionally or otherwise, in the new company which will undertake the electrification of the railway. He is practically the largest holder of ordinary stock in the railway company, and his advice to the Board has always been given in the nature of a friend and not in the capacity of a professional man. Another important point which transpired during the discussion is that until one million sterling has been raised by the new company the agreement is not binding on either party. It was further stated that the new company will make no profit whatever on the carrying out of the work. This syndicate of American gentlemen, who, it is asserted, are of undoubted position and means, look to the future for their real remuneration. The necessity for carrying the Bill through this session of Parliament was impressed upon the meeting, it being pointed out that already a Bill was before Parliament for the construction of a "tube" railway along Fleet-street and the Strand, which, if authorised, will very seriously compete with the District Railway. Other shareholders expressed the hope that the relations between this company and the Metropolitan Company will continue to be of an amicable nature, while others wanted to know what were the practical advantages of electrical traction over steam. The chairman agreed that they ought not to take up a position of opposition to the Metropolitan Company, but if the latter company adopted a system of electric traction which was fatal to the District Company's views, then they would have to take the same course as with other companies and protect themselves. Although he earnestly hoped that their relations with the Metropolitan Company would continue friendly, he might say that there was no chance at present, as had been suggested in some quarters, of an amalgamation between the two companies. Referring to the agreement, the chairman stated that the Board were unanimously of opinion that it was perfectly sound, and was fraught with enormous advantages to the shareholders in the railway company. He appealed to them not to imperil the progress of the scheme in Parliament, and in their own interest to allow the Bill to go upon the terms stated. With regard to the practical advantages of electricity as the motive power, in the first place the company could run more trains a day at a much less average cost per mile than by steam. At the present time they were spending 52 per cent. on the working expenses, whereas with electric traction they were assured that the lines could be worked for 35 per cent., which would mean a saving of £70,000 to the company per annum. Ultimately the resolutions for the promotion of the Bill in this session of Parliament and the adoption of the agreement with the Metropolitan District Electric Traction Company, Limited, were unanimously agreed to.

MUNICIPAL ELECTRICAL ASSOCIATION.

We have seen the official programme of the annual meeting of this association, which is to be held in Glasgow on June 19 and the three following days. It is probably generally known that visitors are cordially welcomed to the meetings of this association, the necessary tickets being obtainable from the secretary, Mr. C. McArthur Butler, at St. James's Hall, London, W., up to the 12th inst.; after that date the secretary will be found at the Windsor Hotel, Glasgow.

The programme, as usual, is a lengthy one. It will, however, be only necessary for us to indicate the business, leaving such readers as desire it to obtain the programme from the secretary and make themselves acquainted with the details. On Wednesday, the 19th, the business of the meeting commences at 9.45, at the Institution of Engineers and Shipbuilders in Scotland, when the Lord Provost will welcome the association, and the president, Mr. W. A. Chamen, will read the presidential address, subsequent to which the following papers will be read and discussed: (1) "Insulated Returns in a Tramway System," by Mr. J. H. Rider, chief electrical engineer, London County Council tramways; (2) "Street Electric Lighting," by Baillie W. Maclay, convener of the Glasgow Corporation Electricity Committee. The meeting for reading and discussion of papers will be adjourned at half-past one, and after luncheon various works will be visited prior to the annual dinner, which will be held on that evening.

On the following day the meeting commences at 10 o'clock at the Freemasons' Hall, Edinburgh, when the following papers will be read and discussed: (1) "Braking Apparatus for Electric Cars," by Mr. A. L. C. Fell, tramway engineer to the Sheffield Corporation; (2) "The Equitable Allocation of Costs in Combined Lighting and Traction Stations," by Mr. W. H. Tittensor, electrical engineer, Dundee Corporation. After the reading of the papers visits will be made to places of professional interest in and around Edinburgh.

On Friday the meeting takes place at the Institution of Engineers and Shipbuilders'. The following are the papers to be read and discussed: (1) "Refuse Destructors in Combination with Electric Power Stations," by Mr. J. S. Highfield, electrical engineer, St. Helens Corporation; (2) "Coal and Ash Conveying Gear," by Mr. R. A. Chattock, chief electrical engineer, Bradford Corporation.

As usual, a number of works are open for inspection. In the evening the annual general business meeting will be held. Saturday is to be devoted more or less to a visit to the works of Messrs. Babcock and Wilcox.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the report of the committee of the Students' Section for the session 1900-01:

During this session 11 ordinary meetings have been held, the average attendance at which has been 20. At some of these meetings have been read some of the reports presented to the Institution by the student reporters appointed by the Council of the Institution, in August last, to report on various classes of exhibits in the electrical section of the Paris Exhibition of 1900. In addition, six papers have been read on various electrical subjects.

Thirteen works and installations of special interest in the neighbourhood of London have been visited by parties of students during the session. Eight visits have also been made by parties of student members from the various technical colleges to the Board of Trade standardising laboratory, at the invitation of Mr. A. P. Trotter, of the Board of Trade.

It is with great pleasure that the committee reports the success of the visit of the Students' Section to Manchester in April last.

The proposal to visit an engineering centre in the Easter vacation of the technical colleges was brought forward in December last, and, with the approval of the Council, a circular letter was sent to all the student members in order to test whether the proposal would meet with sufficient support. To this circular 33 replies were received, and it was considered that this was a sufficient number to warrant arrangements being made for the visit to take place. Manchester was chosen as the centre for the visit, which lasted four days (one day being spent at Liverpool), and was participated in by 32 students, 11 of whom were from London, the majority of the remainder being from the neighbourhoods of Manchester and Sheffield. The party was well received by the firms and engineers whose works were visited, and the success of the visit leads the committee to hope that the experiment may be repeated in future years.

The committee have during the session drawn up a code of rules for the governance of the Students' Section, which was unanimously passed, subject to the approval of the Council at the annual general meeting of the section.

The committee for the session 1901-02 is made up of the following gentlemen: B. H. Morphy and C. W. Wilkinson (Central Technical College); A. H. Bennett (Faraday House); R. L. Longman, P. G. Mitchell, and P. Rayner-Smith (Finsbury Technical College); D. R. H. Browne (King's College); F. J. Hiss, jun., and H. D. Symons (non-collegiate); G. B. Dyke (University College).

Book Received.—The first edition of a new work entitled "A Treatise on Electromagnetic Phenomena," by Commander T. A. Lyons, of the U.S. Navy, has just been published by Messrs. Chapman and Hall, Limited, of London. The price of the book is 25s. 6d.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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ELECTRICITY AND MUNICIPAL TRADING.

This is the title of a communication to the *Times* on Saturday, June 1, to the extent of between four and five of its columns, and upon which communication our contemporary founded a leader. We propose to follow so eminent an example. In the first place, we are strenuously opposed to all that partakes of municipal trading, yet our present purpose is to show that its exponents have much to say in favour of the present condition of things. In our opinion, its opponents are hardly fair in the controversy. So far as we can find, with the exception of ourselves, there has been no attempt to obtain or define a principle in the matter; the whole controversy takes the form of special pleading, and each side argues as if the opposite side were unworthy of consideration. The correspondent of the *Times* chooses his subject "for the reason that probably the present tendency of corporations to seek to compete with private enterprise owes its growth to nothing so much as to the introduction of electricity as a source of light and of traction and motive power." A quarter of a century's experience with corporation work has led us to the conclusion that the prevailing idea in the minds of corporation officials and councils at the time when it was proposed to introduce electrical energy for lighting purposes, was that under no circumstances would it be beneficial to the community at large to promote the introduction of a monopoly similar to the monopoly exercised by the gas companies. At that time gas had held the field for more than half a century. The gas companies had done little or nothing to improve the gas supply or burners; and, in fact, the great progress made in the gas industry has been almost entirely due to the introduction of the competing factor—electrical energy. A great many gas companies were paying, and had paid, large dividends, and it was generally felt throughout the kingdom that too much profit was being made by these monopolists out of the necessities of the population. It is all very well for the advocates for the development of electrical work to pretend that it is not going to follow in the footsteps of gas, and become more or less of the nature of a monopoly in each district. It must in the long run partake very much, if not wholly, of the nature of a monopoly in each district. What is the use of pretending that it will be otherwise, and in attempting to fool the general public into the belief of the impossible? What, again, is the use of arguing as if the street area was illimitable? It is not; and if there were no other reason, this would be sufficient to quash any idea of general competition. We will take the liberty of mentioning another point to show the one-sidedness of the argument put forward. It is stated, and no doubt it is perfectly true, that "there are over two hundred local authorities in the British Isles at the present moment holding provisional orders which have never been put into force." We wonder how many companies during the last twenty years have projected electrical schemes and obtained capital from the public without their schemes being put into force. It is

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the company promoter who has compelled, in a large number of cases, the local authorities to take measures for self-protection. These promoters care nothing about the real introduction of electric light or anything else, except to be able to make much money out of promoting schemes. We are not going to enter again at this time upon the vexed questions of traction and motive power. We have often stated our belief that these are absolutely outside the true work of municipal authorities. Rather let us indicate one or two points which the opponents to municipal trading might expand with advantage to themselves. Is it not a fact that anything of the nature of a monopoly is a bar to anything in the shape of progress in the direction of that monopoly? It seems to us that the march of time has, even with electrical matters, solved that question. We are told that the future of electrical generation is to be upon an enormous scale, and that the time of a comparatively small station is short. If this is to be so, what greater object lesson could the country require. Scores, or hundreds, of these small stations have been installed during the past fifteen years, and if the success of the large generating station is commensurate with the ideas of their advocates, it will be seen that it is far too dangerous for public money to be put into concerns which are characterised by rapid changes.

ELECTRIC LIGHT UNDERTAKERS AND THE NEW FACTORY ACT.

The Bill of Mr. Ritchie to add certain definitions to the Factory Act of 1895, which is an amendment of the Consolidated Factory Act of 1878, has definitely included *electrical generating* and *transforming* stations in the "premises" which are to be inspected by the factory inspectors under the Home Office. If electricity was not an article of manufacture and sale, generating stations could not be included; and if transforming stations were not—in the terms of the Act of 1878—"attendant" on the manufacture of electricity, this could not have been proposed. Any attempt to have the question discussed on independent grounds is precluded by the influence of the Workmen's Compensation Act, from the benefits of which electric light employés might be excluded if the premises in which generation and transformation takes place were not subject to the Factory Acts. If this is the case, any attempt to leave these places out of the definitions in Mr. Ritchie's Bill would meet with opposition, certain to be successful. We understand that street boxes are not "premises," so that they would not be included amongst the various kinds of transforming stations to become subject to the Factory Acts. As there is apparently no chance of being able to show that an electrical generating station for the production of electricity that is for sale is *not* a non-textile factory, the next thing is to try and bring the requirements of the factory inspectors under the influence of professional opinion, so as to prevent, for instance, machinery in a supply station under statute being put out of use under the decision of a magistrate on the motion of an inspector. We believe that the Council of the Institution of Electrical Engineers has this question, so important to prevent unnecessary hampering of the industry, under careful consideration, and that they will seek to obtain a hearing on it, and to maintain a watch in the future on the incidence of this new legislation.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRIGHTON CABLES.

SIR,—I am not interested in the discussion which has taken place in the columns of the *Electrical Engineer* as to the relative tenders submitted by the firms comprising the Cable Makers' Association and the Union Cable Company, excepting on the point raised in the letter from the latter company published in your last issue. An attempt is therein made to explain away the discrepancy in prices by the Union Company taking credit for supplying cables having an electrical conductivity 4·68 per cent. in excess of the cables supplied by the Cable Makers' Association.

To my mind the apparent conductivity inferiority will be found to be due to the adoption of a different temperature basis; the guaranteed resistance in the unsuccessful tenders was most probably based on a standard temperature of 75deg F. If this is so, then there is practically no difference in the respective guarantees of the Cable Makers' Association and the Union Cable Company. But whether this be so or not, there is certainly not a difference of 4·68 per cent. in the conductivity of the copper used by the contending parties.

The high-conductivity copper supplied by my firm is always over 100 per cent. on Matthiessen's standard, and averages nearer 101 per cent. The high-conductivity copper used by the Union Cable Company is, therefore, claimed to be 104·68 to 105·68 on same standard. Where do they get it from? It certainly is not made on a commercial scale neither in this country nor in America.—Yours, etc.,

W. GIBBINGS,
Works Manager to the Liverpool Silver and Copper Company, Widnes.

PERPETUAL MOTION.

SIR,—I beg to own receipt of your favour of 29th inst., and to say emphatically I have entirely overcome the laws of gravity (you say nature) by utilising the whole weight of the wheel to drive itself by a scientific arrangement of levers and driving weights, and that my invention will rank among the most wonderful achievements man is capable of fathoming, and will shortly take the world by utter amazement. Candidly, Sir, yourself, or anybody else, could have no conception as to how it is done, and why you should be so stubborn, and disbelieve what I say, and adhere to the laws of gravity when my invention will knock the shine out of any other since the world was made, I fail to localise, unless it is your policy to harness the inventive propensity of man. If you could pay me a visit, Sir, I can show you something to go back and write upon for the enlightenment of those puzzling their brains over perpetual motion, resulting in the making of your journal. Don't be stagnant! Be enterprising, like our shrewd American cousins.—Yours, etc., ARTHUR E. GILBERT.

Heaton, May 31, 1901.

[The above letter from Mr. Arthur E. Gilbert is the outcome of one we wrote him respecting an invention of his, which he claims is to be the invention of the new century. We regret to find that he is still wasting his time, and, we presume, his money, on the vain attempt to produce a perpetual-motion machine. We have again and again tried to convince Mr. Gilbert that he would find instruction in theoretical mechanics of great use to him, without being able to do so. As regards the proposed visit, we are quite prepared to arrange for one of our editors to

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call upon him at Heaton as soon as he can inform us that he has had the machine running for a day without the application of any external power.—ED. *E. E.*]

CUT-OFF DEVICE.

SIR,—We thank you for the copy of the above paper issued on the 31st ult., and also for the insertion you have respecting our "cut-off" device. We beg, however, to ask you to correct in your next issue the wording of that description, as it is somewhat misleading, and might prove very prejudicial to our interests. You state "that each span shall be independent of its neighbours." Now, this is not so, as we guarantee that our appliance shall be effective in cutting-off the electric current to the extent of six spans, which means, of course, a distance of 240 yards.

Further, with regard to "adding to the somewhat unsightliness of tramway construction," we also beg to state that the device itself when fixed on the pole and painted in harmony with its surroundings is hardly recognisable from the ground, as the levers you mention in your description can be now dispensed with by a chain and a box containing the weights fixed on the pole.

In case of span wires, these would be sufficiently strengthened to carry the weight of the device, but still the chain and weight would be utilised in place of the arms and levers—in fact, our apparatus can be fixed anywhere.

We trust you will be able to give these corrections as prominent a place in your next issue as you did the description on the 31st ult.—Yours, etc,

BOSTOCK AND CHEETHAM.

Brighouse, Yorks, June 4, 1901.

OBITUARY.

We much regret to have to record the demise of Principal John A. Viriamu Jones, professor of physics in the University College of South Wales, in his forty-fifth year. Born at Pentreporth, near Swansea, in 1856, Prof. Jones matriculated at the London University in 1872, being placed first in the honours division. Having entered University College, London, he graduated bachelor of science in 1875, carrying off the university scholarship in geology. Prof. Jones next went to Balliol College, Oxford, where he won a Brackenbury scholarship, obtained a first class in mathematical honours in moderations three years later, a first class in the final honour school of mathematics in 1879, and a first class in the final honour school of natural science (physics) in 1880. In this year he accepted the appointment of demonstrator in the Clarendon Laboratory, Oxford, under Prof. Clifton, and a year later he was appointed principal and professor of mathematics and physics in the Firth College, Sheffield. Prof. Viriamu Jones had occupied this high position for only two years when he was elected principal and professor of physics of the then newly-founded University College of South Wales, a post which he has ably occupied for the last 18 years. The scientific work of Prof. Jones was mainly concerned with the absolute measurement of electrical resistance, and he was a member of the British Association on that subject. In 1894 he was made a Fellow of the Royal Society, and three years later was elected a Fellow of Jesus College, Oxford. As principal of the South Wales College, he did much for the cause of technical and scientific education in Wales. A memorial service will be held in Cardiff on Monday next, and the remains of the deceased scientist will be interred at Swansea on the following day.

THE MOND GAS BILL.

The object of the Mond Gas Bill is to incorporate and confer powers on the South Staffordshire Mond Gas Power and Heating Company to supply a producer gas invented by Dr. Ludwig Mond. The main features of the invention were explained before the Select Committee of the House of Commons presided over by Colonel Welby, which has been enquiring into the merits of the Bill. The gas is purely a power and heating gas, and cannot be used for lighting purposes, its flame being similar to that obtained from spirits of wine. It can be produced from cheap slack, and as the sulphate of ammonia is recovered in the process as a by-product, the cost of the coal, and consequently of the gas, it is claimed, is reduced to a very small figure. The present application to Parliament was practically only to obtain powers to open up streets in order to lay mains for distribution purposes. One of the great advantages which it is claimed will result from the establishment of the company is that they will be able to supply power and heat to the small manufacturer at a very low rate—more cheaply, it is said, than electricity for these purposes can be supplied. Mr. Herbert Humphrey is responsible for the engineering features of the scheme, and, in his opinion, the use of Mond gas will lead to a saving in fuel, in labour, in time, in cost of repairs, and in space, and will give better results with less waste of material than ordinary fuel. The estimated expenditure of the company is £789,686, of which £40,000 is for land, railway sidings, etc., and £387,000 for works at the manufacturing stations, making a total of £427,000, which leaves £360,000 for distribution plant. Altogether it is proposed to erect five manufacturing stations, from each of which will run a 2ft. 6in. arterial main in each direction, which it is estimated will be capable of delivering 120,000,000 cubic feet of Mond gas daily. A considerable number of local authorities opposed the measure, chiefly on the ground of the interference with the streets which the operations of the company will entail. In other cases the ground of opposition was because they supplied coal-gas, with which it was feared the new gas might compete. In answer to this, however, the promoters pointed out that it would only compete where gas was supplied for power or heat, and then only in the larger quantities, because it would not pay to undertake to supply the very small consumers with Mond gas for these purposes. Among the petitioners was the Midland Electric Corporation for Power Distribution, who have power to supply electrical energy in a certain portion of the area proposed under this Bill. The answer to their petition was that an electrical company could supply energy for power, but not for heat. There was also opposition on behalf of six gas companies in the district.

One point put forward by the petitioners was that although the promoters sought power to supply Mond gas, they might not, under this Bill, supply Mond gas at all, but some other producer gas, and accordingly the promoters agreed to the insertion of clauses making it clear that that was not their intention. A question also arose as to whether the undertaking would prove a financial success. It was stated that the company could only start when £225,000 had been subscribed, and Dr. Mond's remuneration, which was to be £75,000 in ordinary shares, entirely depended upon the success of the undertaking. The following provisoes were also inserted on the suggestion of the committee—viz: Any development of the gas permitted by the Bill must be certificated by the Board of Trade. The shares to be allotted to Dr. Mond, the patentee, to rank as follows: 40,000 to rank for dividend with the other shares, 35,000 to rank for dividend after the holders of the other shares have received 5 per cent. per annum dividend. Subject to these conditions the committee found the preamble of the Bill proved.

LIGHT RAILWAYS.

Notices of intention to apply for light railway orders have been given by the following: Lizard light railway (company), electrical power, etc.; Woodbridge and Bawdsley light railway (syndicate), construction of two lines; Gower light railway (company), amending order; Rother Valley light railway (company), construction of three lines; Turton, Tottington, Ramsbottom, and Rawtenstall light railway (company), construction of six lines; Spen Valley and Morley light railways (British Electric Traction Company), extensions; Crewe light railways (British Electric Traction Company), eight lines; South Shields,

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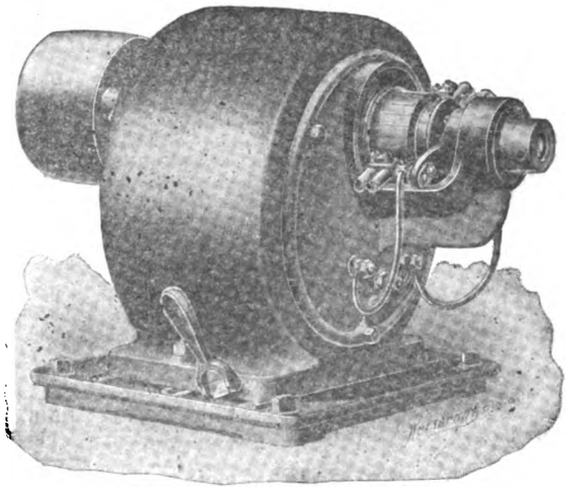
Sunderland, and District light railways (British Electric Traction Company), construction of five lines; Potteries light railway (Potteries Electric Traction Company), extensions; Middleton light railways (British Electric Traction Company), deviation; Southend, Burnham-on-Crouch, to Bradwell-on-Sea light railway (Railway and General Construction and Maintenance Company), construction of five lines; Woolwich, Eltham, and District light railways (the Auxiliary and Light Railways and Tramways Company), construction of one line; Preston-Horwich light railways (the Auxiliary and Light Railways and Tramways Company), construction of five lines; Preston and Lytham light railways (syndicate), construction of four lines; Holmfield and Southowram light railways (syndicate), construction of two lines; Southowram and Elland light railway (syndicate), construction of six lines; Crowland and District light railways (company), extension of time.

THE STERLING DIRECT-CURRENT MOTOR.

The Improved Electric Glow Lamp Company have taken up the manufacture of motors on lines which, commercially, must be acknowledged to be correct lines. Thus the company are making only two sizes of frames, and these will be reproduced in great quantities. The frames being stocked, and also standard windings for the same, the firm will be able to give very prompt delivery. The winding will be varied to suit standard voltages and speeds, and made so interchangeable that at a small cost the voltage of the motor can be altered to suit changes in standard pressure of supply. The sizes of frames chosen are such that one gives ½ h.p. at the rather slow speed of 1,200 revolutions per minute, and the other ¼ h.p. at 1,000 revolutions per minute, and with a very high efficiency and large overload capacity. These speeds are well suited for direct belting to ordinary line shafts and many types of machines without the use of countershafts, gears, or other speed-reducing devices.



The illustration shows the general appearance of these motors. Another good feature in the list before us of the Sterling motors is that the prices include automatic release starting switches.

BLACKBURN ELECTRICITY WORKS.

The accounts of the Blackburn Corporation electricity department show a total expenditure on capital account to March 25 last of £117,724. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Dr.	Revenue Account.	£	s.	d.
Coke, coal, etc.		4 326	7	5
Oil, waste, water, and stores		372	7	11
Wages at generating station		1,283	14	6
Repairs and maintenance of buildings		34	14	4
Boiler and engines		428	2	2
Maintenance of accumulators		43	4	5
Repairs and maintenance of mains		115	18	3
Repairing meters		157	5	6
Lamps, carbons, and fittings, etc.		600	11	7
Rent of works and income tax		690	0	0
Salaries of engineer and assistants		687	10	0
Clerks and meter inspector		313	13	0
Stationery and printing		62	9	4
General charges		210	2	7
Auditors		5	0	0
Insurance		37	0	0
Bad debts		15	0	4
Total expenditure		9,383	1	4
Balance of revenue account		5,082	2	1
		£14,465	3	5

Cr.	£	s.	d.
Sale of current, less discount	13,051	15	11
Rental of meters	346	0	11
Rental of motors and lamps	295	12	3
Fees for testing	6	10	0
Sales of lamps, fittings, etc.	765	4	4
	£14,465	3	5

General Balance-Sheet.

Expenditure and Assets.	£	s.	d.
Capital account—amount expended for works	117,724	10	1
Stores on hand	1,507	10	8
Sundry debtors for current supplied	4,669	6	9
Sundry persons for lamps and fittings	713	6	10
Balance at debit of net revenue account	1,439	10	7
	£126,054	4	2

Liabilities.	£	s.	d.
Capital account—amount received	84,599	3	10
Sundry creditors for coal and stores	4,360	2	10
Amount owing for interest on loans	300	8	7
Amount owing bankers less in hand	28,733	17	4
Sinking fund account—amount uninvested	1 660	11	7
Surplus	6 400	0	0
	£126 054	4	2

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			1,303,498
Quantity sold	Public lamps	179,780	1,159,881
	Private consumers by meter	1,080,081	
Quantity used on works			42,116
Total quantity accounted for			1,201,977
Quantity not accounted for			101,521

Number of public lamps: arcs, 80; incandescents, 248. Total maximum supply demanded, 1,112 kw.

WIMBLEDON ELECTRICITY WORKS.

From the accounts of the Wimbledon electricity department, it appears that the total expenditure on capital account to March 31 amounted to £67,928. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Revenue Account.

Dr.			£	s.	d.
Generation of Electricity.					
Coal or other fuel	£3,183	6 6			
Oil, waste, water and stores	311	10 8			
Wages at generating station	751	14 9			
Repairs and maintenance of buildings and plant	292	0 10			
			4,538	12	9
Distribution of Electricity.					
Wages and other remuneration	11	1 5			
Repairs, etc., of mains	74	4 8			
Repairs, etc., of transformers, etc.	0	4 2			
Repairs, etc., of apparatus	19	15 8			
			105	5	11
Public Lamps.					
Attending and repairs	434	12 9			
Renewals of lamps	76	13 4			
			511	6	1
Rents, Rates, and Taxes.					
Rents payable	1	16 6			
Rates and taxes	103	6 8			
			105	3	2
Management Expenses.					
Salaries—Engineers' department	606	5 10			
Accountant and clerical staff	184	11 5			
Stationery and printing	113	5 9			
General establishment charges	120	16 5			
			1,024	19	6
Special Charges.					
Insurances, etc.	52	7 9			
Expenses for certification of meters	0	10 6			
			52	18	3
Total expenditure			6,338	5	8
Amount carried to net revenue account			3,170	3	8
			£9,508	9	4

Cr.	£	s.	d.
Sale of current per meter, less allowances	9,346	4	9
Rental of meters, etc.	162	5	4
	£9,508	9	4

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GENERAL BALANCE-SHEET

Dr. Liabilities.	£	s.	d.
Capital account—amount received	67,928	2	4
Sundry creditors	2,090	4	9
Due to treasurer on revenue account	2,858	13	6
	£72,877	0	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	57,703	5	9
Stores on hand	1 886	6	6
Sundry debtors for current supplied	2,858	13	6
Cash with treasurer and in hand	10,428	14	10
	£72,877	0	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		724,028
Quantity sold: Public lamps 415,304; Private consumers by meter 229,117·4		644,421·4
Quantity used on works		18,780
Total quantity accounted for		663,201·4
Quantity not accounted for		60,826 6
Total maximum supply demanded (kilowatts)		367

Number of public lamps 903, equivalent to 4,128 8-c.p. lamps.

BARROW-IN-FURNESS ELECTRICITY WORKS.

From the accounts of the Barrow-in-Furness electricity works it appears that the total expenditure on capital account to March 31 amounts to £37,839. The following is an abstract of the revenue account:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	2,066	0	5
Distribution of electricity	127	14	7
Private mains and services	56	5	9
Public lamps	71	19	2
Rents, rates, and taxes	151	0	0
Management expenses	489	3	2
Special charges—insurance premiums	34	14	7
Amount transferred to net revenue account	896	15	8
	£3,883	13	4

Cr. Income.	£	s.	d.
Sale of current	3,493	17	8
Public lamps	322	10	0
Private mains and services	67	5	8
	£3,883	13	4

HANLEY ELECTRICITY WORKS.

From the accounts of the Hanley Corporation electricity works (just issued) it appears that the total expenditure on capital account to Dec. 31, 1900, amounted to £73,330. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., for the past year:

REVENUE ACCOUNT.

Dr. Generation of Electricity.			£	s.	d.
Coal or other fuel, including carriage, etc.	£3,134	4 2			
Oil, waste, water, and stores	272	13 1			
Wages at generating stations	988	6 0			
Repairs and maintenance of buildings, plant, etc.	1 042	16 1			
			5,437	19	4
Distribution of Electricity.					
Wages to linesmen, etc.	65	5 6			
Maintenance of mains	38	18 6			
Maintenance of meters, etc.	238	1 8			
Maintenance of apparatus	105	0 2			
			447	5	10
Public Lamps.					
Attending and repairs	335	12 11			
Renewals of lamps	298	6 3			
			633	19	2
Rates and taxes			753	0	11
Management Expenses.					
Salaries—engineers' department	592	14 10			
Stationery and printing	44	2 4			
General establishment charges	42	19 7			
			679	16	9
Law and Parliamentary Charges.					
Law expenses	27	12 7			
Less returned	13	8 3			
			14	4	4
Special Charges.					
Insurances, etc.			43	6	3
Total expenditure			£8,009	12	7
Amount carried to net revenue account			3,630	13	8
			£11,640	6	3

Cr.	£	s.	d.
Sale of current per meter	9,714	8	0
Public lighting	1,639	0	0
Rental of meters and other apparatus	286	18	3
	£11,640	6	3

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	68,990	0	0
Overdraft on account of loans sanctioned	4,340	3	2
Sundry creditors	836	13	11
Balance due to general district rate account	641	9	3
Sinking fund account	7,786	3	6
Balance	2,866	12	8
	£85,461	2	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	73,330	3	2
Stores on hand	426	8	4
Sinking fund account	7,786	3	6
Sundry debtors for current supplied to Dec. 31, 1900	3,833	7	7
Other debtors	84	19	11
	£85,461	2	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated, B.T. units		740,664
Quantity sold: By public lamps 112,481; Private consumers by meter 530,719		643,200
Quantity used on works		11,575
Total quantity accounted for		654,775
Quantity not accounted for		85,889
Number of public lamps		156
Total maximum supply demanded (kilowatts)		634

MORLEY ELECTRICITY ACCOUNTS.

From the accounts of the Corporation electricity department for the year ended March 31, 1901 (just issued), it appears that the total expenditure on capital account to date amounts to £24,181. We give herewith abstracts of the revenue accounts and general balance-sheet:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,135	16	7
Distribution of electricity	38	9	10
Attending and renewals of lamps	82	10	8
Rents, rates, and taxes	62	10	0
Management expenses	332	14	9
Special charges—insurance, etc.	10	16	0
	£1,662	17	10

Cr. Income.	£	s.	d.
Sale of current, less discounts	932	11	11
Received for public street lamps	346	0	0
Rent of meters	39	14	0
Repairs of apparatus, etc.	7	9	8
Cost of steam supplied to public baths	190	5	0
	1,516	0	7
Balance carried to net revenue account	146	17	3
	£1,662	17	10

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans	22,500	0	0
Amount due to treasurer	4,141	12	3
	26,641	12	3
Surplus, sinking fund, and stores, less deficit on revenue account	463	13	4
	£27,105	5	7

Cr. Assets.	£	s.	d.
Amount expended on works	24,181	4	8
Sinking fund	1,907	8	6
Miscellaneous accounts due	458	4	1
Stores in hand	558	8	4
	£27,105	5	7

ST. PANCRAS ELECTRICITY ACCOUNTS.

The following is the report of Mr. Albert E Pycraft, chief clerk to the St. Pancras Borough Council, on the working of the electric lighting department during the past year. Abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., are also appended:

During the year a loan of £24,320 has been received, making the total amount received at Dec. 31, 1900, by loans of £261,100. Of this amount a sum of £21,186. 14s. 3d. has been repaid. A loan of £77,111 in respect of capital expenditure to the end of

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1899 was applied for to the London County Council in June last, but up to the present has not been received. The expenditure incurred during the year on account of capital amounts to £50,248. 2s. 1d., making a total capital expenditure of £336,794. 14s. 1d. The gross revenue for the year amounts to £49 329. 10s. 2d., an increase over the year 1899 of £4,449. 3s. 2d. This is accounted for by an increase of £3,207. 7s. 8d. received for public street lighting in consequence of an additional 198 public arc lamps having been erected during the year (equal to an increase of 87 per cent.), and £1,241. 15s. 6d. on account of private lighting, etc. The small increase from private consumers is due chiefly to the reductions made in the charges for supply since June, 1900. The total units sold during the first half of the year was 1 056 613, and realised per unit sold 4 48d., and for the second half 1,239,773 units, equal to 3 63d , the difference in price representing a money value of £4,390. 17s. 3d. The result of the year's trading is accounted for by several special circumstances: (1) The reductions in the charges for supply as above (2) The increased price for coal. The average increase in the price of coal over the year was 3s. 3d. per ton, the total consumption being 12,026 tons, representing a money value of £1,954. 4s. 6d. (3) Exceptional charges in connection with alterations carried out at Regent's Park Station, amounting to £944. 19s. 3d. The following table shows the progress of the electricity undertaking since the commencement:

Year ending Dec.	No. of consumers.	Current sold to consumers (not including public street lighting). 3d. per unit. £ s. d.	Current sold to consumers (not including public street lighting). 4d., 5d., and 6d. per unit. £ s. d.	No. of lamps etc., applied for. Incandescent. 16c.p.	No. of lamps etc., applied for. Arc.	No. of lamps etc., applied for. Motors.
1892	172	—	8,167 7 8	9,990	82	11
1893	288	384 11 6	9,161 6 0	12 851	110	19
1894	349	1 236 13 9	10.819 15 9	15,542	129	22
1895	447	2,142 9 6	12,682 6 0	19,195	139	37
1896	672	2 948 14 9	19,430 8 8	26 423	187	47
1897	808	4,081 10 0	25,220 11 5	32,250	256	78
1898	984	8 415 0 0	23 446 5 2	38 124	292	91
1899	1,184	11,699 12 3	25 992 17 6	46,172	315	126
1900	1,438	12,563 16 7*	25,914 5 9	57,456	426	152

* 2d. and 3d. per unit.

Revenue Account.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£13 342 12 6	
Oil, waste, water, and stores	1,268 7 11	
Proportion of salaries of engineers	495 5 3	
Wages at generating stations	3,463 2 6	
Sundry petty expenses	171 7 3	
Repairs and maintenance: buildings, £150. 13s. 7d; engines, boilers, etc., £1,922. 19s. 5d.; dynamos, £879. 18s 11d.; other machinery, £166. 12s. 1d.; less received for old materials, £7. 1s.	3,113 3 0	21,853 18 5
Distribution of Electricity.		
Proportion of salaries	172 17 7	
Wages of outdoor staff	999 0 9	
Repairs, maintenance, etc., of mains, including materials, labour, and tools	2 400 2 6	
Repairs, etc., of meters	716 7 10	
Works in connection with public buildings installations	384 14 10	
Water, etc., at sub-stations	5 4 6	4,678 3 0
Public Lamps.		
Carbons	543 19 0	
Repairs	444 14 5	
Attending	852 6 9	1,841 0 2
Licenses and wayleaves		24 5 0
Rent, Rates, and Taxes.		
Rents payable	126 17 10	
Rates and taxes	1,445 8 0	1,572 5 10
Management Expenses		
Salaries—engineer's department	1,807 10 8	
Stationery and printing	284 12 1	
General establishment charges	307 15 0	2,399 17 9
Law expenses		15 8 8
Special Charges.		
Insurances, etc.	275 18 1	
Fees, testing meters	0 15 0	
Expenses obtaining loans	30 17 0	
Compensation claims	66 18 3	
Alterations to engine-room and dismounting and re-erecting plant at Regent's Park station	234 18 3	
Amount written off boilers transferred from Regent's Park to King's road station	710 1 0	1,319 7 7
Total expenditure		33,704 16 5
Balance carried to net revenue account		15,624 13 9
		£49,329 10 2

Cr.	£ s. d.
Sale of current per meter at 6d. per B.T.U.	21,071 11 0
,, ,, 5d. ,,	3,161 10 5
,, ,, 4d. ,,	1,681 4 4
,, ,, 3d. ,,	7,669 0 9
,, ,, 2d. ,,	4,894 15 10
	38,478 2 4
Public lighting (sale of current, all charges)	9,847 5 4
Indicator rentals	134 5 0
Sundry chargeable works	580 3 6
Fees for testing installations	12 0 0
Rents receivable, £292. 10s. 11d., less repairs, rates, and taxes, etc , £164. 16s. 11d.	127 14 0
Proportion of office expenses chargeable to the lighting (gas department)	150 0 0
	£49,329 10 2

General Balance Sheet.

Dr. Liabilities.	£ s. d.
Capital account—amount received	261,100 0 0
Amount received on loan from bankers	63,850 4 8
Sundry creditors	16,870 8 10
Amounts due under contracts	13 861 11 4
Interest accrued on loans	2,480 17 11
Net revenue account	4,056 6 3
Reserve fund	9,083 1 9
	£371,302 10 9

Cr. Assets.	£ s. d.
Capital account—amount expended for works	336,794 14 1
Stores in hand: coal, £994. 9s. 5d.; oils, waste, etc., £184. 5s.; carbons, £142. 4s.; general, £5,504. 11s.	6,825 9 5
Debtors for current supplied. £17,111. 16s. 2d.; less deposit account, £509. 6s.	16,602 10 2
Sundry debtors	222 0 6
Amounts due on account of public street lamps	10,121 11 7
Suspense account	658 8 10
Cash in hand	77 16 2
	£371,302 10 9

Statement of Electricity Generated, Sold, etc.

Quantity generated (in Board of Trade units)	3,637,309
Quantity sold { Public lamps 712,095; Private consumers by meter 2,296,386 }	3,008,481
Quantity used on works and testing-room	218,014
Total quantity accounted for	3,226,495
Quantity not accounted for	410,814
Number of public lamps	426
Total maximum supply demanded (kilowatts)	2,275

CATALOGUES RECEIVED.

Messrs. Mavor and Coulson, in issuing a new list of the various machines manufactured in their electrical shops, commence the same by instructing their customers how to ask for an estimate. We can quite believe that there is a great necessity for this, and that large firms like the above have to waste a great deal of time and money in preparing estimates which are based on assumptions as to local conditions. It is always much more satisfactory if the would-be customer would give a sufficient description of what the electrical plant has to do to enable firms to give a reliable and close estimate. In this catalogue we find descriptions and lists of a great variety of direct-current plant suitable both for belt driving or for direct coupling. As the firm are doing much work in electric motors for workshop distribution, or for use in collieries, we are not surprised to see in the catalogues a description of a number of electrically-driven accessories. The list is completed by a description in full detail of the Mavor and Coulson C.C. system of concentric wiring.

We have received from Messrs. Mather and Platt, Limited, who have their works in Machester and their London office at 14, Victoria-street, Westminster, a copy of the fourth edition of their catalogue. Besides containing a list of the plant manufactured by this pioneering firm, there is also included in the little volume some useful tabular matter such as is often required by an electrical engineer when working out schemes. The lists of dynamos and motors which are given are most complete, and, in addition to the prices, information as to the space occupied and the weights of the parts are added. Not the least useful portion of this pocket catalogue are those devoted to the electrically-driven specialities manufactured by the firm.

The Berliner Telephone Manufacturing Company, whose agency in this country is worked from 117, Queen Victoria-street, have forwarded to us a copy of their last list of telephones and telephone accessories. A recapitulation of the numerous articles connected with telephone exchanges which are included in this list, would lose interest on account of its great length. The completeness, however, of the list, might be summed up in a few words, by saying that everything required for telephoning is included, except the lady operator.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

383. I have charge of an installation comprising gas-engine and shunt dynamo of about 8 kw., voltage 100. There is also a battery of 53 cells. I wish to charge up 20 new cells. What is the best means of obtaining a steady current at reduced voltage?—A. R.

384. How would you start the design and the general design of a 1,000-watt four-pole dynamo with slotted armature, 1,000 revolutions, 100-150 volts? I know the general workings, such as construction of commutator, armature, bearings, etc., also a knowledge of the magnet and electrical calculations, but have had no experience in the designing of electrical machinery.—W. H. H.

ANSWERS.

Question No. 377.—The supply from a large station fails suddenly near the maximum load through the breakdown of an armature. The output at moment of failure is 2,000 kw. from a number of shunt-wound direct-current machines in parallel. How would you restart the supply so as to restore normal pressure in quickest possible time?

Answer to No. 377 (*awarded 7s. 6d.*).—The best way to start up after a total failure such as that described in the question will depend largely on the way the machines are excited. There are three common modes of arranging the exciting circuits for direct-current generators: (1) the shunts of all dynamos connected to the lighting 'bus bars; (2) shunts connected to a battery; (3) shunts supplied from a special engine and dynamo.

All three methods have certain disadvantages. Methods (2) and (3) are objectionable by reason of the fact that the interruption of the circuit supplying the exciting bar breaks the exciting circuit of all the generators. Of the two methods, excitation from a battery is to be preferred, as less liable to interruption if the battery is used for that only; but the cells should be lead lined in wooden cases to avoid risk of a glass cell breaking. Method (1), which was the method almost universally used in the early days of the supply industry, is open to several serious objections which seem to be contemplated by the question.

Inasmuch as the failure described would hardly have occurred had either of the two last methods of excitation been in use, we shall assume that the fields of all the dynamos are excited from the 'bus bars, which, of course, are always maintained at the proper pressure. In this case the result of a serious short is to more or less demagnetise all the machines by reducing the resistance of the external circuit to a very low amount. The action is further aided by the fact that a large demand is made for current from the machines that are running, which tends to make the output of current from each machine greater than its critical value. If this is exceeded, the drop in volts is so great that the excitation is rapidly diminished, and the two actions react on one another, until in a few seconds the dynamos may be running round without generating any power. They have lost their fields. In such circumstances the first thing to be done is to make the machines excite, and to do this it is necessary that the external resistance should be increased. The generators must be switched off, and run at full speed until they do excite and give normal voltage. If they could be *all* switched in at exactly the same moment fully excited, it is possible that the supply might be restored, but as this cannot be done practically, we must increase the external resistance till it is of such a value that one of the dynamos can safely give the current demanded. This can be done by disconnecting the near feeders, leaving, perhaps, only one of the furthest connected. The dynamo is now switched in, and the other machines switched in parallel as quickly as possible, more feeders being switched on as the dynamos are put in parallel, until all the machines will be taking their normal load.

Should any method of separate excitation be in use, when the failure occurs great care must be taken that no dynamo is switched on until the short has been removed. Assuming there has been a failure, it will not be safe to switch a 500-kw. machine on to a load that was previously taken by, perhaps, five similar machines in parallel, so that some of the load should be thrown off as above described before the generator is switched in. In the case of separate excitation, however, we might proceed in another way. If it were possible to vary the exciting volts from normal down to a very small value, the machines should be run at proper speed (all of them), with armature switches closed and the exciting circuit volts gradually built up, when all the machines would increase their output in about the same proportion, so that no machine would be called upon to carry an excessive load. If the exciting circuit voltage cannot be varied, the plan of running up all the machines simultaneously might be tried, the fields being fully excited, but it would be much more difficult to keep the different units properly loaded in this case. By the methods detailed above it should be possible to restore normal pressure in less than 10 minutes, though it is quite probable that it would take 20 minutes or more. The fact that the works are in darkness in such cases does not add to the ease or celerity of righting matters.—E. D. W.

Answer to No. 377 (*awarded 7s. 6d.*).—The failure of the supply due to the breakdown of an armature might be brought about either by the operation of the "minimum" cut-outs on the remaining machines—*e.g.*, the well-known incident at Brighton a good while ago—or else by the working of the "maximum" cut-outs of the same machines, according to which kind of safety devices they are fitted with, and depending also on the characteristic curves of these machines. If there be a battery connected to the 'bus bars, it should be provided with a "maximum" cut-out, or else it would be probably ruined by the excessive current it would be called upon to supply. Well, the first thing to do is to get some light on the subject: this may be quickly done by switching the station lights on to the battery; if there be no battery a couple of oil hand lamps should be always kept in a certain place where they are easily found, and should be ready for use at a moment's notice. In some stations a small machine is kept running of the stoker-gear shafting, and is of sufficient capacity to keep the works' lights going. Throw-over switches would have to be operated in this case also. It would be very bad policy to switch in a single machine on to the load, as one of two things would happen: either the armature might be burnt out (as was the case at Aberdeen a short time ago), as well as the engine being severely strained by the sudden rush of current, or else the dynamo, being shunt wound, would lose its excitation on being so much overloaded, both cases depending upon the capacity and the characteristic curve of the machine. The best thing to do, therefore, would be to simultaneously parallel two or more of the larger sets of the running plant; to this end they should be got to approximately equal voltages, and the switchboard attendant should have an assistant on the board to switch in simultaneously. It would be advisable to parallel them at a rather low voltage, so as to reduce as far as possible the inevitable strain on the engines when put on the 'bus bars. These machines would be able to carry the load at a somewhat reduced voltage while an additional set is being paralleled, and having got all the original plant running again except the broken-down set, the "stand-by" for the evening (the engine having been previously warmed up) should be run up to replace the disabled machine, which would have been shut down in the meantime. Of course, the rapidity of these operations would depend upon the presence of mind and resource of the shift engineer, whose mind should be fairly well trained as to what to do in the event of a general breakdown; as a

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rule, however, a cut-and-dried scheme flies to the winds when a "bust" is in progress, and very often the engineer simply does the first thing that occurs to him.—D. J.

Answer to No. 377 *(awarded* 5*s.).*—It is not quite clear from the question how the armature of one machine failing should completely stop the supply, for in nearly all present-day stations the machines are in circuit with a maximum or minimum cut-out or fuses, or both, so that when the machine broke down the minimum would open, and the other machines would take up the load. If, however, the machine which broke down was a much larger set than the others, the over-load might be too great for them, and would open their maximum cut-outs or blow the fuses. From this it will be seen that it is no good to close the switches of the machines in the ordinary way when they are at correct voltage. I think the only safe way to start up is to get each engine on the stop valve running at a speed so that it will give about 10 volts; if the supply is at 440 volts, and the load 2,000 kw., the resistance of the load would be ·096 ohm; therefore, when the switch was closed, 104·2 amperes would be flowing. It can then be run up till it is nearly taking its full current; the other machines can then be paralleled with it (of course, at the lower voltage). When sufficient machines are in, the voltage will be correct; each machine as it is paralleled in raises the voltage a little.

It must be remembered that the load coming off so suddenly will cause a good deal of difficulty in the boiler-house through the steam blowing off, so that it would be advisable to let each machine run full speed till you are ready to put it in, when it will have to be slowed down to get the low voltage. If the machines are excited off the 'bus bars, all the shunt wires are connected to one of the horizontal bars, in which case the machines and feeders must be plugged on to that bar, and the machines will then excite themselves. If a battery is in use, it may be used to excite the machines by plugging it on to the bar to which the shunt wires are connected, provided that this bar is not feeding the town, as the battery must on no account be put on to the town till the normal voltage has been restored. If a motor balancer is used, it will be unnecessary to start it until the correct voltage has been reached on either of the sides.—C. L. E. S.

Question No. 378.—What is the best metal to make fuses of, and what is the best form for them to take on a main 500-volt switchboard carrying large currents?

Best Answer to No. 378 *(awarded* 10*s.).*—Fuses operate when the current is largely in excess of the normal, and in case of a short-circuit have to break a high E.M.F. Every fuse must be capable of breaking a "dead short" quickly, and without damage to contacts, etc., hence some effective means of suppressing the vicious and destructive arc often formed is imperatively necessary. Now, the gap bridged by the fuse is filled at the moment of breaking circuit with metallic vapour, and the most successful fuse, generally speaking, will be one which gets rid of this metallic vapour most quickly and effectively. It is also essential that a fuse should go *quickly* on a short-circuit. Experiments to ascertain what metal gives the quickest break have not, as far as the writer is aware, been made, but he has found that with a 230-volt short through four fuses, two of No. 22 copper (fusing current 60 amperes), and two of No. 14 tin (fusing current 37 amperes), the copper fuses are *always* blown, while the tin fuses sometimes go and sometimes do not. In another test, with one fuse No. 24 tin (fusing current five amperes), one two strands of No. 30 copper and two fuses of 22 copper, *all* the fuses were blown, apparently simultaneously.

Now, other conditions being equal, the metal which is least bulky should produce the smallest amount of vapour, and the metal which is the best conductor should break a given current quicker than a worse conductor, as the former may be so much smaller, and have, therefore, less radiating surface. Now, of the commoner metals the only one fulfilling both these conditions is copper, and in practice copper has been found to be by far the most satisfactory all-round metal for fuses.

Up to 300 or 400 amperes a number of copper wires in parallel will be quite reliable. For currents greater than this the use of magnetic cut-outs is to be preferred. If these are used one on each pole, preferably some distance apart, they form a very reliable and safe arrangement, as should a short not be cleared, on restoring the circuit the cut-out first set will break the circuit as soon as the other is reset. The most successful methods of suppressing the arc formed on breaking large currents at 500 volts pressure are: (1) using metals whose vapour will not sustain an arc; (2) interposing large masses of refractory material in and about the path of the arc to cool it; (3) arranging bridges of insulating and refractory material between the poles; (4) placing the fuse in a magnetic field which blows out the arc formed; (5) blowing out the arc by a current of air; (6) quenching the arc by covering the contacts with insulating oil of high flash-point at the instant of breaking. Probably (4) is the most satisfactory arrangement for continuous currents under the conditions laid down in the question.

It is often necessary to rig up a fuse from materials to be found in every station, and in such case a very satisfactory fuse can be made by clamping a strip of tin or copper sheet to two copper blocks about 4in. to 6in apart, and placing a good thick slate bridge between them. The bridge must protrude above the highest portion of the terminals (generally the bolt heads) at least 2in., and the strip is led *over* the bridge. Copper clamping pieces are used between the strip and the bolt heads to ensure good contact all over.—E. M.

Answer to No. 378 *(awarded* 5*s.).*—A copper wire makes the best fuse for large currents—in fact, all fuses for above 10 amperes ought to be copper; if copper is employed for currents below this, the wire is so slight that it is liable to get stretched or cut by the binding screw. Tin or lead should be used for smaller currents, as it has a larger

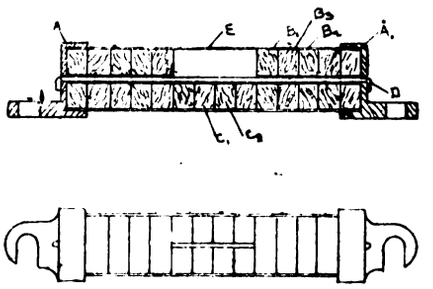

FIG. 1.

section than copper for the same current, thus not being so liable to get damaged. In designing a fuse, the terminals must be so arranged that it is impossible for an arc to form when the fuse "goes." This can be done by arranging the terminals sufficiently far apart. This should never be less than 1¼in., the distance increasing with the voltage. The curve below Fig. 3 gives the distance apart in inches for a given voltage. The fuse can also be improved by inserting a baffling plate (as in Fig. 2) between the terminals. Fig. 1 gives a type of fuse suitable for current up to 20 amperes

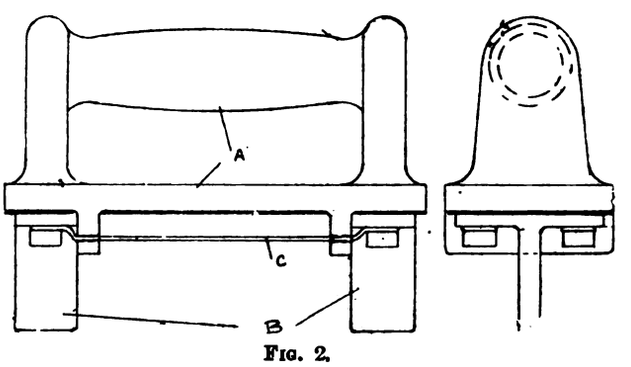

FIG. 2.

and 500 volts. Fig. 2 is more suitable for a lower voltage and heavy current: A, porcelain casting; B, terminals and male contacts; and C, the fuse wire. In the type shown two fuse wires may be used.

In Fig. 1, A is the terminal, shaping, or casting; B_1 B_2, asbestos disc; the centre ones, C_1 C_2, are half disc, so made for inspection; D, fuse wire; E, mica sheet rolled in the

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form of a tube (glass may be used, but it is dangerous, as it might "fly" if a big short comes on). Mordey uses a glass tube with a dry powder in place of the asbestos.

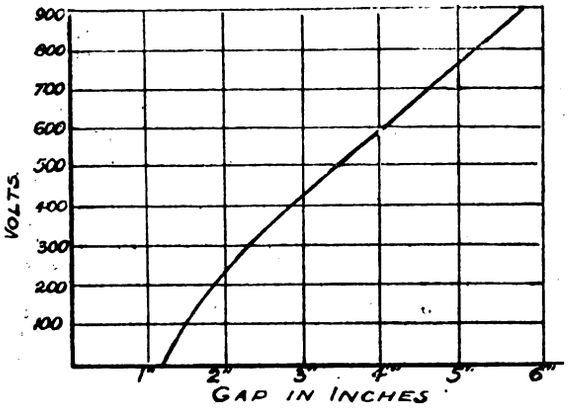


FIG. 3.

The powder will stop arcing This would not be practical for large fuses, so Weston places two fuses in parallel, one bare, the other, a small one, covered with powder. The larger one "blows" first, the small one stopping the arc. This, of course, will blow in turn, but the powder stops the arc. Table I. gives the *fusing* current of copper, tin, and lead wire; 25 per cent. must be taken off the fusing current to get a working current.

TABLE I.

Current in amps.	Copper. S.W.G.	Tin.	Lead.	Current in amps.	Copper. S.W.G.	Tin.	Lead.
1	47	36	35	60	21	11	10
2	43	31	30	80	20	10	9
3	41	28	27	100	19	8	7
5	38	25	23	120	18	7	6
10	33	21	20	150	16	5	4
20	28	17	16	200	15	3	2
40	23	14	13	300	13	5	4

T. W. S. H.

Answer to No. 378 (*awarded* 5*s.*)—The best material to make fuses of is undoubtedly pure copper wire, but in practice ordinary commercial tinned copper wire is found to meet all requirements. Fusible cut-outs composed of tin or lead and tin alloys are altogether unreliable and uncertain in their action, the reason being that the material in the course of exposure to the heating effect of the current, and to the deleterious action of the atmosphere,

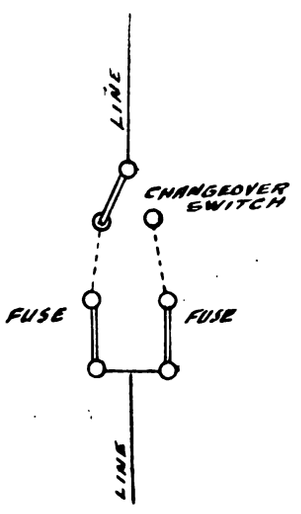
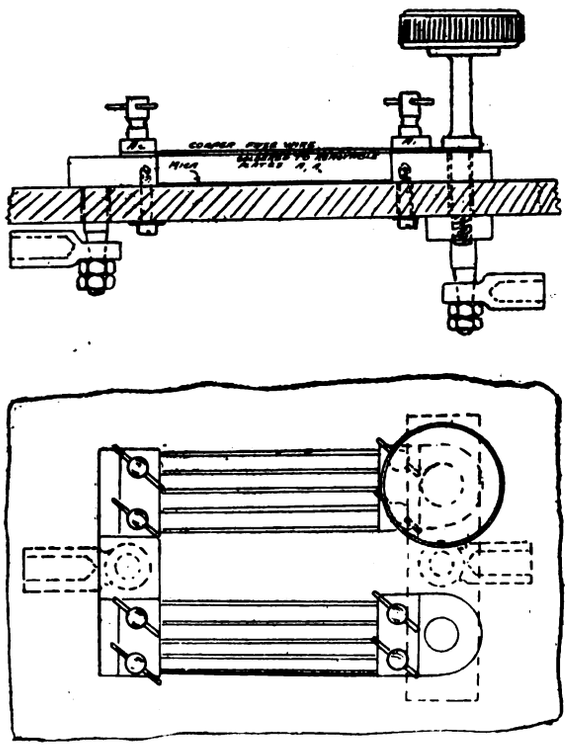


FIG. 1.

forms on its surface an infusible skin, which in its turn considerably raises the melting temperature of the fuse as a whole. It thus frequently happens that serious damage is done to the mains or armature coils before the current is broken. As the excess of current that a fuse will carry over and above that for which it has been calculated is an ever-varying quantity, depending upon local conditions, it is necessary to use a material which is only slightly acted upon by outside influences, and copper, as before mentioned, is found to be suitable in this respect.

In arranging fuses to carry large currents at 500 volts, the following points should be carefully attended to when fitting up on the switchboard: (*a*) The terminal blocks should be of ample section and contact area to avoid heating. (*b*) The fuses themselves should be arranged at the bottom of the board and protected from the marble or slate by a sheet of mica or other suitable material; by doing this damage from molten metal is not incurred. (*c*) The fusible material should be in several strands, and separated as far apart as possible to allow of cooling by means of the circulation of air. (*d*) In all cases fuses should be so designed to allow of easy and expeditious replacement.

A satisfactory method of doing this is to arrange the fuses in duplicate, connecting two terminals to one common sweating thimble and the two other terminals to the two connections of a change-over switch, as shown diagrammatically in Fig. 1. A combined duplicate fuse and two-way plug switch for heavy currents is shown in Figs. 2 and 3.



FIGS. 2 AND 3.

Assuming that the fuse is to be designed to blow at 400 amperes, the strands of copper wire being five in number, as shown in the sketch, each strand must, therefore, carry at the instant of fusing $\frac{400}{5} = 80$ amperes. The diameter of a copper wire to fuse at this current may be found from the formula $d = \left(\frac{C}{a}\right)^{\frac{2}{3}}$, where d = diameter of wire, C = current, a = constant, that for copper being 10,244.—F. H R.

Answer to No. 378 (*awarded* 5*s.*).—Lead and its alloys are being gradually discarded as fuse material in favour of copper. There are many reasons for this, some of which are as follows: Lead fuses always require the use of spring terminals, as with ordinary screw-down terminals the contact is certain to become loose owing to the alternate heating and cooling, as the current varies, and the non-elastic character of the lead. A lead fuse also deteriorates more rapidly than a copper one, partly due, perhaps, to a peculiar effect in large lead fuses—namely, that the metal in the interior of the fuse often assumes a semi-liquid state due to heating, the fuse only being prevented from blowing by the cooler outside crust. A copper fuse will also stand considerably more overload for a short time than a lead one, but will cut out equally well in case of a sudden short. Again, in small sizes, copper fuses are not so liable to be injured by stretching, etc., while being replaced in

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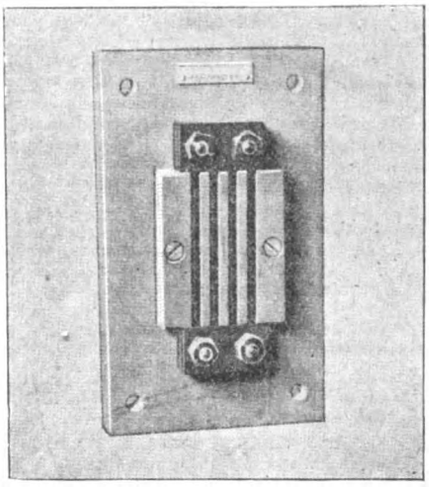
a hurry, as are those made of softer metals. A very good form of multiple cut-out for heady currents is made by Messrs. Cowans, Limited, of Salford, of which a sketch is given. It consists of two massive terminal blocks on the usual enamelled slate base. Between these terminals is a slab of plain slate with four deep grooves in which lie the copper strands which form the fuse, one in each groove. The advantages of this form are that there is no great splash of molten metal when the fuse blows, and the enamelled slate is not injured, as it is protected by the grooved slab, and the arc is chilled at the instant of forming by the cold slate which surrounds it on three sides. This is, of course, a low-tension form of cut-out up to, say,



600 volts; other ingenious devices for higher pressures do not come within the scope of the question.—G. D. L.

PHYSICAL SOCIETY.

At the ordinary meeting held May 31, Prof. S. P. Thompson, president, in the chair,

A paper "**On the Resistance of Dielectrics and the Effect of an Alternating E.M.F. on the Insulating Properties of India-rubber**," by **A. W. Ashton** was read by Prof. Fleming. The author has obtained from his experiments formulæ for the charging and discharging currents of a condenser with rubber dielectric. The currents are exponential functions of the time. Curves for various potential differences have been plotted and were exhibited. These curves show that the insulating properties of rubber are increased by the application of high alternating E.M.F.'s. Prof. Fleming then read a note by Mr. Ashton '**On the Electrification of Dielectrics by Mechanical Means.**" A sheet of pure Para rubber was placed in a condenser, the plates of which were connected to a quadrant electrometer. A 2lb. weight was then dropped on to the condenser from a height of 3in. The electrometer received two impulses of opposite sign, one quickly following the other. The rubber was then stretched while in position, and a potential difference of seven volts was shown between the plates, the top plate being negative. The condenser and electrometer were then discharged, the sheet reversed, and the experiment repeated. The same effect was produced, the top plate again being negative. It appears, therefore, that polarisation of a dielectric being thus produced by mechanical energy, some part of the mechanical energy expended on the indiarubber during manufacture would remain in the dielectric as electric energy. "**A Model which Imitates the Behaviour of Dielectrics,**" by Prof. Fleming and Mr. Ashton, was exhibited by Prof. Fleming. The behaviour of dielectrics with regard to their residual charge is analogous to that of wires subjected to mechanical stress. A simple twisted wire is not, however, able to imitate all dielectric effects, and the present paper describes a model which represents things more completely. Six pistons separated by springs are placed inside a vertical cylinder. The bottom piston fits fairly tightly in the cylinder. The second piston fits slacker than the first. The third piston has a small hole in it, and each succeeding piston has a greater area cut away, the top piston having just sufficient metal left to make the spring come to rest without vibration after being compressed. The cylinder is filled with machine oil and vaseline. To the top piston is attached a rod, by means of which pressures can be exerted on the pistons for any length of time. This represents the charging of the condenser. The motion of the rod after releasing the weights represents the discharge of the condenser. This is registered graphically by a revolving drum, and the curves obtained are very similar to those from condensers with dielectrics.

Prof. Ayrton said he would like to know in what respect the model shown was superior to a strained wire. He had noticed about 10 years ago that alternating E.M.F. s appeared to improve condensers. He was then working with comparatively small voltages, and he was interested to know that Mr. Ashton, working with high voltages, had established the improvement. The deflection obtained by stretching the indiarubber sheet might be due to changes in temperature, the dielectric having a high thermo-electric power.

Mr. Price was glad that the question as to what actually might be called the resistance of a dielectric had been raised. There are two theories of residual charge—one due to Maxwell, and the other to Heaviside. The model exhibited represents Maxwell's theory. He considered that the electrometer experiment with the rubber dielectric favoured Heaviside's theory—that is, that the dielectric is composed of small charged bodies similar to the small magnets conceived to constitute a magnet. He expressed his interest in the fact that the top plate of the condenser was always negative.

Mr. Blakesley suggested putting a small hole in the bottom piston of the model, so that it might represent a condenser passing a small steady current. With regard to the stretched-rubber experiment, he said it would be interesting to make observations with the plates of the condenser vertical.

Mr. Campbell said he had made experiments, and found that the change in capacity of the rubber condenser affects the voltage sufficiently to mask the real effect.

Mr. Appleyard said it was important to have perfect contact between the dielectric and the metal plates.

It was pointed out by a visitor engaged in the cable industry that manufacturers are aware that pressure affects the insulating properties of guttapercha. Rubber is a mixture, and different rubbers behave differently under the action of alternating potential differences.

The **Chairman** said that if the quantity of electricity taken in on charging was equal to the quantity given out on discharge, then there could be no dielectric hysteresis.

The society then adjourned until June 14.

COMPANIES' MEETINGS AND REPORTS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

At the half-yearly meeting of the shareholders in this Company at the Cannon-street Hotel on Tuesday, **Major L. Darwin** stated that the object of the half-yearly meeting was to obtain their approval to the payment of an interim dividend; but it was usual on these occasions for the Board to take advantage of the opportunity, and to give some information as to the progress of the Company's business during the preceding six months. Since December last he was glad to say that, with the exception of guttapercha, the prices of raw material had eased, and the Company had been able to sell their manufactures at lower prices than had ruled for the previous 18 months. These reductions had, however, not been considerable. As a result of this, and of a general slackness in trade, their turnover did not compare favourably with the similar period last year. Within the last two months an improvement had taken place, and should this be maintained the Board hoped to meet the shareholders in December with a statement of affairs showing much the same results as they submitted six months ago. The Company had just completed the laying for the Commercial Cable Company of a cable between Weston-super-Mare and Waterville, in Ireland, and their steamer "Buccaneer" had just terminated her charter to the Western Telegraph Company. Owing to the continued state of unrest in South Africa, their agency in Durban and that in Buluwayo had not yet been able to do any profitable work, but the Board hoped that when hostilities ceased the Company would be fully prepared to take advantage of every opening for business which might present itself. The market prices of the different grades of guttapercha were lower than they were recently, but the quality of these grades was below the usual standards, with the net result that buyers got less useful material for the money they paid than was formerly the case. To enable the Company to increase the facilities for production at their French works, the Board had just completed the purchase of a small neighbouring property. This purchase became a necessity, as during the last three or four years they had been much hampered for want of room. In conclusion, he moved the declaration of an interim dividend of 2½ per cent., or 5s. a share.

Mr. A. Scott seconded the motion, which was carried unanimously.

ELECTRICAL POWER DISTRIBUTION.

The ordinary general meeting of this Company was held on Tuesday at the offices, Surrey House, Victoria-embankment, under the presidency of Mr. W. L. Madgen, managing director.

The **Chairman**, in moving the adoption of the report and accounts (which appeared in our last week's issue), said the Board fully expected that the rate of profit which had accrued to them during the past nine months would be maintained. He wished to call attention to an item on the credit side of the balance-sheet as expenditure on Power Bills and new schemes—viz., £16,840. The directors felt that this amount was fully justified by the value of the schemes now being developed. The attention of many would no doubt have been drawn to the vast strides which had been made in connection with electrical work in America, on the Continent, and in our own Colonies. That progress had been relatively more rapid than it had been in this country, but many of them

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felt some years ago that the time had arrived when there was good promise of similar undertakings in connection with electrical power distribution proving remunerative in this country. It seemed, indeed, necessary in the interests of the country that something should be done to give our industries the same facilities as those which similar industries were enjoying abroad. The Electrical Power Distribution Company went to work and they had obtained a very fair measure of success. In the session of last year four Electrical Power Bills were passed through Parliament. Of these this Company secured two and for districts which he thought were exceptionally favourable – viz., the county of Durham, one of the greatest industrial areas in the country, and the north metropolitan district, which had exhibited during past years an enormous increase in population in the residential districts, and had also in more recent years shown a tendency to industrial development along the banks of the River Lea. The cost of these two Power Bills was included in the item to which he had alluded. In addition to these the Company had secured rights for electricity supply in numerous other districts, particulars of which were given in the appendix to the report. These latter undertakings, of course, would not in themselves offer such a large scope for investment as the Power Bills, but in some cases they were the nucleus of what might be equally large undertakings later on. No time was lost after these two Power Bills passed through Parliament, and the work was immediately put in hand. Last month the Company successfully inaugurated the main power station of the Durham scheme at Gateshead. The British Electric Traction Company had in that district the beginning of a very extensive electric tramways scheme, and the first business of the power station was to supply these tramways with electric current. The general electricity supply for the town of Gateshead and neighbouring districts was making very rapid progress, and the directors were led to believe that their confidence in the suitability of the districts for power purposes would be well justified. With reference to the North Metropolitan scheme, there would be two power stations, both on the River Lea, where facilities for coal and water supply were best. During the present month the second of these power stations would be inaugurated at Hertford. In Barnet the supply of electricity had already been inaugurated, and the number of consumers was steadily increasing from week to week. Concessions had been obtained in this district for light railways, and these would be worked in connection with the electricity supply. The construction of these light railways would be commenced in the autumn of the present year. Most of the other works referred to in the report would be completed during the present year, and the directors confidently believed that a very profitable business would be done. It was the one object of the Company to bring the electricity supply in this district within the reach of all classes, and to adopt methods to this end. There were clear indications not only abroad, but already in this country, that the era of separate generating stations, one for each town or district was passing away, and that the era of electrical power distribution on a large scale was now beginning. The operations of this Company placed them directly in this line of development, and the Board felt pretty confident that they had made a good start, and that the Company would derive a large measure of success in the business which had already been inaugurated, and that which they had taken steps to inaugurate in the years to come. In conclusion, he moved the adoption of the report and accounts.

Mr. E. P. Sellon seconded the motion, which was agreed to without discussion.

Mr. Emile Garcke and Mr. J. S. Raworth having been re-elected directors, the meeting closed.

At an extraordinary meeting held immediately afterwards several alterations in the articles of association were agreed to.

MIX AND GENEST, LIMITED, OF BERLIN.

The twelfth annual meeting of shareholders was held on May 18, when a most satisfactory balance sheet was submitted. The gross profit has amounted to £55,400, of which £17,750 were absorbed by income tax, salaries, and general expenses, £11,700 were written off for depreciation on plant, tools patents, and premises, thus leaving a net profit of £25 950, out of which a 14 per cent. dividend has been paid to the shareholders. In the report of the directors the continued progressive movement in the development of the concern was emphasised, especially the fact that during the last year the contracts placed by the Government Telephone Department with the firm for multiple switchboards and telephone instruments had been of considerable magnitude. All departments had not only been fully occupied, but in a good many instances overtime had to be worked to cope with the increasing orders. No less than 1,700 hands are at present employed, and although the new factory has only been built within the last four years, additional land had to be acquired in order to allow of further extensions, which when completed will cover an area of nearly 10,000 square metres. The prospects for the present year are considered to be highly promising, as evidenced by the considerably increased turnover as compared with the corresponding months of the previous year.

MEXICO ELECTRIC TRAMWAYS.

The fourth ordinary general meeting of the shareholders was held on Wednesday at Winchester House, E.C., Colonel Sir Euan-Smith, chairman, presiding.

In moving the adoption of the report, the **Chairman** said the main fact that had to be recognised was that the Company had had to contend with very great difficulties during almost the whole of the past year. Under these circumstances the Board was of opinion that the shareholders might be congratulated on their having earned the dividend which the Board now recommended, and which exceeded that of last year, for owing to the sewage operations in the city of Mexico it had taken their officials all their time to carry on the tramway services with punctuality and efficiency, and still more to make the service pay a satisfactory dividend. That was the main fact that had to be considered in connection with the operations of the past year, and that, coupled with the commercial depression under which the country had been labouring, might be regarded as having had the minimum possible injurious effect upon the dividend. The relaying of the track, the extension of the electrical system, the erection of the necessary power-houses and other buildings, and the provision of the required rolling-stock, was being proceeded with in a satisfactory manner, and they confidently looked forward to giving the shareholders each successive year a better, and still better, account of the progress of the operations. Since the commencement of the current year (1901) the Board had concluded a most advantageous arrangement, which had had the effect of leasing the whole lines of the Ferrocarriles Company to the Mexico Electric Tramways, Limited, under which name the operations of their Company would be henceforth conducted in Mexico.

Mr. Ludwig Breitmeyer seconded the motion, which was carried unanimously.

Vice-Admiral A. H. Markham and Mr. A. Parrish having been re-elected directors, a resolution adopting the dividends recommended was agreed to.

A vote of thanks to the chairman concluded the proceedings.

APPOINTMENTS VACANT.

Tramways Manager, South Lancashire Tramways Company. Details in our advertisement columns.

Charge Engineer, city of Bristol electricity department, £3 per week. Details in our advertisement columns.

Assistants (Two), Birkenhead Corporation electric tramways, 30s. per week, June 11. Apply to Mr. W. Bates, borough electrical engineer.

Instructor in Electric Wiring Classes, two evenings per week, Battersea Polytechnic, £35 per session. Details in our advertisement columns.

Mains Assistant and Draughtsman, Islington borough electricity department, £2 per week, June 11. Details in our advertisement columns.

Assistant Engine-Driver, Islington borough electricity department, 7½d. per hour, 56 hours per week, June 11. Details in our advertisement columns.

Meter Inspectors, borough of Nelson, 30s. per week, June 15; Bradford, accustomed to Ferranti, Thomson, and Bastian meters preferred, 30s. per 50-hour week. Details in our advertisement columns.

Student Demonstrator in Mechanical and Electrical Engineering, for session September to July, part time only, Battersea Polytechnic, £50. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Glasgow.—The Corporation invite tenders for the supply of electricity meters. Tenders by June 10. Details in our advertisement columns.

Islington.—The Lighting Committee invite tenders for free or assisted wiring. Tenders by June 11. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of branch rubber-covered cables. Tenders by June 10. Details in advertisement columns.

Edinburgh.—The Corporation invite tenders for ash-conveying plant, Dewar-place station. Tenders by June 15. Details in our advertisement columns.

Walthamstow.—The Urban District Council are prepared to receive tenders for electric lighting meters (ordinary penny-in-the-slot). Tenders by June 14.

Sutton Coldfield.—The Corporation invite tenders for meters (direct-current) and cut-outs. Tenders by June 15. Details in our advertisement columns.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection of dry-back marine-type boilers. Tenders by June 8. Details in our advertisement columns.

Wigan.—The Electric Light and Tramway Committee invite tenders for 12 double-deck single-truck electrical cars. Tenders by June 18. Details in our advertisement columns.

London, E.C.—The East Indian Railway Company invite tenders for electric overhead travelling cranes, etc. Specification may be seen at the Company's Offices, Nicholas-lane, London, E.C. Tenders by June 12.

Islington.—The Lighting Committee invite tenders for the painting of the arc lamp columns and crutches, of which 298 are

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in use in the borough. Tenders by June 11. Details in our advertisement columns.

Peterborough.—The Corporation invite tenders for the supply and erection of one Lancashire boiler, 30ft. by 8ft., and one 120-kw. steam dynamo. Tenders by June 14. Details in our advertisement columns.

Exeter.—The Town Council invite tenders for erection of the buildings of their new electricity generating station. Specifications, etc., may be obtained from Mr. Donald Cameron, city engineer and surveyor. Tenders by June 14.

West Ham.—The Council invite tenders for two 500-kw. continuous-current tramway generators, coupled direct to three 850-i.h.p. steam engines, and 11 water-tube boilers. Tenders by June 25. Details in our advertisement columns.

Christiania.—The Government Railways invite tenders for 37,600 ko. 4mm. galvanised iron wire, 9,300 ko. 3mm. galvanised iron wire, 12,800 insulators, etc. Tenders by June 26. Particulars, etc., at the office, Jernbanetorvet 8-9, Christiania.

Madrid.—The Public Works Department of the Department of Agriculture, Madrid, invite tenders for the construction and working for 60 years of an electric tramway from Santiario de la Yedra to Balza. Tenders by July 26. Particulars at that office.

Edinburgh.—The Corporation invite tenders for the electric lighting installation, etc., of the first portion of the Colinton Mains Fever Hospital, the number of lighting points being about 1,550. Tenders by June 12. Details in our advertisement columns.

Rotherham.—The Corporation invite tenders for the wiring of the police buildings preparatory to a supply of electricity from the Corporation mains. Specification, etc., may be obtained from the borough electrical engineer, Mr. E. Cross. Tenders by 20th inst.

Leith (Scotland).—Tenders are invited for the supply and erection of one Sinclair's No. 1 Lancashire boiler and additional steam-piping at the electricity works. Specification, etc., may be obtained from the Burgh Electrical Engineer. Tenders by 12th inst.

Exeter.—The Council invite tenders for boiler-house equipment, pipes, etc., engine-room equipment, switchboards, connecting cables, coal bunkers and conveyors, and feed and condensing water tanks. Tenders by June 14. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and erection of a switchboard at their electricity works, Valley-road, Bradford. Specifications, etc., may be obtained from Mr. R. A. Chattock, M.I.E.E., city engineer, Town Hall, Bradford. Tenders by 13th inst.

West Ham.—The Town Council invite tenders for the construction of three transformer chambers in Bridge-road, Stratford, Great Eastern-road, Forest Gate. Specification, etc., may be seen at the Borough Engineer's Office, Town Hall, West Ham, E. Tenders by 11th inst.

Wigan.—The Electricity Committee invite tenders for one complete direct-reading potentiometer, one ditto photometer, tramcar spare wheels, ditto pit jack, car body lifting jack, and one complete Thomson's balance. Tenders by June 12. Details in our advertisement columns.

Taunton.—The Corporation invite tenders for the construction, supply, and erection of one 250-kw. steam alternator, one 15-kw. motor-generator, switchboard extensions, one water-tube boiler, superheater, jet condenser, and air-pump, and sundry pipe extensions. Tenders by June 11. Details in our advertisement columns.

Burnley.—The Electricity Committee invite tenders for (A) five injectors, capable of dealing with 700 gallons per hour; (B) one feed pump, capable of dealing with 3,500 gallons per hour. Specifications, etc., may be obtained on application to Mr. Robt. Birkett, the borough electrical engineer, Aqueduct-street, Burnley. Tenders by June 10.

Barking Essex).—The Urban District Council invite tenders for the supply and erection of condensing plant, comprising surface condenser, cooling tower, electrically-driven air and circulating pumps, steam grease extractor pipework. Full particulars, etc., may be obtained from the Engineer, Electricity Works, East-street. Tenders by June 19.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

Kearsley.—The Urban District Council invite tenders for the taking-up roadway and repaving, laying of rails, points, etc., and all labour required for the construction and completion of tramways from Market-street to Unity Brook and along Longcauseway at Kearsley. Specifications, etc., may be seen at the office of the Council's surveyor, Mr. Herbert Nuttall, A.M.I.C.E., 20, Market-street, Bury. Tenders by June 13.

London, S.W.—Tenders are invited for the supply of 13,400 tons of steel rails and 958 tons of fishplates for the Queensland Railways. Tenders will be received at the Queensland Government Office, 1, Victoria-street, London, S.W., until 2 p.m. on June 11, endorsed "Tender for Steel Rails and Fishplates," and accompanied by a preliminary deposit of 1 per cent. on the tender. Specifications, drawings, etc., may be obtained at the office of the Agent-General for Queensland.

York.—The North-Eastern Railway Company invite tenders for the following articles, in such quantities as they may require, during six months ending Dec. 31, 1901, delivered carriage paid at the telegraph stores at York: (1) telegraph apparatus; (2) telegraph wire and line stores. Particulars may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by June 10.

Warrington.—The Corporation invite tenders for the supply, delivery, and erection of one water-tube boiler and pipework; supply, delivery, and erection of 500-kw. high-speed engine of the Willans type, with direct-coupled continuous dynamo; and supply, delivery, and laying of underground mains, stoneware conduits, etc. Specifications, etc., can be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Tenders by June 13.

Uganda.—The Crown Agents for the Colonies, acting on behalf of the Uganda Railway Committee, invite tenders for the supply of galvanised iron wire, specification and form of tender for which can be obtained on application to the Crown Agents, at whose office the drawing will be on view between the hours of 10 a.m. and 4 p.m. (Saturday, 10 to 2). Tenders to be delivered, addressed to the Crown Agents for the Colonies, Downing-street, S.W., and endorsed "Tender for Galvanised Iron Wire, Uganda Railway," not later than noon on June 11.

Mansfield.—The Corporation invite tenders for the supply and erection of—boiler-house plant: three Lancashire boilers, mechanical stokers, steam pumps, economiser, and motor; engine-house plant: three 200-kw. high speed steam generators, motor transformer, balancing motor transformer, and accessories; Korting condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains; public lighting: arc lamps, posts, and accessories; meters, and workshop equipment. Tenders by July 12. Details in our advertisement columns.

Erith.—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, economiser, feed pumps, etc.; pipework, etc., in engine and boiler house; surface-condensing plant, three steam alternators (vertical enclosed high-speed engines direct coupled to three-phase alternators), main switchboard and connections, 10-ton engine-room travelling crane, transformers, sub-stations, and equipment, underground mains, conduits, roadwork for private and public lighting, arc lamps (open type), posts, and station lighting. Tenders by June 24. Details in our advertisement columns.

RESULTS OF TENDERS:

Barnsley.—The Town Council have accepted the tender of Kenworthy, Taylor, and Co. to supply electric light service boxes.

Aberdeen.—The Tramways Committee have accepted the tender of J. Leith, jun., for the execution of the work in Great Western-road.

Lancaster.—The Corporation have accepted the tender of the British Westinghouse Electric and Manufacturing Company, at £2,220, for a 200 kw. set of engine and dynamo.

Dundee.—The Tramways Committee have accepted the tender of the International Electric Company, Leeds, at about £4,000, for a new engine and dynamo for the electric station.

London and India Docks.—Mr. G. W. Clarke, of London, Harold Wood, and Grays, has been awarded the contract for the supply of incandescent lamps for the coming year to the Dock Company.

Woolwich.—The Borough Council have accepted the tender of Messrs. Smith and Son, London, at £40,574 (foundations £6 437 and station £34,137), for the electricity and destructor station, Plumstead.

Islington.—The Guardians have accepted the tender of Julius Sax and Co., Limited, of 51, Rupert-street, W., for additional telephones at £44, and for lighting the carriageway inside the grounds from the front gate at £178.

Trafford Park.—The Electrical Company, Limited, 122 and 124, Charing Cross-road, W.C., have obtained an order from Messrs. Browett, Lindley, and Co., Limited, for one direct and three-phase current dynamo, with one armature, 600 kw. on either side, for Trafford Park electric light and power station.

Shoreditch.—The Borough Council have accepted the following tenders: The Renewable Lamp Company, for the supply of incandescent electric lamps for the period ending March 31, 1902; W. and T. Henley's Telegraph Works Company, Limited, for the supply of the necessary cable required for the extension of mains during the next nine months, £10,516. 5s.

Middlesbrough.—The Corporation have accepted the following tenders in connection with the extensions to the municipal electricity works, subject to the sanction of the loan by the Local Government Board: (Section A) Holdsworth and Sons, boiler-house plant—one 30ft. by 8ft. 6in. Lancashire boiler and accessories, £915. 10s.; (B) Witting Bros., Limited, engine-house plant—one 300-kw. high-speed steam generator (Browett engine and Kolben dynamos) and pipework, £3 564; (C) Crompton and Co., Limited, condensing apparatus—ejector condenser, with circulating pumps, £557; (D) British Insulated Wire Company, Limited, underground work—cables, troughing, trenching, and boxes, £737. 10s. 2d.

Bristol.—The following contracts have recently been let in connection with the Avonbank electricity works of the City Council: E. Nuttall, Manchester, foundations, retaining walls, culverts; R. Wilkins, Bristol, buildings; Babcock and Wilcox, London,

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boilers and coal conveyor and elevator; E. Benniss, Bolton, coal-discharging plant; Bumsted and Chandler, Hednesford, induced-draught plant; G. J. Weir, Cathcart, Glasgow, steam, electric, feed, and general service pumps; Doulton and Co., Lambeth, water-softening plant; Higginbottom and Mannock, Manchester, electric travelling crane; Siemens and Willans, steam alternators and steam dynamos; W. H. Allen and Sons, Bedford, condensing plant; Babcock and Wilcox, steam and other piping. General—British Electric Transformer Company, London, alternating-current transformers; E. Nuttall, underground sub-station; S. Z. de Ferranti, Hollinwood, low-tension switchboard at Temple-back works.

Bradford.—The Corporation have received the following tenders for the construction and erection of a five-ton electric travelling crane for their new tram depôt, Leeds-road, Thornbury, to operate on a 500-volt direct-current circuit:

Thornton and Crebbin, Bradford (accepted)	£355
Higginbottom and Mannock, Crown Ironworks, Manchester	468
Witting Bros., Limited, 49, Cannon-street, London	520
Witting Bros., Limited	618
Isles, Limited, Steam Crane Works, Stanningley, Leeds	520
J. Booth Bros., Limited, Rodley, Leeds	525
T. Smith, Rodley, Leeds	550
Jessop and Appelby Bros., Limited, Leicester	580
J. Carrick and Sons, Limited, Dalry Ironworks, Edinburgh	685
British Schuckert Electric Company, Limited, Clun House, Surrey-street, Strand, London, W.C.	658

BUSINESS NOTES.

TRACTION.

Isle of Man.—It is expected that the Isle of Man tramways undertaking will shortly be sold.

Nottingham.—It is hoped to have the Basford section of the electric tramways finished by July 1.

Greenock.—The electric cars will probably be running between Cathcart-street and Gourock by July 1.

Aberdeen.—An extended service of tramcars was put on all the routes of the Corporation tramways on Saturday last.

Wigan.—Major Druitt, Board of Trade inspector, has inspected the new electric tramway between Wigan and Boars Head.

Blackburn.—Major Druitt has held an enquiry on behalf of the Board of Trade into the tram collision at Ewood on March 27.

Huddersfield.—By the large majority of 3,183 the people of Huddersfield have decided to have a service of trams on Sundays.

Motorcar Goods Service.—A motorcar service for the conveyance of goods between London and Tunbridge Wells will start to-day.

Bristol.—The total number of passengers carried on the tramway company's system during the week ended 31st ult. was 1,118,784.

Continental Scheme.—The proposed new electric railway from Zermatt to Zinal, costing £240,000, and passing through some of the most beautiful Alpine scenery, is about to be commenced.

Uxbridge.—The Board of Trade have granted the London United Tramways Company an extension of time for two months in connection with the light railway extensions in the district.

Berlin.—The Berlin municipal authorities are reported to have granted £1 000 for the preparation of a plan for an underground railway, which is to run from north to south of Berlin, following the line of the Friedrichstrasse.

North London Electric Underground.—It is expected that the tunnel work in connection with the Great Northern and City deep-level electric railway from Finsbury Park to Moorgate-street will be finished by the end of this year.

Wednesbury.—The Corporation have decided to appoint an engineer, "or other fit person nominated as referee by the Board of Trade," to value that portion of the South Staffordshire tramways which they are now entitled to purchase.

Portsmouth.—The Town Council have decided to create a new 3 per cent. redeemable stock to an amount not exceeding £610,000, this sum being required for the purchase of the local tramways and the equipment of the lines for the electric traction.

Blackpool.—The new Marton section of the Corporation electric tramways, which was opened a week ago, has proved very popular. The receipts for the first five days were about £240, but of this the receipts on Monday and Tuesday alone were £202

Glasgow.—The Tramways Committee have had under consideration reports by Mr. John Young, general manager of the tramways, on the progress being made at the Pinkston power station, and on accidents and the rate of speed of electric cars. The reports have been generally approved.

Bournemouth.—A largely-attended meeting has decided to oppose the Corporation's Tramway Bill as a protest against the proposal to take away a portion of the north-west corner of St. Peter's Churchyard for the purposes of widening the road at that point in connection with the tramways scheme.

Halifax.—The Tramways Committee have resolved on several alterations in the tramcar service with a view to effecting a material saving in the weekly expenditure. These alterations include a reduction in the number of cars on certain of the routes, and the adoption of an earlier hour for the last car to the out-districts.

Cheltenham.—At the last Town Council meeting, the Electrical Engineer reported that he had tested the first steam dynamo for traction purposes, and the results were satisfactory. All the cables for the tramway had been delivered, and a good start made with the laying of them, and he hoped to complete the laying in a fortnight.

Rochdale.—At a meeting of the Tramways Committee it was reported that a quantity of the rails to be used in Rochdale had been tested and found very satisfactory. Plans of the proposed tramshed and offices at Bridgefold were approved subject to certain slight alterations. It is expected that the actual work of laying the lines will commence on the Norden section next week.

Ipswich.—The chances of an agreement as to the price of the purchase of the tramway system by the Corporation being remote, the parties have had recourse to arbitration. Sir Fredk. Bramwell sat at the Surveyors' Institute this week, when evidence was taken on behalf of the tramway company. The further hearing was adjourned *sine die*.

Pontypridd.—The Board of Trade have granted a provisional order to the Urban District Council for the construction of electric tramways in the district. The aggregate length of the new lines will be just over three miles. While power is given to the Council to enable them to work these tramways, they have no authority to construct any station for generating electrical power. A clause is also inserted to protect the property of the Cardiff Corporation, including the Taff Fawr water-mains.

Burnley Tramways Purchase.—In connection with the acquisition of the undertaking of the Burnley and District Tramways Company, the balance of the purchase-money, with interest and costs, amounting to £51,000, has just been paid to the company's solicitors by the various local authorities concerned. The money will be handed over to the shareholders of the tramway company in perhaps a couple of weeks, and the directors have given it out that the share money will be paid in full—20s. in the pound—with (as usual) 5 per cent. interest.

Glossop.—The Board of Trade have granted a provisional order to the Urban Electric Supply Company, Limited, for the construction of a system of electric tramways in the borough. The main line of the authorised system will be just four miles in length. From the main line a short line will be constructed just over half a mile in length. The tramways will be laid as single lines, with the necessary passing places, on a gauge of 4ft. 8½in. The right of purchase by the Corporation is not to be exercised until the expiration of 57 years from June, 1900.

East London Electric Trams.—It is announced that the East Ham electric tram system, which is owned by the local District Council is practically completed, and that the trams will be running in the course of a few days. The system runs from Manor Park to North Woolwich, through East Ham and Becton, and will join when completed, with the Ilford Council's projected system at one end and the West Ham Corporation's system at the other. When the joint schemes are completed there will be a network of trams more than 30 miles in extent in East London.

Darwen.—At the last Town Council meeting, a resolution was proposed that "in view of the serious financial position of the borough, the surveyor be instructed not to make any further contracts in connection with the Hoddlesden tramways before the next Council meeting, and that in the meantime a special committee be appointed to enquire and report upon the extent to which the Corporation is already committed by contracts in the matter and the probable cost of rescinding the same." After some discussion, the motion was defeated by a large majority.

District Railway.—A company is about to be formed to carry out the work of converting the District Railway Company's system to electric traction. This company, which is known as the Metropolitan District Electric Traction Company, Limited, proposes to lay down the new permanent way, provide the new rolling-stock, and erect a generating site. A site for the station has been selected at Lots-road, Chelsea and it is understood that when complete the premises will be leased by the traction company to the railway company at a rent based on a percentage of the expenditure.

Brighton—At the last meeting of the Town Council the Works Committee again brought up the matter of the extension of Volk's electric railway east of the Paston place groyne. They reported that Mr. Volk had had an interview with them, and had expressed his willingness to give up the connecting piece of line across the Madeira-road lawn and the Paston-place groyne, the terminus of the present line remaining unaltered, and the new part to commence from the eastern part of the groyne, provided the Corporation agree to waive their right to determine the license within the first seven years. The committee recommended that Mr Volk's offer be accepted.

Glasgow.—The result of working the tramways in the financial year just ended shows that since 1895 the takings have gone up no less than £156 000 For the past year the earnings amounted to £484 900, or £20 000 more than in the previous 12 months. Half of this increase has been secured since the Glasgow Exhibition opened on May 2. The weekly advances top £2,000, and as electric traction has been introduced within the last three weeks, it is expected that far larger profits will be secured during the ensuing year. At the Eastern Police Court last week a tram driver in the employ of the Corporation was fined a guinea or seven days' imprisonment on the charge of "reckless driving."

Bavarian Electric Railways.—A demonstration recently took place on the Palatinate (Bavaria) railways of the system of electric

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traction which has been introduced for the purpose of affording a means of communication between suburban localities and the stations at which the express trains stop for the reception of passengers. The first two trial sections were between Ludwigshaven and Neustadt, a distance of 20 miles, and between Ludwigshaven and Worms, 14 miles separating these two towns. The system of traction in use is the storage battery method, there being four long coaches, each of which can travel separately, or any combination can be made in the form of a train with trailer cars when necessary.

Epping Forest.—It is reported that an application is about to be made by the North Metropolitan Tramways Company to the Light Railways Commission for an order authorising the construction of a network of tramways, to be known as the Tottenham, Walthamstow, and Epping Forest Light Railways. The proposed route starts from Tottenham, and runs through Walthamstow, Leytonstone, Wanstead, Snaresbrook, Woodford, and Buckhurst Hill. It is felt that if the application of the tramway company is granted the natural beauty and solitude of a large tract of the Forest will be destroyed, and a public meeting of property owners and prominent gentlemen residing in the neighbourhoods affected by the scheme has decided to strenuously oppose the application.

Taunton.—The workmen engaged in excavating the roads preparatory to the laying of the lines for the new electric trams have gone out on strike, and the work is completely at a standstill. The men were being paid at the rate of 4½d. per hour, and they demanded 6d. The contractors offered 5d., but this was refused. Great inconvenience is experienced from the state of the roads, and a large part of the excavations have been filled in. The British Electric Traction Company, who are carrying out the undertaking, are under an agreement with the Town Council to complete the tramways by Aug. 1. The Council have agreed to supply the electric power, and are applying to the Local Government Board for sanction to a loan for making the necessary extension of plant at their electric light depôt.

Accrington.—At the Town Council meeting on Monday, it was stated that the provisional agreement entered into with the British Electric Traction Company was to have expired on the 31st ult. A suggestion was then put forward that if the agreement had really lapsed the Corporation should negotiate with the tramways company for the resumption of the portion of the lines now leased to the company and worked by them, with a view to this section being converted from steam to electric traction. It was further explained that Accrington could not obtain possession of the whole of the tramways undertaking owing to the fact that Haslingden and Rawtenstall Corporations had signified their intention of buying the portions of the lines within their respective boroughs. The consideration of the matter was deferred.

Birkenhead.—The extension of the electrical tramways system in the borough is proceeding apace. The New Ferry route is already very popular, and a source of substantial income. For the four weeks ending May 19 the total number of passengers carried was 189,803 on that section. The Tramways Committee passed a resolution some time ago directing that application be made to the Board of Trade for sanction to the borrowing of £21,700 for the conversion of a single tramway track into double tracks and the construction of passing places. It is now proposed to rescind that resolution, and that the sum of £9,902 be the amount borrowed for a similar purpose, but with a more limited estimate. The Council will also be asked to sanction applications for the borrowing of £13,000 for the provision of 15 additional cars, and £7,500 for the purchase of extra electrical generating plant.

Sunderland.—Experiments with a new form of lifeguard are at present being made on one of the Corporation tramcars. We take the following description of the device from the local Press: In the front of the car is a piece of wirework stretching right across the front. This is placed vertically, and moves up and down at the will of the driver. Underneath, in place of the customary horizontal fender, is one which, though ordinarily horizontal, can be dropped down by the driver. Therefore, in the event of the vertical wirework not preventing the person getting under the car, it would be next to impossible for anyone not to be picked up by the fender underneath. The apparatus is called Wilson and Bennett's patent automatic lifeguard, and it is made by Messrs. Gabriel and Co., of Birmingham. The takings on the whole system of tramways for Monday and Tuesday in Whit week are put down at £700.

Manchester.—The Board of Trade have given their formal approval of the opening of the Cheetham Hill and Hightown routes of the Corporation electric tramway system for public traffic. The principal condition which is laid down relates to the speed at which the cars shall be run. Four different speeds are mentioned. The cars may not travel round curves at more than four miles an hour, along crowded streets at more than six miles an hour, along moderately busy streets at more than eight miles an hour, and along suburban streets at more than 10 miles an hour. With regard to the equipment, the Board of Trade suggests a slight alteration in the lifeguard at the front of each car. This is fixed so as to be about 3in. above the roadway. The Board of Trade fully approves of the form of guard adopted, but suggests that it would be more efficient if fixed a little lower. The cars will be available for public use to-day.

Barcelona Tramways.—The net profit for 1900, including £1,211 brought forward, is £22,120. The service of the debentures and debenture stock absorbs £10,264, the dividend on the preference shares £5,000, and after deducting the loss on realisation of stud and the suspense account, there remains £317 to carry forward. The directors regret that the accounts do not enable them to recommend a dividend on the ordinary shares. The grant of the concession for working the Ensanche system by electricity is now only subject to certain formalities. When these are settled, the directors hope to enter into a lease or working agreement to the mutual advantage of both companies. A new concession, to be worked by electricity, has been obtained for an extension of about 1½ miles of one of the company's principal lines. This, the Board is satisfied, will be of considerable value, and the work of construction will be taken in hand without delay.

Sheffield.—The most forward section of the Corporation tramway extensions is that from Broomhill to Ranmoor. The length of the route is 1,400 yards, and the greater part of the track has already been laid. The line is single, with loops. Cable pipes are now being put down; the cables will be laid shortly, and the fixing of the overhead equipment will not be a long undertaking. It is expected that the route will be ready for passenger traffic by the end of this month. As soon as this extension is finished, a start will be made with the work of carrying the lines further forward to Nether Green—a distance of 800 yards—and it is expected that this will occupy six weeks. The Ecclesall section is also to be extended to Nether Green, by way of Rustlings-road, and a beginning has been made with the sewer work in that thoroughfare preparatory to the laying of the lines, which will be proceed with shortly. Good progress is being made with the extension to Intake village. An official statement shows that the traffic receipts for the week ended 2nd inst. amounted to £4,590, or nearly £1,000 in excess of the takings during Easter week, which amounted to £3,670. Last April it was anticipated that an average of £3 000 a week might be relied upon. In face of last week's, however, it is assumed that before very long an average of £4,000 a week will be reached, representing more than £200,000 per annum.

Baker-street and Waterloo Railway.—In their report to the creditors and shareholders of the London and Globe Finance Corporation the liquidators state in reference to the Baker-street and Waterloo Railway that up to the present Messrs. Perry and Co., the contractors for the construction of the line, have continuously carried on the works, and the same are now in progress, and a considerable portion of the tunnelling between Baker-street and Waterloo completed, the payments for same being provided by the railway company out of the funds in its possession. The report proceeds: "We desire to point out that the purchasers of this line, in addition to the provision of the sum of £500,000 before referred to, will become responsible for the completion of the line from Baker-street to Waterloo, together with the extensions from Paddington to Baker-street and Waterloo to the Elephant and Castle, thereby incurring a liability for an additional sum of over £1,500,000." In conclusion, the liquidators state that whether or not a sale is effected as a result of the negotiations which have been proceeding, they are of opinion that the corporation's interest in the railway will be sold sooner or later. They are satisfied that there are several parties who would be prepared to purchase, but at a price which in the interest of both creditors and shareholders ought not to be accepted because of its insufficiency.

LIGHTING AND GENERAL.

Rotherham.—It is proposed to extend the electric light cable to Moorgate.

Sculcoates.—The question of electric lighting generally of the workhouse is being considered.

Rathmines.—The Urban District Council have fixed the rate to be charged for current at 4½d. per unit.

Hoylake and West Kirby.—The electric lighting works at Hoylake will be opened on the 8th inst.

Share Market.—Taken as a whole, electric shares were firm during the week, with but little change.

Crewe.—The Town Council will apply for sanction to borrow a further sum of £5,000 for electric lighting purposes.

Birkenhead.—The salary of Mr. W. Bates, the borough electrical engineer, has been increased by £100 per annum.

Commercial Cable Co.—The directors have declared a quarterly dividend of 1¾ per cent. on the capital stock, payable July 1.

Sunderland.—The borough electrical engineer's last report shows a profit of £1,257 on the electric light undertaking for the past year.

Limerick.—The Town Council have decided to ask the Board of Trade for a further extension of their electric lighting provisional order.

Stone Asylum (Bucks).—The County Council have decided upon an electric light and power installation for the asylum at a cost of £4,700.

Hessle.—A committee has been appointed to consult with the Hull Corporation with a view to the introduction of the electric light to Hessle.

Removal.—The head offices of Messrs. Crompton and Co., Limited, will be removed on June 10 next to Salisbury House, London-wall, E.C.

Derby.—Two alternators have been sold for the sum of £150 by the Electric Lighting Committee. Mains have been ordered to be extended to Werburgh-street.

Stockton.—The Corporation have agreed to enter into further extensions of the electric works by the purchase of a new engine and dynamo at the price of £3,450.

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Aberdeen Harbour.—At the last meeting of the Works Committee of the Harbour Board, it was agreed to obtain electric machinery for the bascule bridge at Regent Quay at a cost of £480.

Ilkley.—On the application of Mr. Alfred H Gibbings, of Cheapside, Bradford, the Board of Trade have granted to him a provisional order for the supply of electricity throughout the urban district of Ilkley.

Berkhampstead.—A special meeting of the Urban District Council will be held next month in order to discuss a resolution that the Council apply for a provisional order to supply electric light for the district.

Worksop.—The surveyor reported at Tuesday's meeting of the Urban District Council that progress was being made with the electric light works; the arc lamp standards had arrived, and would shortly be fixed in the streets.

Gloucester.—The advisability of adopting an electric motor for driving the laundry machinery at the new hospital at Over is under consideration. The Council have obtained sanction to borrow £9,425 for the purposes of electric lighting.

Colchester.—The Town Council have accorded to Messrs. Siemens Bros and Co, Limited, a vote of thanks for the efficient manner in which they had conducted the borough electric light works during the two years it was under their control.

New Branch.—Mr. G. W. Clarke, of Harold Wood and London, has recently opened a branch office and showrooms at 15, High-street, Grays, for the fitting-up of a large number of shops, etc., shortly to be connected to the new supply station.

Worcester.—The expenses of the deputation to the electricity works at Islington, Hammersmith, Brighton, Bradford, Southport, Blackpool, Bolton, Manchester, etc., came to £74. 16s. 6d. It is understood that the deputation comprised four members.

Little Lever.—The question of the supply of electric current in the township will be the subject of discussion at an interview between the General Purposes Committee of the Urban District Council and the Lancashire Electric Power Company shortly.

Norton.—The Board of Trade have granted to the Northern Counties Electricity Supply Company their provisional order for the manufacture and supply of electricity in Norton. The order includes all such portions of the town at present lighted by gas.

Torquay.—The high-tension main from Market-street being overloaded, it is proposed that a new high-tension feeder be laid from the town hall to Castle-circus at an estimated cost of £186. In Croft-road 130 yards of main are to be laid to supply Sorel with light.

Brighton.—Application is to be made for sanction to the borrowing by the Corporation of the sum of £663. 10s in order to defray the expense of purchasing two houses, required in connection with the erection of the buildings for the electricity generating (tramway extension) station.

Hartlepool.—The Guardians have decided to enquire into the advisability of lighting the workhouse by electricity. The present expenditure on gas is £400 a year, and it is thought that by a little outlay the boiler and engine at the workhouse could be used for generating electricity.

London-to Brussels Telephone. — The installation of the London Brussels telephone is now completed, and trials are at present in progress which will continue for the next month or six weeks. It is expected that the service will be placed at the disposition of the public about the middle of July.

Middlesbrough.—At last Wednesday's meeting of the Electric Lighting Committee it was reported that during the month of May £12 profit had been made by supplying electric light. The question of giving preference rates for lighting chapels and churches is being enquired into.

Horsham.—Sanction has been obtained to the borrowing of the sums of £13,700 for purposes of electric lighting and £300 for the purchase of land for depôt purposes, together with the Local Government Board's formal approval of the use of land belonging to the Council for the purpose of the electric lighting order.

Alfreton.—The Board of Trade have replied to the Urban District Council in answer to the Council's request for the reasons why the provisional order to enable the Council to light the town with electricity had been refused, stating that it was contrary to their regulations to give the information desired by the members.

City of London Electric Lighting Co.—We note the following particulars of the revenue of this Company for the past March quarter: sale for current, etc., £91,611. 12s. 7d.; working expenses, £45,728. 1s. 5d.—leaving available for interest on debenture stocks and loans, depreciation, special charges, and dividends, £43,883. 11s. 2d.

British Electric Works Co.—In the case of the petition of Messrs. Samuel Walker, Limited, for the compulsory winding-up of the British Electric Works Company, Limited, which had stood over for a month in order to enable a scheme of reconstruction to be perfected, adjournment for another month was granted on Wednesday.

York.—At the meeting of the City Council on Tuesday it was stated that as the result of the working of the electric lighting department for the past 12 months they had been able to pay their interest and sinking fund, and the whole of the preliminary expenses, amounting to something over £300. There was a small balance in hand in addition.

London Gazette.—The partnership between R. Lomax and H. Lomax, electrical engineers, 6A, Market-street, Darwen (trading as R. Lomax and Co.), has been dissolved by mutual consent.—The final meeting of the St. Helens and District Tramways Company, Limited (in liquidation), will be held on July 1 at Pearl Insurance-buildings, St. John's-lane, Liverpool.

Eastern Extension and Great Northern Telegraph Companies. A duplicate cable has been laid between Chefoo and Taku. This additional cable will lessen the risk of interruption of telegraphic communication with the North of China, and facilitate the transmission of trade exchanged with Taku and beyond.

Nelson.—The Town Council have approved the plans of the borough surveyor (Mr. B. Ball, A.M.I.C.E.) for the erection of an electricity generating station in connection with the refuse destructor at Reedyford, and have authorised application to be made to the Local Government Board for borrowing powers for £7,500 for that purpose. As the current will be required at the end of September, the work will be put in hand at once.

South Shields.—The half-yearly balance-sheet of the electric light works states the income for the half-year ending March 31 at £8 147. 18s. 3d., and the working expenses at £3,468. 9s. 11d., leaving a gross profit of £4,679. 8s. 4d. After paying interest on loans and contributions towards sinking fund there is a net profit of £2,802. 5s. 6d. From the commencement of the undertaking in 1896 there has been a net deficit of £3,435 12s. 3d. in the income.

Newcastle.—At a meeting of the Town Improvement Committee of the Corporation on Wednesday a report was received from Mr. Mordey, who had been called in by the Corporation to advise them with respect to a communication received from the Board of Trade, informing the Council that the Newcastle Electric Supply Company were going to endeavour to get powers to put down new cables in the streets with greatly increased voltage. It was decided to hold a special meeting on Friday to go fully into the matter.

Travellers' Colloquial German.—Mr. H. Swan, principal of the Central School of Foreign Languages, London, has come out with a third edition of his phonetic handbook for English-speaking travellers and students just at the time when members of the Institution will be able to find particular use for it. By its means pronounciation of jaw-breaking words is made easy, and the appendices for cyclists and photographers will be specially appreciated. The little book is published by Mr. David Nutt, 57-59, Long-acre, at the modest sum of 1s. 6d., which should prove an excellent investment.

Stock Exchange. — The Stock Exchange Committee have appointed June 19 a special settling day for British Electric Traction Company, Limited, further issue of 30,000 6 per cent. cumulative preference shares of £10 each (issued at £1 10s. premium), £7. 10s. paid (of which £6 is capital and £1. 10s. is premium), Nos. 160 001 to 190,000. The committee have also ordered to be quoted in the official list British Electric Traction Company, Limited, further issue of 2,074 ordinary shares of £10 each, fully paid, Nos. 120,001 to 122,074. The committee have further been asked to allow to be quoted in the official list Oxford Electric Company, Limited £50,000 4 per cent. debenture stock.

Paignton.—The Lighting Committee presented at the District Council meeting on Tuesday a report with reference to the scheme of electric lighting proposed to be carried out by Mr. Paris Singer at his own cost in the first instance, to be purchased by the town within 10 years. The committee stated they were unable to recommend further progress with the scheme but that the thanks of the Council be accorded to Mr. Singer for his kind offer. The Chairman explained that it was impossible for them to pledge the Council to purchase some years hence. He very much regretted that they could not avail themselves of Mr. Singer's offer. He was quite willing to carry out his part of the scheme, but they could not get powers. The report was adopted.

Post Office Telephones.—The Wandsworth County Court judge on the 4th inst. decided that the Post Office is not subject to the conditions proposed to be imposed by the Corporation of Richmond on the Post Office in laying wires in the streets of Richmond. The Corporation had demanded that if the positions of the cables had to be altered on account of street widening, the Post Office should pay for such alteration. We understand that the new system will be in operation at the beginning of September next in the City area, Westminster, and a portion of the Thames Valley extension. With reference to the statement that considerable orders for telephonic apparatus has been placed in America, the engineers' department state that the American orders have been mainly for switchboards, patented in America, and more suitable than English apparatus.

Salford.—The Electric Light Committee on Wednesday recommended that the "maximum demand" system of charging for current be abolished, and replaced by a uniform charge per unit of current consumed, 2d. per unit to be charged for power purposes and 4½d. per unit for lighting purposes; that a discount of 2½ per cent. be made on payment of accounts within one month of the demand note being delivered; and that in all cases where consumers had their own plant and used the Corporation's supply only when their own plant failed a maximum price of 8d. per unit be charged, with a minimum price of 13s. 4d. per quarter. The Chairman of the Committee (Mr. Alderman Shaw) said, according to the *Manchester Guardian* the "demand system" had caused a loss to the Corporation within the last three months of £1,900, and the loss would go on as long as the system was continued. The resolution was adopted, a course we regret to see taken, as other remedies might have been available. By abolishing the maximum demand system the committee run the risk of losing their best customers and to retain only the more casual users of the light.

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Bournemouth.—Sanction has been received to a loan of £12,000 for public lighting. The lighting of Pokesdown and the purchase of the Bournemouth and Poole Electricity Company's undertaking are under consideration.

Chorley.—Sanction has been obtained by the Town Council to a loan of £21,300 for electric lighting purposes. The Town Council have resolved to interview the Lancashire Electric Power Company, and if possible obtain terms for a supply of electricity in bulk. The Local Government Board have also sanctioned a loan of £7,646 for a refuse destructor.

Glasgow.—Edward Paterson, dealer, Rodney-street, Glasgow, has been sentenced at Glasgow Sheriff Court to 15 months' imprisonment for receiving stolen electric cable, valued at about £90, the property of the electric lighting department of the Corporation. The prisoner declined to say from whom he got the material, and the thieves have not been discovered.

Islington.—A report from the Lighting Committee will come before the Council to-night recommending the laying of various lengths of distributing mains required in order to connect consumers who have already applied for a supply of electricity at an estimated cost of £612, as follows: Highbury-broadway, £235; Caledonian-road, £90; Anson-road, £121; Liverpool-road, £166.

Goole.—The Board of Trade have decided to grant a provisional order to the Urban District Council of Goole for the supply of electricity to the whole of the urban district of Goole, as constituted at the commencement of the order. The maximum price which the District Council may charge consumers is 11s. 8d. per quarter for any amount up to 20 units, and for each unit over 20 an additional 7d.

Wireless Telegraphy in the Navy.—Coastguardsmen who were signalmen of the higher standard are to be trained in wireless telegraphy at Portsmouth, so that they may take charge at the signal stations which have recently been fitted. It was intended by the Admiralty that the places should be held by naval signal ratings, but these are none too abundant, and the men cannot be spared from the ships.

St. Helens.—At the last meeting of the St. Helens Electric Supply and Tramways Committee it was decided to apply to the Local Government Board for sanction to the borrowing of £16,500 for the purpose of providing additional plant for electric lighting. At the same time instructions were given to apply to the Board of Trade for permission to borrow £10,000 for additional plant for electric traction purposes.

Cirencester.—At the last meeting of the Urban District Council the Lighting Committee presented a long and elaborate report on the question of supplying the town with electric light. They were of opinion that it was desirable to establish a system of electric lighting, and recommended that a provisional order be applied for in the next session of Parliament. The consideration of the report was adjourned to the next meeting.

Poplar.—The Borough Council have decided to petition the Home Secretary to furnish a return showing the number of deaths that have occurred to lead workers during the past three years. If no such return were available, the Home Secretary is to be asked to direct that a departmental enquiry be held upon the whole subject of the conditions of work in lead factories, and as to whether amended and improved regulations are necessary.

Chichester.—At Friday's meeting of the Town Council the Town Clerk read a report from a deputation who recently visited Windsor and inspected the electric lighting works there. The committee thought if works were constructed they should be in the hands of the Corporation. They contemplated a visit to inspect the works at Peterborough. It incidentally transpired that the members of the Council who went upon these visits paid their own expenses.

Fire at Charlton.—At the electrical engineering works of Messrs. Johnson and Phillips, Victoria Works, Charlton, an outbreak of fire occurred on Monday afternoon soon after 2 o'clock, resulting in a building of one floor 100ft. by 40ft. being partly burnt out, considerable damage being done to buildings, plant, and stock. We are informed that the fire will not cause any delay in execution of orders, as the firm are able to utilise other portions of their extensive premises to carry on the work.

Birkenhead.—The Borough Council propose to apply for sanction to the borrowing of £40,000 for the purpose of extending the electric lighting mains, providing generating plant for the south end of the borough, for the Rock Ferry district, and other places. Application is also to be made to the Board of Trade for a provisional order authorising the Corporation to supply electrical energy for public and private purposes within the districts of Higher and Lower Bebington and the district of Prenton.

Newcastle.—At the last meeting of the Newcastle Finance Committee of the Corporation, Mr. Laws, the city engineer, submitted plans for the erection of a lift from the street level to the municipal offices. Estimates are to be obtained from contractors, including local firms, with the view of the work being at once proceeded with. It was stated that the lift would be completed in four months, and if a supply of electricity could not be obtained from their own sources, arrangements could be made to obtain power to work it from one of the local companies.

Electric and General Investment Co.—We are informed that, subject to audit, the directors have decided to recommend the payment of the following dividends, etc., for the year ended May 31, 1901: a dividend of 5s. per share on the ordinary shares, of which 2s. per share was paid on account in December last, leaving 3s. per share to be distributed, and a bonus of 2s. per share, making together a present distribution of 5s. per share, or 25 per cent., or a total distribution of 7s. per share, or 35 per cent. for the year, and a dividend for the year ended May 31, 1901, of £50 per share on the founders' shares.

Personal.—We are informed that owing to rearrangement of the staff of the Edison and Swan Company, Mr. A. W. Hill will be severing his connection with the same after an uninterrupted period of 20 years, he having joined the staff of the American Edison Company before the formation of the English company, and was superintendent of the central station, Holborn-viaduct, with charge of the erection and maintenance of all the installations in London and district for the Edison and Swan Company. Mr. Hill has held the position of works foreman and engineer for the last 10½ years at the Ediswan Factory, Ponders End.

Lancaster.—The last report of the electricity department for the second half of the year shows that the price of current was increased ½d. per unit, both for lighting and motive power, in order to meet the additional cost of coal. The total net profits are £1,177. 9s. 3d., as compared with £670. 18s. for the previous year, disposed of as follows—viz.: to reserve fund, £750; to district fund, £427. 9s. 3d. The total for sale of current has increased from £3,876 4s. 8d. to £5,021. 19s. 11d., and for public lamps from £627. 12s. 9d. to £658. 8s. 11d., whilst the total expenditure has increased by £659. 12s. 4d., the increased cost of coal amounting for £395 13s 7d. of this amount. The reserve fund now amounts to £1 200. The total capital authorised and borrowed is £35,000, and the amount expended £35,380. 1s. 7d.

Cheltenham.—The Town Council have approved of an agreement with Mrs. A. F. Skarratt for the tenancy from year to year by the electric department, as electric supply offices and stores, of 335, High-street, at a rental of £80 per annum, with option of purchase at £1,750. At the meeting on Monday a letter from the Local Government Board was read, asking for further information as to an electric lighting loan of £6,000, and stating that the action of the Council in carrying out works in anticipation of loan sanctions was irregular. A reply was approved of giving the information required and calling the Board's attention to the fact that the application for sanction was made on Oct. 5 last, and the enquiry was not held until April 4, and unless the undertaking was to come to a standstill, it was practically impossible that works should not be carried out in anticipation of the Board's sanction.

Typeprinting Telegraph.—The Typewriting Telegraph Corporation, Limited, of Dashwood House, New Broad-street, E.C., have just issued an illustrated pamphlet descriptive of their typeprinting telegraph (Steljes's patent), by means of which any person is enabled to telegraph messages on either a telegraph or telephone line, which messages appear on the instrument at each end of the line similarly printed in Roman type on a paper ribbon. Amongst the advantages claimed for this system we note that batteries are not required, saving expense and trouble of maintenance. Very little practice is needed, and messages are automatically received during the absence of addressee, and privacy assured by locking the instrument case. There is no noise or publicity, as in telephoning, and the message being printed both by the sending and receiving instrument, ensures accuracy, fixes responsibility, and furnishes both parties with a record. Messages can be simultaneously sent to several receiving stations from one sending station. Printed and spoken messages can be transmitted simultaneously on the same telephone circuit. We are informed that the corporation will supply the apparatus by sale outright, with or without royalty, or on inclusive rental terms, and that instruments can be hired from H.M. Postmaster-General, and the National Telephone Company, Limited, who will contract for their maintenance.

Barnstaple.—Progress is being made with the electric lighting scheme. The report of Mr. Trentham has been considered in committee, and it is understood that it has given much satisfaction. It provides for the lighting of the whole of the town, with steam as the generating power. The Electric Lighting Committee intend to recommend the Town Council to use the extensive premises in Castle-street lately in the occupation of Mr. C. C. Cox for the purpose of an electric lighting station. Mr. Trentham considers that the water power at Raleigh is too small to be utilised, and recommends steam for the motive power. Public lighting is to be confined to streets where mains are laid for private lighting. In view of the narrowness of the streets, incandescent lighting could with advantage be adopted at Barnstaple. Mr. Trentham considers that 2,600 lamps of 16 c.p. would be soon taken up in the compulsory area, and the capital expenditure for this would be £16,225. If 5,400 lamps were provided for, a total expenditure of £21,450 would have to be incurred. A profit and loss account showed an estimated balance of £727, the charge to private consumers being placed at 6d. per unit. The Town Council have adopted the committee's scheme, and will apply to the Local Government Board for powers to borrow the money required. Mr. Trentham has been instructed to prepare the necessary plans and estimates in preparation for the enquiry.

New Issues.—The business of Messrs. Drake and Gorham has been formed into a limited liability company with a capital of £125,000. The vendors take £40,000 in shares and £66,000 in cash. The assets are certified at £40,000 and the stock at £12,541, and a further £10,500 for working capital is to be provided out of the issue of 85,000 £1 shares just being issued. The profits for the past five years are given as: in 1896, £10,166; 1897, £12,095; 1898, £11,411; 1899, £12,756; 1900, £12,349. The vendors, Messrs. Drake and Gorham, will continue to act as managing directors for seven years. The Uxbridge and District Electric Supply Com-

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pany, Limited, who have a share capital of £20 000 divided into 4,000 ordinary shares of £5 each, of which 1,350 shares have been already issued, are issuing 2,650 ordinary shares of £5 each at par, for the purpose of working a provisional order under the Electric Lighting Acts, 1882-1888, granted and confirmed last session, under the title of the Uxbridge and District Electric Supply Order, 1900, to a syndicate, for the supply of electricity for lighting, and for all public private purposes within the area of supply, which consists of the township of Uxbridge and the parish of Hillingdon West, together comprising the Uxbridge urban district, and the parishes of Hillingdon East, Ickenham, Cowley, and Hayes, in the Uxbridge rural district, all in the county of Middlesex; and the parish of Denham, in the Eton rural district and the county of Buckingham.

Keighley.—At the meeting of the Town Council on Tuesday the committee reported that the Fleece Mills Company had, by advertisement in the papers, given public notice of their intention to apply for powers to carry on some business or businesses which in their opinion might conveniently or advantageously be combined with the business of the company, and that amongst such business were included the following—viz.: "To manufacture, provide, store, and sell gas and electric energy, etc.; to lay down mains, pipes, and cables, etc.; to hire out fittings, lamps, dynamos, and other requisites in connection with gas and electricity, etc.; to borrow or raise money for such purposes; and to apply for and promote, and obtain any license or order from the Board of Trade, or provisional order, or Act of Parliament to carry such objects into effect." The committee had instructed the town clerk to oppose such application, unless an undertaking was given by the Fleece Mills Company to the Corporation that such powers to be applied for were limited to the premises now owned by the company, and the committee asked the Council to confirm their action in the matter. Further conferences have taken place between the promoters of the Yorkshire Electric Power Bill and representatives of various non-county boroughs in the West Riding, including Keighley, with the result that satisfactory terms have been come to for the amendment of the Bill so as to meet the requirements of the boroughs, and the committee have, therefore, instructed the town clerk to withdraw the petition against the Bill.

Hampstead. — The Lighting Committee reported at the last meeting of the Borough Council that the delegates appointed by the committee had attended a conference with the London County Council and other metropolitan boroughs, at Spring-gardens, upon the question of the establishment of generating stations for the supply of electrical energy in bulk within the county of London, when the following resolutions were passed: (*a*) "That the conference regards it as essential to the interests of London as a whole that the present purchase clause of the Electric Lighting Acts which applies to defined areas should also be made to apply to such companies as propose to supply electrical energy in bulk to the whole of London without regard to area." (*b*) "That, while preserving intact the rights of the local authorities with regard to electric lighting and energy, in the opinion of this conference it is desirable that the London County Council should be in a position to undertake, if it so determine and if so requested by the local authority, the supply of electrical energy in bulk for the convenience of any districts desiring to be so supplied, provided that the Council does not become competitive with the local authority." "That these resolutions were passed with a view to the London County Council preparing a Bill on the subject, a copy to be sent to all municipal authorities interested for consideration before presentation." It was decided that enquiry be made of the Postmaster-General when the Government system of telephones will be at work in the borough, and that the parties complaining of inconvenience owing to the withdrawal of connection by the National Telephone Company be informed accordingly.

NEW COMPANIES.

The following new companies have been registered since our last issue:

Ossett and District Omnibus Company, Limited.—Capital, £500. Object: to work omnibuses and tramways by electric and other power.

J. Stenner and Co., Limited.—Capital, £15,000. Object: to acquire the business of Messrs. J. Stenner and Co., and to carry on the business of manufacturing and electrical engineers, etc.

T. C. Welding and Co., Limited.—Capital, £1,000. Object: to acquire and take over the business of Messrs. T. C. Welding and Co., of Liverpool, and to carry on the business of manufacturers of and dealers in electric fittings, etc.

Eagle Engineering and Motor Company, Limited.—Capital, £6,000. Object: to adopt an agreement between Messrs. R. Jackson and J. Kenworthy and J. B. Bindloss, jun. (for the company), and to carry on the business of engineers, electricians, wheelwrights, tubemakers, etc.

Millington, Everett, and Co., Limited. — Capital, £3,000. Object: to acquire from F. Millington the benefit of certain existing inventions, and to carry on the business of electricians, suppliers of electricity, manufacturers of and dealers in electrical, galvanic, and magnetic apparatus, etc.

Drake and Gorham, Limited.—Capital, £125,000. Object: to acquire the business of Messrs. B. M. Drake and J. M. Gorham at 66, Victoria-street, S.W., with the tenancy agreements of the premises where such business and its branches are carried on, and certain patents for use in the said business, etc.

Reading and District Motorcar Company, Limited.—Capital, £5,000. Object: to carry on in Reading, Berkshire, or elsewhere, the business of builders of and dealers in and with motorcars and other vehicles, carriers of goods and passengers, electricians, mechanical engineers, suppliers of motive power, traction, light, and heat, etc.

A. Reyrolle and Co., Limited.—Capital, £20,000. Object: to acquire the business carried on at 20, Pancras-street, Tottenham Court-road, London, as Reyrolle and Co., to adopt an agreement with A. C. Reyrolle, and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of electrical appliances, etc.

PROVISIONAL PATENTS, 1901.

MAY 23.

10654. Improvements in resistances for the control of electric currents. Thomas Edgar Weaver, 159, Russell-street, Moss Side, Manchester.

10655. Improvements in or connected with electrolytic bells or apparatus. George Bell and George William Bell, 15, Water-street, Liverpool.

10686. An improved street lantern for gas and incandescent electric lighting. William Edgar, 23, Lower-mall, Hammersmith, London.

10687. Prepayment apparatus for the supply of gaseous, electric, or other fluids for a given period of time. Henry Cooney, 64, Carminia-road, Upper Tooting, London.

10730. Improvements in electric tram and railways. Robert Hacking, Augustus Wyvill Hancock and John Leighton, 24, Southampton-buildings, Chancery-lane, London.

10733. Improvements in high-potential electric switches. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William Le Roy Emmet and Edward M. Hewlett, United States.) (Complete specification.)

10734. Improvements in train-control systems for electric railways. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

10735. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Samuel B. Stewart, jun., United States.) (Complete specification.)

10736. Improvements in high-potential electric switches. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (William Le Roy Emmet, Edward M. Hewlett, and Charles C. Badeau, United States.) (Complete specification.)

10737. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Samuel B. Stewart, jun., United States.) (Complete specification.)

MAY 25.

10743. Improvements in electrical engines for surgical and dental purposes. Ernest William Mayer, 71, Great Portland-street, London.

10747. Improvements in electric ignition plugs for internal-explosion engines, and chiefly as used with motor road vehicles. Edward Gardner, Thomas Harry Gardner, and Lawrence Gardner, 55, Market-street, Manchester.

10756. Improvements in magnet coils or solenoids. Bernard Mervyn Drake, Charles Cornfield Garrard, Gilbert Scott Ram, and the Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

10757. Cut-out for incandescent lamps with glowers consisting of conductors of the second class. Charles Cornfield Garrard and the Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

10758. Improvements in electric incandescent lamps in which the glower or light-giving body is a conductor of the second class. Gilbert Scott Ram and the Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

10766. Improvements in electromagnetically-controlled looms and kindred textile machinery. Arthur Penrhyn Stanley Macquisten, 33, Renfield-street, Glasgow.

10769. Improvements in prepayment devices for telephones. Robert B. Jentzsch and Gebhard von Alvensleben, 33, Cannon-street, London.

10793. Improvements in electric indicators. William Joseph Polyblank, 4, Harley-street, Bow, London.

10795. Generating electricity for the propelling of machinery or for other similar and useful purpose. William Sunter, 8, Calton-hill, Edinburgh.

10848. Improvements in apparatus for winding coils for continuous-current dynamo and motor electric machines. Arthur William Tomkins, 62, Market-street, Manchester. (Complete specification.)

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10869. Manufacture of incandescence bodies for electric lighting. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

10871. Improvements in telegraph and telephone systems. Frederick George Thomas Parsons and Douglas Hubert Sturman, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

10879. Improvements in voltaic cells. William Kennedy Laurie Dickson, 18, Southampton-buildings, Chancery-lane, London.

10887. Improvements relating to electric arc lamps. Hermann Otto Schmidt, 45, Southampton buildings, Chancery-lane, London. (Complete specification.)

10888. Improvements relating to electric switches. Friedrich Wilhelm Busch, 45, Southampton buildings, Chancery-lane, London.

MAY 28.

10903. Improvements relating to the electrolysis of salt. Eleanor Jane Plumber, Colinton, Midlothian.

10932. Improvements in wire cables. Ludwig Luckhardt, 100, Wellington-street, Glasgow. (Complete specification.)

10933. Improvements in joint and like boxes for electric cables. Albert Edgar Tanner and William Paul James Fawcus, 4, St. Ann's-square, Manchester. (Complete specification.)

10935. Improvements in domestic telephone plants for physicians and others. Albert Traub, 83, Alte Jacobstrasse, Berlin, Germany. (Complete specification.)

10951. Battery elements support. Charles Bernhardt Schoenmehl, 52, Chancery-lane, London. (Date applied for under Patents, etc., Act 1883, Sec. 103, Oct. 30 1900, being date of application in United States.) (Complete specification.)

10960. Circuit-closing device for the winding gear of electric clocks and the like. Max Möller, 321, High Holborn, London. (Complete specification.)

10961. Electric striking clock. Max Möller, 321, High Holborn, London. (Complete specification.)

10967. Improvements in stationary armatures and inductors. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts Gesellschaft, Germany.) (Complete specification.)

10971. Improvements in and relating to controllers for electric railway and like vehicles. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Walter W. Tice, United States.)

10974. Improvements in and connected with electrodes for electrolytic cells. Philip Middleton Justice, 55, Chancery-lane, London. (Castner Electrolytic Alkali Company, United States.) (Complete specification.)

10975. Improvements in electrodes for electrolytic cells. Philip Middleton Justice, 55, Chancery-lane, London. (Castner Electrolytic Alkali Company, United States.) (Complete specification.)

10976. Improvements in electrolytic cells. Philip Middleton Justice, 55, Chancery-lane, London. (Castner Electrolytic Alkali Company, United States.) (Complete specification.)

10988. Improvements in telephone circuit systems. Ellis Freedom Frost, 111, Hatton-garden, London. (Complete specification.)

11000. Improved electric heating device. Emil Kastner, 111, Hatton-garden, London.

11003. Improvements relating to apparatus for transmitting and receiving electric signals. Georg Friedrich Rudolf Blochmann and Christian Emil Bichell, 45, Southampton-buildings, Chancery-lane, London.

11007. An improved combined electrical and mechanical motor. Andrew Benson and John Pugh Price, 18, Buckingham-street, Strand, London. (Complete specification.)

11013. Improvement in circuit-closing and interrupting devices. Franz Kuhlo, 37, Chancery lane, London.

MAY 29.

11034. Improvements in starting switches for electric motors. Thomas Edgar Weaver, 159, Russell-street, Moss Side, Manchester.

11050. Electric arc lamp. Edward Maurice Barnes, 31, Cannon-street, London.

11071. Improvements in electrical connections. John Gray, 16, Emperor's-gate, South Kensington, London.

11076. Improvements in and relating to means for extinguishing electric arcs applicable to lightning arresters, switches, and the like. Harry Lamm, 322, High Holborn, London. (Complete specification.)

MAY 30.

11112. Improvements in trolleys and junction frog-plates for use on electric railways and tramways. David Blythe Foster, Brotherhood Works, Leeds.

11120. Improvements in galleries or holders for gas, electric light, oil lamp, and the like globes or shades. Bertrand Frank Wyler, 1, Broad-street-buildings, Liverpool-street, London.

11134. Improvements in rail bonds for electric railways. Charles Burton Thwing and Charles Godfrid Wiborg, 15, Took's court, Cursitor-street, Chancery-lane, London. (Date applied for under Patents, etc., Act. 1883, Sec. 103, Nov. 10 1900, being date of application in United States.) (Complete specification.)

11135. Improvements in or relating to electric arc lamps. Samuel Henry Johnson, 111, Hatton-garden, London.

11168. Improvements in vehicles driven by electricity. Victor Isidore Feeny, 60 Queen Victoria street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

11172. Improvements in electricity meters. Martin Kallmann, 18, Southampton-buildings, Chancery-lane, London.

MAY 31.

11214. Improvements in wireless telegraphy. Harry Shoemaker, 111, Hatton garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 17, 1901, being date of application in United States.) (Complete specification.)

11237. Improvements in or relating to electric arc lamps. Societa Generale Italiana Edison di Elettricita 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc, Act, 1883, Sec. 103, Nov. 26, 1900, being date of application in Italy.)

11242. Improvements in electrical primers. Sir W. G. Armstrong, Whitworth, and Co., Limited, and George Stuart, 24, Southampton buildings, Chancery-lane, London.

JUNE 1.

11248 An improvement in the form of glass chimneys and globes for incandescent gas and electric lighting. George A. Lewes, 12, Evelyn mansions, Carlisle-place, London.

11253. Improvements in or connected with the application of electric motors to the driving of machine tools. The British Electric Plant Company, Limited, and Wilfred L. Spence, 19, Waterloo-street, Glasgow.

11254. Improvements in incandescent light fittings, more particularly applicable to electric incandescent lights. Clarence Metcalfe Stead, 30, Park row, Leeds.

11257. Improvements in and relating to electrolytic incandescence lamps. John Robert Quain and Thomas Thomson Turnbull, 9, Warwick-court, Gray's-inn, London.

11277. An improved apparatus for utilising electric lamps in the heating of plates and other domestic utensils and in the boiling of water and other liquids. Richard Wade Boyd, 11, Southampton buildings, Chancery-lane, London. (Complete specification.)

11280. Improvements in electrical reversing switches and in mechanism for operating them. Coloman de Kandó, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London. (Complete specification.)

11290. Improvements in electric contact makers and breakers. The Pick Motor Company, Limited, and John Henry Pick, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 22.

1900.

7691. Electrical work measuring instruments. Johnson. (Hartman and Braun.)

10065. Automatic magnetic circuit breakers. Lake. (Scott.)

10974. Electric brakes for railway cars and the like. Newell.

10172. Apparatus for starting and controlling electric motors. Preece.

11011. Electrical switches and cut-outs for heavy currents and high potentials. Clothier.

11677. Parallel running of alternate-current machinery. Leake.

13515. Overhead trolley wires or conductors for electric traction, overhead electric cables, or the like. Hacking.

13573. Apparatus for electrically lighting railway trains. Parker.

13639. Electric meter. Bloxham. (Soc. Ch. Mildé, Fils, et Cie.)

13865. Insulating supports for electrical conductors. Wright and Aalborg. (Date applied for under International Convention, Jan. 2, 1900.)

13999. Arc lamps. Bénard.

14069. Lightning arresters. Wise. (Actiengesellschaft Elektricitätswerke, vorm. O. L. Kummer und Co.).

1901.

181. Electric light switches. Lundberg and Lundberg.

2394. Distributing electricity and apparatus for use therein. Ransford. (Soc. Anon. des Brevets Dolter.)

5026. Machine or apparatus for measuring the lengths of electric cables or wires, ropes, and the like. Claremont and Hyde.

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5098. Multiple-conductor cable terminal or analogous fittings. Nisbett.

3513. Electric meters. Vittorio Alessandro Arcioni.

3964. Means for use in operating from a car or train switches employed with a surface-contact system of electric traction. Parker.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 1	715	645	+ 70	—	—
Birmingham Trams.	,, 1	5,646	4,500	+1,145	94,315	—
Blackburn Corp'rat'n	May 31	663	452	+ 211	10,031	8,843*b*
Blackpool Corporatn.	,, 30	1,862	455	+1,407	5,333	3,271
Blackpool-Fleetwood	June 1	1,863	371	+1,492	6,993	5 895
Bolton Corporation..	,, 2	1,852	1,336	+ 516	30,401	20,881
Bradford City Trams	,, 2	1,431	462	+ 969	13,960	8,556
Bristol Tramways Co.	May 31	6,597	3,046	+3,550	—	—
Carlisle Tr'mw'ys Co	June 1	216	—	—	3,086	—
Central London Ry.	,, 1	6,368	—	—	136,468	—
City & South London	,, 2	1,815	1,434	+ 381	43,286	27,754
Cork E. T. and L. Co.	May 30	585	456	+ 129	8,800	7 593
Darwen Corporation	,, 31	204	159	+ 415	3,817	3,207
Dover Tramways ...	June 1	289	185	+ 104	3,950	3,587
Dublin & Lucan E.R	—	—	—	—	—	—
Dublin U.T., elec. cars	May 31	4,108	3,412	+ 696	—	—
Dublin S.D. Electric	,, 31	1,011	857	+ 154	—	—
Dundee Tram Co. ...	,, 29	701	421	+ 280	—	—
Glasgow Corporation	June 1 1	1,381	9,461	+1,920	—	—
Halifax Corporation	,, 2	1,682	1,034	+ 648	—	—
Huddersfield Corp'n.	,, 1	1,178	672	+ 506	6,843	6,168
Hull Corporat'n E.S.	,, 1	1,965	1,124	+ 841	71,358	35,799
Liverpool Corporat'n	May 25	9 378	8,283	+1,165	173,965	148,592
Liverpool Overhead	June 2	2,079	1,352	+ 727	34,455	31,009
Portsmouth Corpn...	—	—	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 2	4,590	—	—	—	—
Southampton Trams	—	—	—	—	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—
Wolverhampt'nC'p'n	—	—	—	—	—	—

b Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £347 decrease.

Barcelona Ensanche y Gracia, £67 decrease. Barcelona, £257 increase.

Brisbane, £56 increase.

Buenos Ayres and Belgrano Electric, £325 increase.

Calcutta, £155 increase.

Cape Town (month of February), receipts, £13,463; expenditure, £6,004.

Mexico Electric (month of April), receipts, £17,500; expenditure, £10,000.

Perth Electric, £174 increase.

Port Elizabeth (month of February), receipts, £3,043; expenditure, £1,803.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅞-1
Aron Electricity Meter. 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
—— Ordinary, 1-125,000	1	..	13/16-15/16
British Electric Works, Ordinary, 50,001-95,000	1	—	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1	—	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108	—	85-90
British Insulated Wire, Ord., 1-70,000	5	—	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2½-2⅝
—— 4½ per cent. Debenture Stock	100	..	103-108
—— 4½ per cent. 2nd Debenture Stock	100	—	101-104
Callender's Cable, Debentures	100	—	109-113
—— Ordinary	5	—	14-15
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	3	—	3¾-4
—— 5 per cent. Debentures	—	—	101-104
Edison and Swan United, Ordinary	3	—	1-1½
—— 5 per cent. Debentures	5	—	2-3
—— 4 per cent. Deb. Stock, Red.	100	—	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	—	—	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	100-103
Giffre Electro-Chemical and Power, Ord., 20,001-180,000	1	—	0-½
W. T. Henley's Telegraph Works, Ordinary	5	—	15½-16½
—— 4½ per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	15	—	35-39
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5½-6
Willans and Robinson, Ordinary, 1-20,000	5	—	10-11
—— 6 per cent. Cum. Pref., 20,001-60,000	5	—	6½-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	—	70-75
Bournemouth and Poole, Ordinary	10	—	11½-12½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7⅜-8½
—— 7 per cent. Preference	5	—	8¼-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	7-7½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	6-6½
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	—	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	—	—	101-103
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	100	—	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	5½-5¾
—— 6 per cent. Cum. Pref.	5	—	5¾-6
—— 4½ per cent. First Mort. Deb.	100	—	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	—	4½-5½
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5½-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7⅜-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	—	11-12
—— 4 per cent. Debenture Stock, Red.	100	—	102-105
Kensington and Knightsbridge and Notting Hill	100	—	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1½-1¾
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101
Metropolitan, Ordinary	10	—	14-15
—— ,, 85,001-93,769	5	—	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1½-1¾
—— £5 Shares	5	—	6¾-7¼
—— £4½ Shares, New	4½	—	5¾-6
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	65-75
Royal Electrical Company of Montreal	$100	—	200-220
—— 4½ per cent. First Shares Mortgage Debentures	$100	—	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	—	80-90
South London, Ordinary	5	—	3½-3¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	15-16
—— 7 per cent. Pref.	5	—	3½-3¾
—— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9½-10
—— Pref. Half-Shares	5	—	4½-5
—— ,, ,, deferred	5	—	4¾-5¼
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	113-118
City and South London, Consolidated Ordinary	100	—	51-53
—— Ordinary	10	—	4¾-5¼
—— 4 per cent. Debenture Stock	100	—	111-116
—— 5 per cent. Pref. Stock '91	100	—	132-137
—— ,, ,, ,, '96	100	—	123-127
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13¼
—— Ordinary, 1-50,000	—	..	7⅜-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	102-104
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	4-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	124-129
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	—	2½-2¾
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	—	4¼-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	—	6¾-7
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	—	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	..	99-101 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	—	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	—	1½-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5¼-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	100	—	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1	—	1¼-1⅜
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	15-16
—— 3½ per cent. Mort. Debs., 1-8,000, Red.	100	—	98-102
Imperial Tramways, Ordinary	all	—	22-22½
—— 6 per cent. Cum. Pref.	all	—	14½-15½
—— 4½ per cent. Deb. Stock	100	..	113-114
Kidderminster and District Lighting and Traction, Pref.	5	—	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	—	104-106
New General Traction, Ordinary	5	—	2-2½ nl
—— 6 per cent. Cum. Pref.	10	—	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10¾
—— 5 per cent. Cum. Pref.	10	—	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	105-107
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	—	1
—— £51,132 6 per cent. Preference	6s.	—	5/16
—— £50,000 ,, ,,	1	—	1
—— £500,000 4½ per cent. Debenture Stock	83½	—	83½
Telephones.—			
National Telephone, Ordinary	5	—	3⅞-3¾
—— 6 per cent. Cum. First Pref.	10	—	11½-12½
—— 6 per cent. Cum. Second Pref.	10	—	11½-12½
—— 5 per cent. Non. Cum. Third Pref.	5	—	4¼-4½
—— per cent. Deb. Stock, Red.	100	—	96-98
—— 3½ per cent. Deb. Stock, Red.	100	—	87-89
Oriental Telephone and Electric Company	1	—	¾-1

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THE RIVAL WEST OF SCOTLAND POWER SCHEMES.

The parliamentary enquiry into the rival schemes promoted by the Caledonian Electric Power Company and the Clyde Valley Electric Power Company respectively for supplying electrical energy to a large area of the West of Scotland around Glasgow has resulted in a victory for the Clyde Valley Company. The proceedings before the Select Committee of the House of Commons presided over by Sir James Woodhouse lasted for more than three weeks, and in the end the chairman declared the decision of the committee to be in favour of the Clyde Valley Bill. Among the petitioning bodies against both schemes were Port Glasgow, Motherwell, Paisley, Partick, Greenock, Kilmarnock, Ayr, Hamilton, Govan, Airdrie, Coatbridge, Kinning Park, and others. Reduced to simple terms, the case for these burghs was that they wanted to reserve their rights to provide electrical energy within their own areas for their own people. The scheme which the Select Committee have passed is by a long way the smaller of the two, but the decision in favour of the Clyde Valley Bill must be taken as representing the balance of testimony of the manufacturers and technical witnesses. The area over which the Caledonian Bill proposed to supply comprises no less than 1,135 square miles—practically the whole of Ayrshire and Lanarkshire—whereas the area included in the Clyde Valley scheme is 732 square miles. At the present time a supply of electricity is only being given in 13 square miles out of 710, excluding Glasgow. Large iron and steel works are situate in this area and a great many coal-pits. Altogether, there are some 1,200 works of importance which will come within the range of supply. In regard to the system of supply, all calculations have been based on the adoption of the multiphase alternating-current system, which is largely used in America and the Continent. In the event of a local authority taking a supply in bulk for lighting and also for power, it is thought that it will be possible to give a supply for power by an alternating current, and for lighting a separate supply transformed into continuous current. It is proposed to erect the three generating stations provided for under the Bill in the parishes of Dalzell, Renfrew, and Paisley respectively, and to place them so as to be coupled up for the purpose of an interchange of factors, and also so that they may supplement each other and be mutually supporting in the case of any failure of the plant. The capital of the company will be £900,000, with £300,000 borrowing powers, or £1,200,000 in all. Provision has been made in the estimates for two stations of 10,000 kw., and one of 5,000 kw., with a voltage of 10,000. The estimates of cost include £75,000 for connecting the stations, and £105,000 for transformers, which brings the total initial cost of distribution plant, etc., up to £400,000. One argument which seemed to influence the committee very considerably in deciding in favour of the Clyde Valley scheme, was that it is promoted by the largest industrial consumers in the district. They include Lord Hamilton of Dalzell, Sir Wm. Pearce, Bart., Sir Mitchell Thomson, Bart., Sir Chas. Cayzer, Sir David Richmond, and others. These gentlemen, it is said, do not look so much to profit out of the company as to a supply of electrical power, which will certainly tend to develop all kinds of manufacturing

Map of the Areas included in the Clyde Valley and the Caledonian Power Bills. The black contour shows the area of the Clyde Valley Scheme, while the shaded spots numbered 1, 2, and 3 denote the proposed sites for the generating stations. The area proposed under the Caledonian Bill is included in the shaded contour, and the thick black spots show where it was proposed to erect the seven generating stations.

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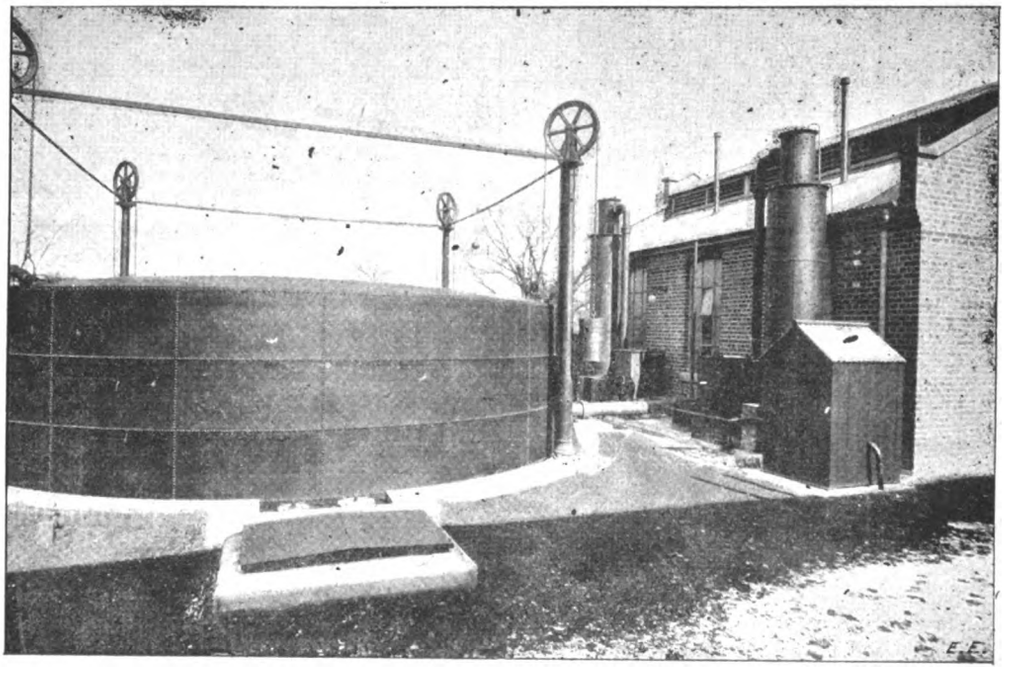
industries in the area, and to help the establishment of tramways for the greater convenience of the working classes. We have reason to believe, however, that the committee were influenced more by the fact that the Clyde Valley Bill is the less ambitious scheme of the two, and that while the proposed area is only 732 square miles, as compared with 1,135 square miles under the Caledonian Bill, it really embraces the whole of the important manufacturing and mining districts around Glasgow. Again, the Caledonian scheme provided for no less than seven different generating stations as against three under the other scheme. At present the use of electrical power in coalmines is very limited, but a supply of power on a large scale and at the cheapest possible rates—3d. per unit for the first 400 hours and 2d. per unit for any further quantity are the maximum charges under the Bill—will do much to forward the application of electricity to underground haulage. The engineer to the Clyde Valley scheme is Mr. Robert Robertson, of Glasgow, and in the course of his evidence before the Select Committee he referred to the danger from motor-generators in fiery coalmines. He agreed that there was risk from sparks in such mines. Such a risk would make it quite impossible, in his opinion, to put in anything in the way of an electric continuous-current motor. Under the system of distribution proposed by the Clyde Valley Company, the motors would be on the alternating-current system, the use of which in mines gave rise to little danger owing to the fact that there was practically no liability to spark. Before being allowed to proceed, the Clyde Valley Bill was severely handled as regards clauses. The city of Glasgow is expressly excluded from the scheme, and provision is made for the protection of the Corporation against any damage which may result either from electrolytic action or from the carrying out of the works under the Bill. In addition to the general provision for the protection of "authorised distributors," including local authorities to whom provisional orders have been granted, there now appear special clauses for the protection of the burghs of Govan, Partick, Port Glasgow, Paisley, and Hamilton. In respect of the first three places, the company are prohibited from exercising any of the powers under the Bill except with the consent of the local authorities, while in regard to Paisley and Hamilton they are permitted to lay mains through these burghs to any other place within the area of supply. With regard to the position of burghs which in the future may become authorised distributors, the amended Bill places them in the same position as burghs already authorised. Special provisions are also inserted for the protection of the Trustees of the Clyde Navigation, railway companies, the Hamilton, Motherwell, and Wishaw Tramways Company, and the Scottish House-to-House Electricity Supply Company. When declaring the preamble of the Clyde Valley Bill proved the chairman explained that the intention of the committee was that the supply of power should be of such undoubted magnitude that the use of it for lighting purposes should be subordinate to that of the ordinary power. On the proceedings for the adjustment of clauses a clause by the promoters, suggesting that subscribers might be allowed to use 25 per cent. of the power taken for motive purposes for lighting, was objected to on the ground that 5 per cent. was quite sufficient. The chairman took the view that this was a very important matter, as it had come up for the first time, and the decision of the committee might form a precedent. Eventually the following clause was agreed to: "Provided that where energy is supplied to any person for power within the area of supply of any authorised distributors the energy used by such person for such lighting purposes shall not in any year, except with the consent in writing of the authorised distributors, exceed 20 per cent. of the total amount of energy supplied to such person, and save as aforesaid the company shall not supply energy for lighting purposes."

The engineer to the unsuccessful Caledonian Bill was Mr. A. A. Campbell Swinton, of Victoria-street, S.W.



Gasholder and Producer House, Isolation Hospital, Walthamstow.

The Clyde Valley Bill, as amended, stands reported for third reading.

THE ENGINEERING EQUIPMENT OF THE NEW ISOLATION HOSPITAL, WALTHAMSTOW.

We are indebted to the British Westinghouse Electric and Manufacturing Company, Limited, for the following description and photographs:

The new isolation hospital of the town of Walthamstow has just recently been completed. It is built throughout on the most modern lines, and there are many points of interest and novelty in the engineering equipments. In 1894 the District Council acquired some 20 acres of land at Chingford, near Epping Forest, of which 5½ acres has been enclosed for the grounds and site of the new hospital and its future extensions. The population of Walthamstow is over 100,000, and considering that the buildings at present erected are capable of accommodating only 46 patients, while the usual provision is at the rate of one bed per 1,000 inhabitants, it is probable that extensions will be carried out very shortly.

The hospital buildings are seven in number, comprising four pavilions for the patients, the administrative building, the engineering building, and a porter's lodge. Of the

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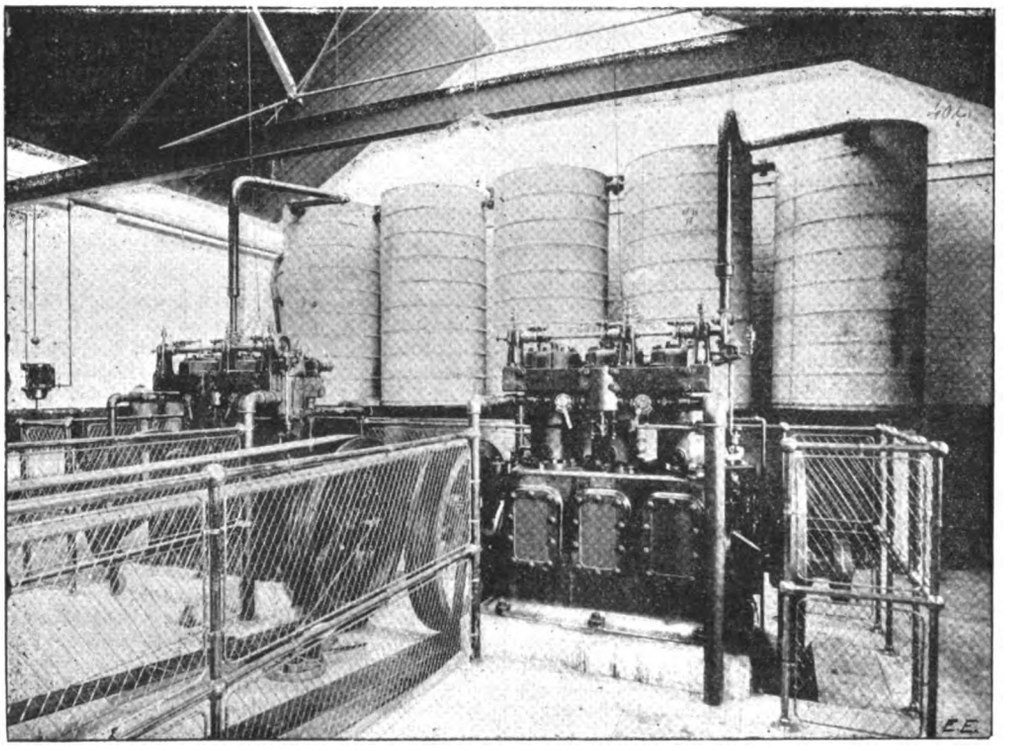
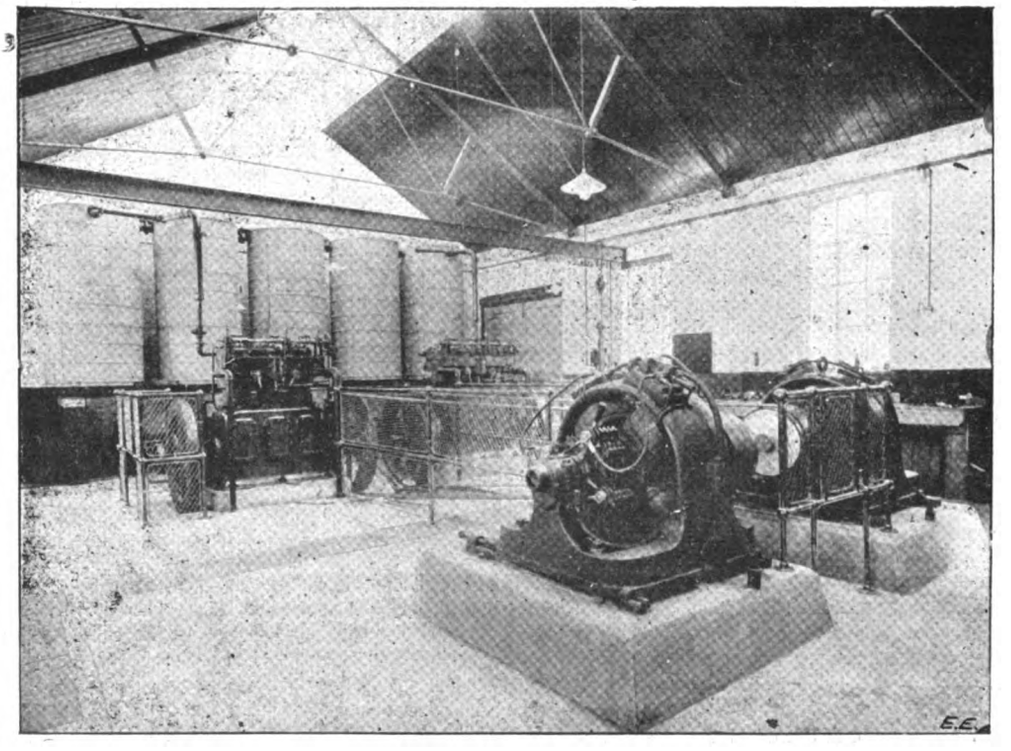
four pavilions, three contain 14 beds each, and the other one four beds. The interior walls are finished with Keen's cement, and all corners are rounded. The floors, partitions, etc., are of polished teak. They are one storey high, the three larger pavilions being divided by an intermediate



28-h.p. Westinghouse Gas-Engines, Isolation Hospital, Walthamstow.

nurses' duty-room into two wards of six beds and eight beds respectively. The cubic space per bed is 2,009 cubic feet, and the floor area per bed is 154 square feet. The wards are heated by a Manchester firegrate in the centre and by an open fireplace at one end. Warmed air is



Westinghouse Generators, Isolation Hospital, Walthamstow.

admitted to the wards by inlet pipes under each bed, the outlet being by valves set high up on the walls. All the buildings are of red brick, with roofs of board, felt, and slate. The administrative building is of similar materials and style to the others. It is for the accommodation of the resident medical officer, matron, nurses, and the general domestic staff, and is two storeys high, containing separate apartments for the staff, large dining-rooms, kitchens, etc.

The engineering plant of the hospital is of exceptional interest. In a separate building are located gas producers, electric plant, laundry, and disinfecting machinery. The gas and electricity plants are in duplicate. Two Dowson gas generators are installed, each capable of producing 1,000 cubic feet of gas per hour. Each producer has its full complement of additional plant, including vertical steam-boiler fitted with superheater, injector, and the usual fitting; a condenser, a hydraulic box, a coke scrubber, and a sawdust scrubber. The gasholder is 24ft. in diameter by 10ft. deep, fitted with an inlet pipe 8in. in diameter, and with two outlet pipes of 5in. and 4in. diameters respectively. The fuel used is anthracite, and the total cost of producing the gas is about 7d. per 1,000 cubic feet.

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The gas supply is utilised for all power, heating, and lighting purposes through the hospital buildings. Two Westinghouse gas-engines are operated by the producer gas, being fed from the 4in. main. These engines are of the well-known three-cylinder type. Since their introduction a few years ago Westinghouse gas-engines have quite revolutionised gas-engine practice, and competed successfully against the best of steam-engine practice. They are equal to the best of steam-engines even on such points as noiseless running, even rate of rotation, automatic speed regulation with widely varying loads, self-starting, and economy in operation. Westinghouse gas-engines are built in stock sizes up to 650 h.p. units, but they are in use in sizes of over 1,000 h.p. each. The two installed at the Walthamstow Hospital are of 28 h.p. each, and are used for driving electric generators supplying current for the electric lighting of the hospital buildings, throughout which there are in all about 350 incandescent lamps installed. Two dynamos are installed, each belt-driven by a gas-engine. A storage battery of 55 cells is placed across the supply mains. The generators are compound wound, but when the battery is in circuit the machine series windings are cut out. The electric mains between the generators and the hospital buildings are of lead-covered cables drawn into iron pipes in the ground, and the mains are all duplicated, so that risks of total or lengthy interruptions to the supply are reduced to a minimum. The buildings are wired on the steel tube conduit system, and the circuits are taken from distribution switchboards, no one circuit having more than eight 16-c.p. lamps on it.

The laundry and disinfecting arrangements are on the most modern and improved principles. A hydro-extractor, two washing machines, two mangles, an ironer, a blower for the drying chamber, and a ventilating fan are all operated by a 6-b.p. electric motor, which drives an overhead shaft, to which the machines are coupled by belts. The disinfecting chamber in connection with the laundry is divided into two parts, and a Washington Lyons disinfector is built in the dividing wall. The infected clothing is received at one side, placed in the disinfector, where it is subjected for some time to steam at a pressure of 22lb. per square inch, and then dried by a current of hot air, and withdrawn at the other side.

The gas supply drawn from the gasholder 5in. outlet pipe is distributed throughout the buildings for heating, cooking, and gas-lighting purposes. There are four gas-heated water-boilers, each capable of heating a circulating tank of 80 gallons capacity; also a boiler for heating a 50-gallon tank for scullery purposes. These hot-water supplies are used for baths, lavatories, and general domestic purposes. The cooking apparatus consists of a large gas oven 4ft. 8in. by 2ft. 9in. by 2ft. deep, a cooking range of three ovens 17in. by 17in. by 27½in. deep, hot-plates, carving tables, cupboards, etc., all heated by gas. The gas supply to the lighting, cooking, and heating apparatus is carburetted to give a decided and unmistakable odour for the detection of leakages.

The total cost of the buildings and their equipments, which are now practically complete, will work out to be about £30,000. Walthamstow is a town which embraces a large area, and its population is increasing at a very rapid rate. It would hardly do to express the hope that the District Council's new hospital may be brought into very great use, but it is certain that no more convenient or better place could be provided for those unfortunate ones who are compelled to avail themselves of its advantages.

ON TESTROOM METHODS OF ALTERNATE-CURRENT MEASUREMENT.*

BY ALBERT CAMPBELL, B.A.

The object of this paper is to describe a number of methods of measurement, some of which are capable of fairly general application, while others are only of use in special cases. Many of these methods are novel, I believe, and most of the others are not well known. Owing to the nature of the subject it is not possible to connect the whole into a coherent sequence, but for convenience of reference I have numbered the methods consecutively.

* Paper read before the Institution of Electrical Engineers.

SECTION A.—TRANSFORMER METHODS OF MEASURING CURRENT, VOLTAGE, AND POWER.

In the testroom there is no special difficulty in measuring either currents or voltages of ordinary magnitudes; with continuous currents the use of moving-coil instruments renders the measurement of very large or very small values easy and accurate. With alternating currents, however, the measurement of the extreme values is not so easy, and it is for this purpose that transformer methods are specially valuable. Fig. 1 shows

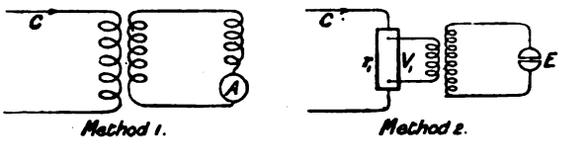

FIG. 1.

two typical methods. In the first method (which is fairly well known), C, the whole current to be measured, goes through the primary coil of a transformer, the secondary of which is connected to an ammeter, A. In Method 2 the current passes through a low non-inductive resistance, r_1, giving a small voltage drop, V_1, which is transformed up so as to give readings on the electrostatic voltmeter, E. As to Method 1, some years ago I investigated the conditions by which the ratio of current transformation can be kept sufficiently constant and independent of frequency. I found that it was necessary to have: (*a*) an air-core transformer, or one with a well-closed iron circuit; (*b*) relatively low resistance and high inductance in the secondary circuit.

Method 2.—It is to Method 2, however, that I wish to draw special attention at present. Here the measuring instrument, being electrostatic, is unaffected by variations in frequency, and if of good type has a very high degree of accuracy. [If a reflecting electrostatic voltmeter be set up in a fixed position, and a scale for it (say, at 2m. distance) be drawn by calibration with a potentiometer and direct current, an accuracy of at least 2 in 1,000 is attainable over a large part of the range. In most of the measurements in this part of the paper I have used such a voltmeter.] For currents from five amperes and upwards, the resistance, r_1, should be so small that not more than 0·5 or at most one volt is lost in it. If the voltmeter reads to about 120 volts, this necessitates a high transformation ratio—at least, 1 : 100 in the transformer. To keep the voltmeter readings proportional to the current, I find it best to use a transformer with (*a*) a well-closed iron circuit; (*b*) a highly inductive primary coil of very low resistance—*i.e.*, large time constant.

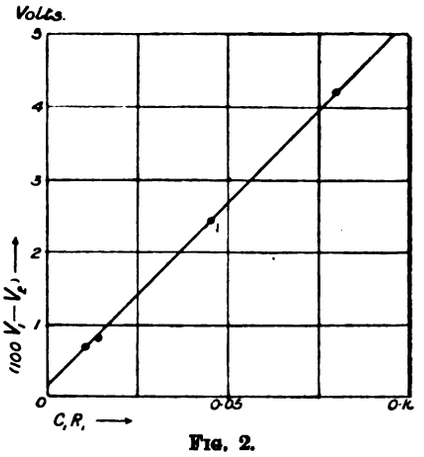

FIG. 2.

It is difficult to thoroughly carry out condition (*b*) without employing a considerable weight of either iron or copper, but very fair accuracy may be attained with a quite small transformer, as the following instance will show: The core consisted of annular iron stampings of total weight about 1·5 kilos; the primary coil had 100 turns of No. 16 wire, the secondary 10,000 turns of No. 40; r_1 had a resistance of one ohm and the resistance of the primary coil was 0·107 ohm. The divergencies of the observed ratio, $V_2 : C_1$, from the value 10 are shown in Table I.

TABLE I.

Frequency. ⌒ per second.	Error in ratio, per cent.
39	−1·9
86	−0·8

The primary current at one volt (86 ⌒ per second) was 0·17 ampere. By inserting known resistances in the primary circuit the curve in Fig. 2 was obtained, and thus it was proved that these divergencies are (practically) entirely due to the ohmic drop of volts in the primary. If such a

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transformer is to be used on a circuit of nearly constant frequency, the ratio of the windings can be altered slightly so as to give an error almost negligible, or a few extra ends may be brought out to suit various frequencies. Perhaps an easier plan is to have a small range of adjustment on one of the parallel wires forming the low resistance, r_1. It is possible, however, to compensate for changes of frequency by Method 2*a*, shown in Fig. 3. Here the total current, C, after passing through the small resistance, r_1, passes through a turn or two on a very small compensating transformer, *t*, whose secondary is connected (reversed) in series with the secondary of T and the voltmeter. As the frequency is raised the

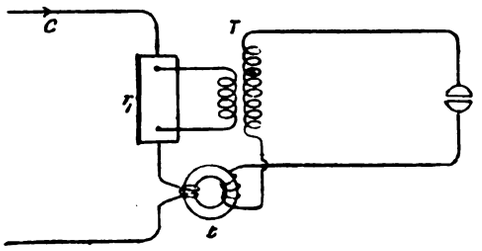

FIG. 3

transformer, *t*, subtracts more and more from the voltmeter reading, and thus compensation can be secured. The advantages of Method 2 are that with one voltmeter and a set of low resistances a very wide range of currents can be measured; also no disturbing inductance is introduced into the main circuit. It will be noticed that a transformer of high ratio like that described above gives a means of measuring small voltages with very small expenditure of current, but it is mainly to its use in conjunction with a low resistance that I would draw attention.

Measurement of Power.—For the measurement of power (or energy) transformers are often of great assistance, and in several well-known types of watt-hour meter they are employed with success. Under this head I shall content myself with mentioning two methods (3 and 4) shown in Fig. 4, the first due to Mr. M. B. Field, and the second published recently by myself. In

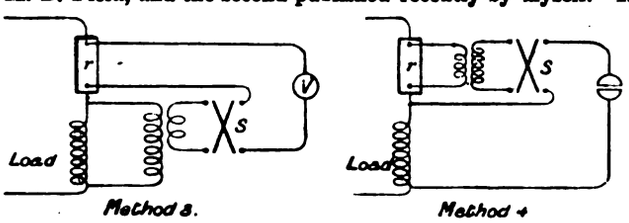

FIG. 4.

both of these a small resistance, *r*, is placed in series with the load, and S is a reversing switch. In Method 3 the voltage on the load is transformed down and added and subtracted from that on *r*, giving resultants P and Q, measured on a hot-wire voltmeter. In Method 4 the voltage drop on *r* is transformed up and the resultants P and Q (similarly obtained) are measured on an electrostatic voltmeter. For both methods

$$\text{Watts} = \frac{P^2 - Q^2}{4\,m\,r},$$

where *m* is the ratio of the transformer.

Method 4 can be used with fair accuracy to measure power with power factors down to 0·1, or even lower. For this the resistance of the primary of the transformer must be made very small, so that the secondary voltage may be almost exactly in opposite power phase to the primary potential difference. (The

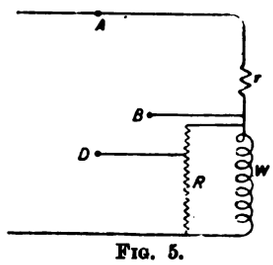

FIG. 5.

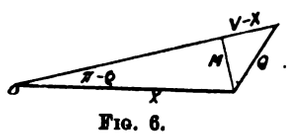

FIG. 6.

small angular deficiency may be measured by Method 6 below.) For example, with 50 volts on the load and 50 volts from the transformer, a power factor of 0·1 would give $P - Q \doteqdot$ seven volts—*i.e.*, the error of reading could be below 2 per cent. even on a voltmeter reading to 100 volts.

Method 5.—The three-voltmeter method as usually employed has several disadvantages; these are mainly due to the fact that, in order to get good readings, the auxiliary resistance must use up a considerable fraction of the total available voltage, and, what may be worse, tends to alter the wave-forms in the circuit. In the two-voltmeter methods (3 and 4) this is avoided; there is, however, a simpler modification of the three-voltmeter method which also gets over the difficulty. This is shown in Fig. 5, where *r* is a relatively small resistance, and R a very high resistance in parallel with the load, W. A convenient fraction $\left(\frac{1}{n}\text{th}\right)$ is picked off R by B D, and the three-voltmeter method is applied to A, B, and D. The result multiplied by *n* gives the power taken by W. In another modification the resistance, R, is put across both *r* and W, but a more complicated formula is then required.

Method 6.—*Measurement of Power Phase Differences close to* 180*deg.*—Let the effective voltages be V and X. (1) Let V be nearly equal to X, and let the small difference V − X be measured by an electrostatic voltmeter and a quick change-over key. Then Q, the small effective resultant of V and X, is found either by a low-reading voltmeter or by the help of a phase turner, or a transformer of high ratio, and an ordinary range electrostatic voltmeter. Then, as will be seen from Fig. 6,

$$\text{Sin}\,\phi \doteqdot \frac{M}{X} = \frac{\sqrt{Q^2 - (V-X)^2}}{X}$$

(2) If V is not nearly equal to X, let a high resistance be put across the greater (say V) and V^1 a fraction of it picked off as nearly as possible equal X. V^1 and X are then combined as in (1). [The transformer must not be used here for measuring Q.] I have found the above method useful for measuring approximately the power lag between the primary and secondary (open) potential differences in transformers. In one case, for example, the lag was found to be (180deg. − 0·15deg.). Similarly, the lag between two independent voltages very nearly in phase may be measured by reversing one of them and proceeding as above.

SECTION B.—THE TESTING OF WATT-HOUR METERS.

I. *Real Non-Inductive Loads.*—When sufficient power is available (at the proper frequency), the tests are usually easy, the chief difficulty sometimes being to find the gearing ratio between the quickest moving part and the dials, for some of the makers cannot be persuaded to mark this clearly on the meter. When the loads are above 2 kw. or 3 kw.,

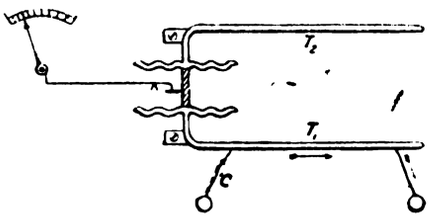

FIG. 7.

special non-inductive resistances are desirable in addition to lamps. I have found that a very convenient and cheap type of resistance frame for this purpose consists of strips of copper nickel each 1cm. broad, 1m. long, and capable of carrying 50 amperes. As the strips sag with the heat developed they are pulled taut by light springs which pull at the middle points of the strips. With such frames a steady non-inductive load is easily obtained. Some meters are so much affected by inductance in the load that the introduction even of a small Kelvin balance (to measure the current) is undesirable. The want of a non-inductive ammeter in this and other cases led me, seven or eight years ago, to devise and make a thermal ammeter which, although I exhibit it now only as a curiosity, has some points of interest about it. It consists (Fig. 7) of a form of differential air thermometer in which the bulbs are replaced at each side by thin-walled metal tubes, T_1 and T_2, of small diameter (1mm. to 2mm). Each of these is connected with a small aneroid chamber of extremely small internal volume. These chambers act against one another, and their differential action is magnified by ordinary aneroid mechanism, as shown in the figure. The current to be measured is passed along the tube T_1 (or a set of tubes electrically in parallel), while tube T_2 in the same enclosure acts as a compensator. The use of the thin hot tube acting as its own air chamber is to give the maximum quickness in attaining steady readings. To compensate for the decrease in the expansibility of the air as the temperature rises, the hot tube was made of a material having a considerable resistance temperature coefficient. Such a hot-tube ammeter, though non-inductive, dead-beat, and low in resistance, was scarcely accurate enough for careful testing work, but I think the principle is worth recording here.

II. *Inductive Loads.*—As several types of energy meter suitable for measuring inductive loads are now in common use, it is often necessary to test with inductive loads going down to power factors of 0·6 to 0·7. To use an ordinary wattmeter as standard is objectionable, as its errors may be as large as those of the watt-hour meter under test. I have used

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the following method (7) for some years past and have found it convenient and accurate.

Method 7.—This is shown in Fig. 8, in which M is the watt-hour meter under test. The load consists of a non-inductive resistance, L, in series (through mercury pools) with an inductive part consisting of a Kelvin balance and a set of copper coils (N) wound inductively. In order to be able to make sudden measurements of the resistance of this inductive portion, mercury-cups are so arranged that it can be quickly switched

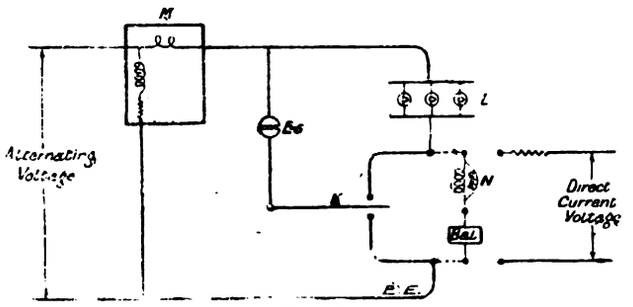

FIG. 8.

over into connection with a direct-current circuit and the resistance measured by reading current and potential difference on a Weston instrument. While the meter is running, the current, C, is read on the balance, and by the help of the switch, K, the voltage, V on L, and the total voltage, U, are read on the electrostatic voltmeter, Es. If r = mean resistance of the inductive part, then

$$\text{power} = C\,V + C^2\,r,$$

and

$$\text{power factor} = \frac{W}{C\,U}.$$

In practice r is made as small as possible, so that a small error in $C^2 r$ has a very small effect upon the value of W, while the C V part can be measured with extreme accuracy. The coils which make up N must have no iron near them, eddy currents must be avoided, and mutual induction must be

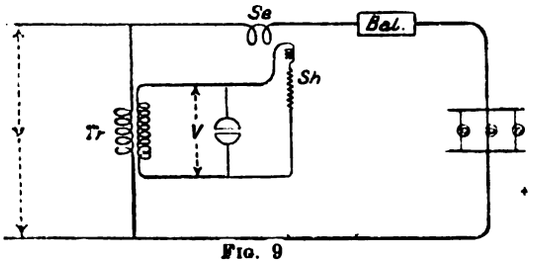

FIG. 9

guarded against except where two of the coils are identical in winding, in which case their impedance in parallel can be conveniently varied by varying their relative positions. The method is also suitable for testing wattmeters.

Method 8.—I have sometimes found it convenient to use a somewhat different method by which the measurement of resistance is rendered unnecessary. This consists simply in measuring w, the power in the highly inductive part, by the three-voltmeter method (or by an ordinary wattmeter), the total power being C V + w. Since w can be made to be only a small part of the whole power, this is accurate enough, and the coils, N, may here have iron cores.

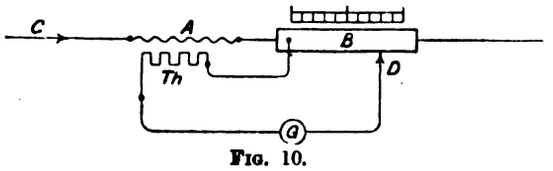

FIG. 10.

III. *Fictitious Loads.*—Unfortunately it very often happens that sufficient power (at the proper frequency) is not available to allow the meter to be tested with the actual loads at which it is to be used. It thus becomes necessary to arrange fictitious loads whose action on the watt-hour meter shall be practically identical with that of the corresponding real loads.

Method 9.—When the source of supply can furnish the current, but not at a voltage quite high enough for the load required, the well-known arrangement shown in Fig. 9 may be used. The shunt coil, Sh, is disconnected from the series coil, Se, and is connected with a transformer, Tr, which raises the supply voltage, v, to a suitable value V. The voltage v must be high enough to allow the series circuit (series coil, balance, and lamps) to be practically non-inductive.

Method 10.—When a large current is required, a method which I have published recently will be found useful. In it the large current obtained at a low voltage passes through the Kelvin balance, the series coil of the meter, and a low non-inductive resistance. A transformer of high ratio, with its primary across this low resistance, furnishes from its secondary the volts for the shunt circuit.

SECTION C.—THERMOPILE METHODS.

A well-known but little used way of measuring a current consists in passing the current through a conductor near which are one set of junctions of a thermopile. With rightly chosen conditions, the deflections of the galvanometer connected with the pile are practically proportional to the square of the effective value of the current. In common with many other thermal methods, the action is dead-beat, but there is usually the accompanying disadvantage of sluggishness, the zero point not being regained instantly on switching off the current. By making the hot wire and the junctions extremely small, this sluggishness can be much reduced. I have tried a thermopile of iron and

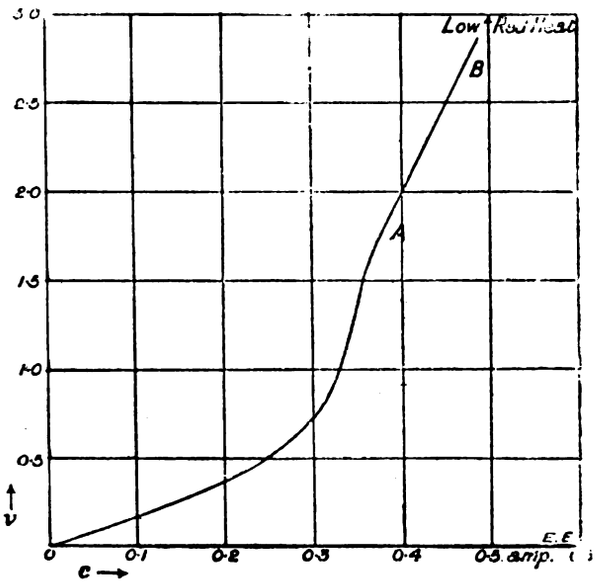

FIG. 11.—Nickel-Wire Diam. 0·05 mm. (2 mils.).

nickel wires of 0·15mm. (six mils) diameter. From a deflection of 100 divisions (400mm.) the light spot, after the switching off of the current, returned to within 1·5 divisions above zero in 30 seconds, and was still 0·5 division from zero after 75 seconds. This is prompt enough for many purposes, and it is no difficult matter to braze the junctions of such a thermopile. I have succeeded in brazing junctions of much thinner wire, and gained considerably in promptness of working, but this gain scarcely repaid the extreme difficulty of construction.

Method 10.—I may mention here a somewhat interesting null method of measuring continuous current which I have tried; it is shown in Fig. 10. The current passes, wholly or in part, through the thin wire, A, and also through B, a strip or rod of very low resistance. The heating of A by

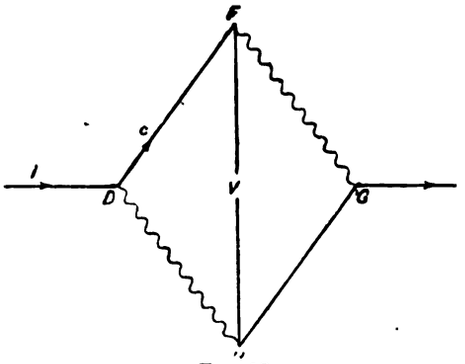

FIG. 12.

the current causes the pile, Th, to give an E.M.F., e, which is balanced against a part of the voltage drop along B by moving the slider, D, until the deflection of the detector galvanometer, G, is brought to zero. Here $e = k\,C^2$ and $v = r\,C$, r being the resistance of the fraction of B for which $e = v$. Then $r = k\,C$, and hence the graduations of the scale of the slider are directly proportional to the current measured.

SECTION D.—ON OBTAINING STEADY CURRENTS.

In accurate testing work it is of great advantage to be able to obtain very steady currents and voltages. By the help of an automatic thermal arrangement I have succeeded in obtaining very exact regulation, even when the supply voltage is varied

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by 10 or 12 per cent. The method depends upon the alteration of resistance due to rise of temperature. In the following description I shall take a concrete instance with wires of nickel and manganin as typical of conductors of large and small temperature coefficients respectively. If a curve be drawn for any conductor showing the connection between c, the current through the conductor, and v, the voltage applied to its ends, the form of the curve will depend on the material of the conductor and on the temperatures to which it is raised by the current. It is convenient to call this curve the *characteristic* (*curve*) of the conductor. I assume that, in drawing the characteristic curve, steady conditions of temperature are reached at all points. For manganin, not overheated, the characteristic is practically a straight line whose steepness measures the resistance of the conductor, but for a thin wire of

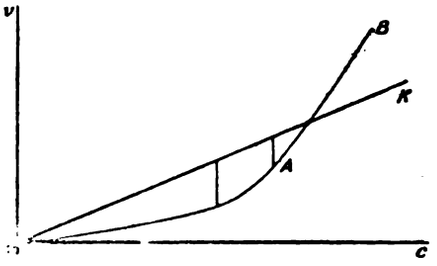

FIG. 13.

nickel the characteristic curve is of the form shown in Fig. 11, which is drawn from an actual experiment with wire of 0·05mm. (two mils) diameter. It will be noticed that the higher part of the curve (from A to B) is very nearly a straight line.

Method 11.—Now let a Wheatstone's bridge be arranged, as in Fig. 12, in which the arms, D F and G H, are equal resistances of nickel, while D H and F G (also equal to one another) are of manganin. In Fig. 13 let O A B and O K be the characteristic curve of D F and F G. Then it is easy to show that, as long as the branch from F to H is kept on open circuit, the potential difference from F to H, for any particular value of the current, c, will be proportional to the vertical distance between the two characteristic curves. It is easy to choose the relative values of the nickel and manganin resistances, so that O K shall be parallel to the straight portion A B, as in Fig. 14, and when this is the case $n\,m$ will be constant from A to B, and thus V will be practically constant for all values of the current, c, corresponding to the part A B. As I show in Appendix 2, this regulation also holds even when current is taken across F H the constant value of V, however, depending on the current taken. The construction for this case is shown in Fig. 15. O L is taken equal to C, the current through F H and L K is drawn parallel to the characteristic for the manganin wires; V^1 will

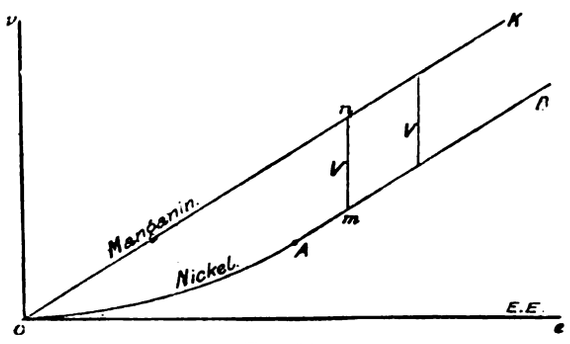

FIG. 14.

then give the value of the constant voltage from F to H. Thus it is possible to obtain very constant voltage and current, although the main current, I (Fig. 12), be drawn from a variable source, such as the mains of a supply company. With actual apparatus the maximum steady voltage which I have obtained has been about one-third of the supply voltage used; with alternating currents the use of a transformer makes this limitation of small moment.

Compensation for Variation of Temperature of Enclosure.—Unless the temperature of the enclosure containing the nickel wires can be kept constant, it is necessary to introduce compensation for temperature. This can be done by replacing part of each manganin resistance arm by copper (in the same enclosure as the hot arms), sufficient cooling surface being allowed so as to prevent undue heating by the current. The curves in Fig. 16 show the results of experiments at enclosure temperatures of 24deg. and 37deg. C. with a regulator compensated in this way. The arms of the regulator (in cyclic order) consisted of a two-mil nickel wire of 3·5 ohms; 20 ohms of manganin in series with 3·4 ohms of copper; and two equal manganin resistances of 125 ohms each.

It will be noticed that near 0·45 ampere both the regulation and the temperature compensation are satisfactory. The level part of the curve (Fig. 16) corresponds to temperatures of the nickel wire between about 400deg. and 600deg. C. It would,

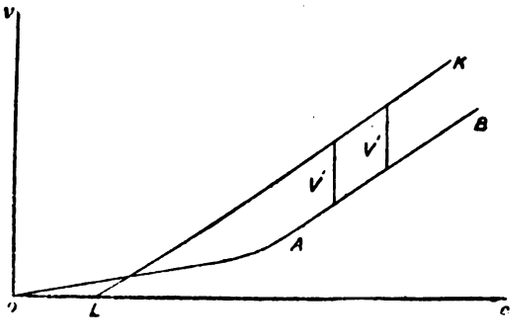

FIG. 15.

I believe, be possible to obtain more extensive and better regulation by using platinum or other material instead of nickel, since the nickel has an abrupt bend in its temperature resistance curve. Also, by replacing parts of the manganin

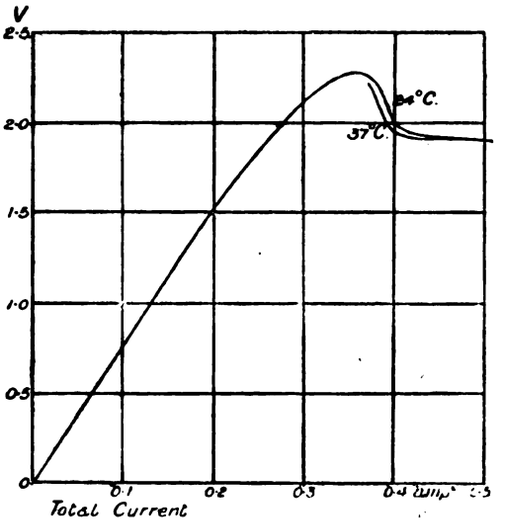

FIG. 16.

arms by heated nickel, say of larger diameter than that used in the other arms, it would be possible to make the upper characteristic bend up slightly, as in Fig. 17, and so to attain more exact parallelism of the two curves, and hence better

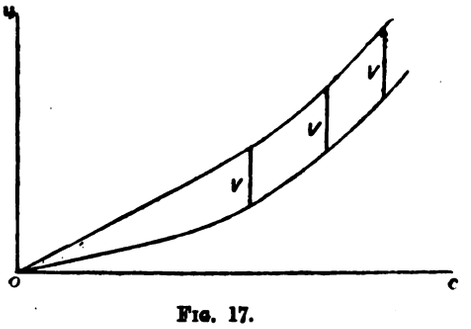

FIG. 17.

regulation. Again, by applying a once-regulated voltage to a second regulator a much greater steadiness would be obtained.

Method 12.—It will be noticed that in the above regulator the function of the Wheatstone's bridge is merely to obtain the

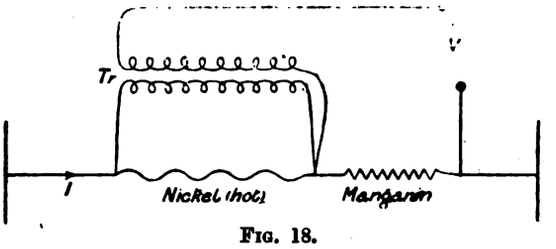

FIG. 18.

difference between the voltages on the nickel and the manganin resistances. With alternating currents the same may also be done by means of a transformer, as shown in Fig. 18, where the transformer, Tr, is connected so as to give a regulated voltage at V.

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Uses of Regulated Voltages.—It is not difficult to find instances where regulated voltages would be of use in testing work. Standard incandescent lamps may thus be run at constant brightness. Shunts of watt-hour meters may be kept on constant voltage during test. With constant voltage, the mere measurement of the current taken by an inductive coil usually gives an approximate indication of the frequency. A constant current from a supply circuit may be used to get direct readings in a simple electric resistance thermometer.

SECTION E.—NULL METHODS OF MEASURING CURRENT.

If in the Wheatstone's bridge arrangement the resistances are so chosen that the characteristics intersect, as in Fig. 13, then we may obtain, for I and V, a curve such as that in Fig. 19, which is drawn from actual experiment (with direct

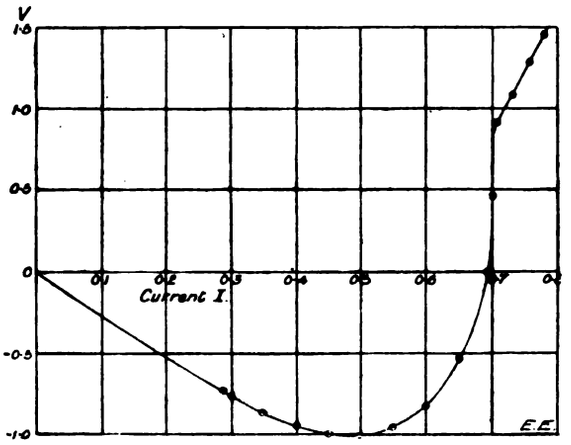

FIG. 19.

current). With proper temperature condensation V vanishes for a perfectly definite value of the total current, I, and if a sensitive detector be added the arrangement becomes *a thermal standard of current*. I have found a telephone with an intermittent contact in its circuit a convenient means of detecting the vanishing of V, the intermittent contact being of advantage even with alternating currents. The accuracy of such a standard is considerable.

Method 13.—If such a combination be put in series with a resistance having a part adjustable by a sliding contact, as in Fig. 20, it furnishes a simple null method of measuring a voltage—*e.g.*, of a supply company—which varies between small limits; the slider is adjusted to give silence in the telephone, and the corresponding value of the voltage is shown by the position of the slider. With alternating current the transformer method (12) is also applicable here, but a detector other than a telephone is necessary; for since the transformer alters the wave form slightly, it is found impossible to get any position of complete silence with the telephone.

Method 14.—In conclusion, I may point out that if a voltmeter be put across V (Fig. 12), it will be seen from the curve in Fig. 19 that a very open scale can be obtained corresponding either to the total current, I, or the outside volts; this furnishes

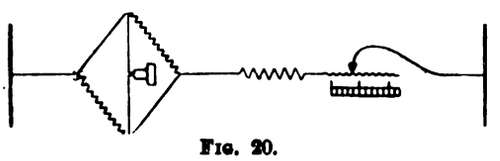

FIG. 20.

a thermally "set-up" instrument. I have found platinum better than nickel for this. Compensation for temperature can be applied as in the other methods.

APPENDIX I.

In connection with my remarks on the measurement of power, I should like to draw attention to an instrument invented by Prof. Riccardo Arnò for measuring the phase difference between two currents. It consists of two co-axial coils carrying the given currents, A and B, and a search-coil, S, connected to an electrodynamometer. (For simplicity, suppose A=B.) The main coils are by trial placed at such an inclination to one another that the search coil shows the same effective induced voltage in all positions as it is turned co axially to the other two. Prof. Arnò shows that with sine-curve wave-forms the angle between the main coils is then the supplement of the angle of phase difference between A and B. I proceed to show that, for any wave-forms (not containing direct-current components), the phase angle obtained is the power phase difference between the currents A and B. In Fig. 21 let the position angles of the three coils be as shown, O X, the initial line bisecting the angle A O B.

Let ϕ = angle of idleness between A and B;
2α = angle of position between main coils;
also let C = current in search coil;

then, by Fig 22, k C is the resultant of A cos $(\alpha+\theta)$ and B cos $(\alpha-\theta)$ at an angle ϕ.

Hence $$k^2 C^2 = A^2 \cos^2(\alpha+\theta) + B^2 \cos^2(\alpha-\theta) + 2AB \cos(\alpha+\theta)\cos(\alpha-\theta)\cos\phi;$$

$$\therefore 2k^2 C^2 = A^2+B^2+2AB\cos\phi\cos 2\alpha + [(A^2+B^2)\cos 2\alpha + 2AB\cos\phi]\cos 2\theta + (A^2-B^2)\sin 2\alpha \sin 2\theta.$$

If C = constant for all values of θ,

then $$(A^2-B^2)\sin 2\alpha = 0,$$

and $$\cos\phi = -\frac{A^2+B^2}{2AB}\cos 2\alpha.$$

Since $$A=B \quad \therefore \cos\phi = -\cos 2\alpha.$$ Q. E. D.

NOTE.—In the above I have assumed that there is no disturbing mutual induction between the search coil and the main coils.

APPENDIX II.

Mathematical Investigation of Bridge Regulator.—As in Fig. 24, let the equation to the upper straight part of the nickel characteristic be:

$$c = \frac{v}{m} + c_0,$$

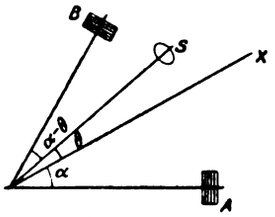

FIG. 21.

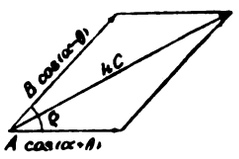

FIG. 22.

where c of course must be kept within its proper limits. If r = resistance of each nickel wire, then

$$\frac{1}{r} = \frac{c}{v} = \frac{1}{m} + \frac{c_0}{v} \quad \ldots\ldots\ldots \quad (1)$$

Now let the bridge potentials and resistances be as in Fig. 23.

Let V = voltage on R
= U − 2 v.

If the outer voltage U be variable, let us find the condition for V = constant.

We have $$v = \frac{U-V}{2} \quad \ldots\ldots\ldots \quad (2)$$

and $$\frac{v}{r} - \frac{V}{R} + \frac{v-U}{a} = 0 \quad \ldots\ldots\ldots \quad (3)$$

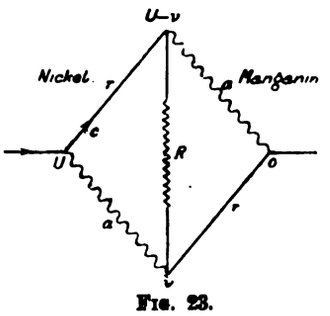

FIG. 23.

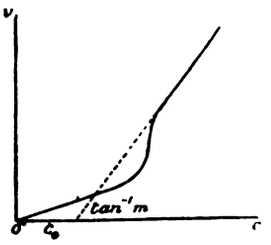

FIG. 24.

Hence, from (1) and (2),

$$\frac{U-V}{2m} + c_0 - \frac{V}{R} - \frac{U+V}{2a} = 0,$$

or, $$U\left(\frac{1}{m} - \frac{1}{a}\right) + 2c_0 = V\left(\frac{1}{m} + \frac{2}{R} + \frac{1}{a}\right)$$

Since V is to be constant,

$$\frac{1}{m} = \frac{1}{a} \quad \therefore m = a \quad \ldots\ldots\ldots \quad (4)$$

Hence $$V = \frac{2c_0}{\frac{1}{m}+\frac{2}{R}+\frac{1}{a}} = \frac{c_0}{\frac{1}{a}+\frac{1}{R}} \quad \ldots\ldots\ldots \quad (5)$$

also $$v = \frac{c_0}{\frac{1}{r}-\frac{1}{a}}$$

Thus we see that, whatever the value of R, the condition for regulation is simply that $m = a$—*i.e.*, that the characteristics of the nickel and the manganin should be parallel (for the upper straight part of the former). Equation (5) gives the value of the regulated voltage for any particular value of R.

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NOTES.

Asphyxiation by Carbonic Acid Gas.—We note that a Bill will be introduced in the next session of the United States Congress, at the instance of the Allegheny County Medical Society, to authorise the asphyxiation of criminals sentenced to death by carbonic acid gas in place of the hangman's rope or the electric chair.

The German Visit.—We are informed that, in the unavoidable absence of the President, Mr. Alexander Siemens (past-president) will assume the leadership of the Institution party throughout the visit to Germany. Members are reminded that their applications for tickets should be forwarded before Saturday, June 15.

The Lancashire Motor Trials.—Referring to the trials of motor vehicles for heavy traffic which were made last week in the Liverpool district under the auspices of the Liverpool Self-Propelled Traffic Association, we understand that the judges have awarded a gold medal to each competitor in Classes A, B, and C. The awards in Class D will be announced n about three weeks.

Presentation.—The staff and employés of the Hammersmith Borough Council electricity works presented Mr. W. E. Brandreth, the late mains superintendent, with a case of drawing instruments and an illuminated address containing over 60 signatures as a mark of esteem on the occasion of his leaving to take up the position of resident engineer and manager to the Wycombe Borough Electric Light and Power Company.

The Longest Transmission Line. — The Bay Counties Power Company, of America, recently inaugurated what is stated to be the longest line for the transmission of electric power for commercial purposes in the world. The line in question extends from a generating station on the north fork of the Yuba River to Oakland, California, a distance of 140 miles. The current is transmitted at a potential of 40,000 volts.

Kew Bridge Works.—Through the courtesy of the engineers, Sir John Wolfe Barry and Mr. C. A. Brereton, a large party of the members of the Institution of Junior Engineers were enabled on Saturday last to pay a visit of inspection to the Kew Bridge works, which are now in active progress. The visit concluded with a cordial acknowledgment of the facilities which had been afforded the party for inspecting the operations.

Automobiles in the States.—The Automobile Club of America, we learn, have resolved to organise an annual road race, to be known as "The Automobile Club of America Sweepstakes," which will probably amount to about £1,000. The race, it is stated, will be international, open to competitors from all over the world. The first contest will, as at present arranged, take place in the middle of September next, probably over the Buffalo-Erie course. It has also been decided to organise an annual race for the mile record.

Arabian Telegraphs.—The Turkish Government have decided on further telegraphic extension in Arabia. The new line which is to be established will run between Bassora and Nedseh, which is situated in the interior of Arabia. The Ottoman Government also, we note, are taking action in the same direction. It is reported that they intend to connect the telegraph lines in the southern province of Yemen with the northern lines situated in the Hedjas. This new line will extend to close upon 800 miles. Starting at Lohija, it will pass along the coast of the Red Sea, and will reach its terminus at Lith, the south-west corner of the Hedjas. We learn, further, that the Turkish postal authorities have been granted a special credit to renew the submarine cables between Galata and Stamboul.

Wireless Telegraphy at Dover. — A Marconi wireless telegraphy installation is now being set up at Dover for the use of naval vessels only. This will be the first Government installation of Marconi's system on our coasts, but there is reason to believe that before long we shall hear of other well-known important seaports being provided with wireless telegraphy by the Government. The site at Dover is on the Western Cliff fortifications, overlooking the Shakspeare Cliff near the coastguard station. The mast will be in three sections, and when erected will measure 180ft. to the top.

Determination of the Specific Heats of Metals.—The *Journal* of the Chemical Society gives an abstract of some experiments carried out by Miss A. Serdobinsky and Miss A. Emelianoff for the determination of the specific heats of metals by their cooling rate. In their method the authors use a horizontal wire, the ends of which are fixed in rigid supports whilst the middle point is loaded to keep it taut. The wire is heated by the passage of a known current and then allowed to cool, the temperature at any instant being known from the length of the wire, which in its turn is calculated from the sag of the middle point. The authors' measurements yield for the mean specific heat of platinum the values 0·0319 and 0·0318.

Wireless Telegraphy for Canada.—Advices from Montreal state that the Canadian Government are considering the question of installing a system of wireless telegraphy as an aid to navigation in the Gulf of St. Lawrence, and to this end a series of tests are shortly to be carried out. Federal officials having examined the system in use on the steamship "Lake Champlain," instruments have been cabled for to England for the purpose of the proposed experiments. According to present intentions, one operator will be placed at Belle Isle and another on board a Government steamer. The general opinion among shipping men in Montreal is that the installation of the Marconi system, for instance, would reduce the dangers of navigation at the entrance to the St. Lawrence by 75 per cent.

Alternating-Current Integrating Meter.—We are pleased to hear that the Board of Trade have now finally approved of the Shallenberger alternating-current integrating wattmeter for the measurement of electrical energy when supplied on the constant-potential alternating-current system, and also that they further approve of the means provided for fixing these meters and for connecting them with service lines. The meter specifications and instructions were deposited at the Board of Trade by the British Westinghouse Electric and Manufacturing Company, Limited. We are particularly pleased to note that one more meter has been added to the list of the few previously approved by the Board of Trade, and, in view of the severe tests to which these meters are put, consider it a great compliment to the firm.

Osmium Lamps.—Some experiments have recently been carried out in order to test the relative efficiency of osmium lamps with ordinary carbon lamps. In one test four 25-volt osmium lamps in series and four 100-volt carbon lamps in parallel were arranged on a 100-volt circuit, and both gave the same illuminating power, but the osmium lamps consumed only 40 per cent. of the current required for the ordinary lamp. In another test an osmium lamp consuming energy equal to 24 watts gave a light of 20 c.p., while a carbon lamp with the same consumption gave a light of only 6 c.p. Osmium lamps can be made to give a light of from two to two hundred candles, and lamps that have become darkened can be restored without renewing either

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the bulb or the filament. The supply of osmium is becoming rather limited, and the question still remains as to how far the price of the metal is prohibitive.

Tynemouth Electricity Works.—With respect to our description of the electricity works belonging to the Corporation of Tynemouth which appeared in our last week's issue, we understand from Mr. C. Turnbull, the borough engineer, that the following slight correction should be made in our notes. It is with regard to the arrangements for stopping and starting the pump, drawing water from the hot-well, and forcing it up to the top of the cooling tower. The automatic arrangements which we described and illustrated are to be slightly altered so that the pump is not actually stopped as the water-level falls, but is slowed down so as to draw the water at a slightly slower rate. It will be readily seen that this will be a decided improvement. With respect to the diagram of the regulating switches for the accumulators, these were actually put on the neutral side of the cells, and hence were not arranged quite as shown in the diagram.

Motorcars for the Army.—The question of providing the British cavalry in South Africa with remounts has apparently had the effect of sharpening the wits of some of our legislators. In the House of Commons, for instance, an hon. member hit upon the brilliant idea of substituting motorcars for horses, observing the while that they could go into places where horses could not proceed, that they could move faster and carry heavier goods. A charge of cavalry mounted on motorcars would certainly be something more than unique, and the spectacle of mounted Boers being pursued over kopjes by motorcars brought forth some jocular remarks from the hon. members assembled. Later on, however, it was stated that the Government are alive to the importance of motorcars for transport purposes, and are now conducting experiments with a view to their utilisation in the army. In connection with this, we may mention that representatives of the War Office were present at the recent Liverpool trials, and watched the results throughout.

Electric Tramway Switch.—In the *Street Railway Review* for May 15 the description is given of an automatic electrical and mechanical track switch which is being introduced by the American Electric Switch Company, of Pittsburg. The arrangement of this switch is such that the driver of the electric cars can operate it, and in this way the expense of keeping a pointsman at the turn-outs is avoided. The switch is operated by means of a solenoid, through which the current to the tramcar is passed. A small section of the trolley wire, about 20ft. from the switch point, is insulated from the rest of the trolley wire, and all current going to this small section is passed through the switch. If, then, the driver keeps the current on as he goes over this small section the electric switch will be operated, and he will take the turn in the track in one direction. Should, however, he desire to go straight on, he will not take current from the line when going over this section, and the switch will remain in its normal position. A drawing is given of the apparatus in our contemporary, but the essential details of the gear require larger illustrations to make them clear.

Theft of Electric Current.—The issue of *Electricity* for the 15th inst. refers to the case of a farmer located near New Egypt, N.J., who is being sued by the Bordentown Trolley Company for the larceny of electric current. It seems that for some time the trolley company has been wondering how it happens that it required a greater amount of electric current to run the Bordentown branch than it did to run any other road of similar length and grade in the country. After considerable investigation by electrical experts, it was discovered that the ingenious Bohemian farmer referred to above had tapped one of the main feeders, and was utilising the current thus obtained to stimulate the growth of certain crops on his farm. A perfect network of wire was discovered under a certain patch 300ft. long by 200ft. wide in which radishes were grown, which are claimed to have matured in 19 days, whereas radishes grown under ordinary conditions required six weeks. This raises a nice point for the consideration of the court. Our contemporary suggests that the question for the judge to decide is, what number of amperes of current equals one month's natural growth of a radish in a sandy soil?

Comparative Testing of Fan Motors.—Mr. S. D. Gilbert contributes to the *American Electrician* a short description of a device he has used for testing fan motors to find out which circulates most air with the least consumption of energy. In our opinion, the apparatus used does not find out what is required, because the means of carrying out the test interposed resistance to the current of air, which may entirely alter the working of the fan. The device consists of placing a large disc pivoted on a knife-edge opposite the fan and about 1ft. from it. The motor is then run up to speed, and the lever on the disc counterweighted until it occupies the same position as before. The weight required to keep it in this position is then used as a means of ascertaining the work done by the fan, while the energy given to the motor is measured in the usual way. While with the same class of fan and the same pitch of blades the apparatus may give some idea of what is being done, the method is quite incapable of giving any reliable results when the above-mentioned conditions are varied. In any case, the fan will deliver much less air with the disc in front of it than it would do if delivering into an ordinary room.

An Aerial Machine.—A new flying machine, which has been built in "great secrecy" by Messrs. Denny Bros., of Dumbarton, has recently been experimented with, and is reported to have given much satisfaction. The owners of this machine are two Spanish gentlemen, father and son, who apparently are extremely anxious that no details shall leak out, and in order to observe strict secrecy the trials were carried out in some private grounds. Notwithstanding these precautions, however, some particulars of the machine have appeared in the daily Press. We are told, for example, that the mechanism is somewhat after the style of that adopted by Mr. Henry Suter, of Zürich, having a pedal arrangement. This form of engine was adopted in preference to a petroleum engine after repeated experiments. The flying machine itself measures 40ft. from tip to tip of the wings, and the weight, including that of the driver and steerer, is about 6cwt. The trials are said to have been attended with much success. The machine rose steadily, and demonstrated the accuracy of the principle on which it is made, although the driving power was inadequate to cause the wings to flap and oscillate.

German Patents.—As in the case of this country, a considerable increase is shown in the number of applications for new patents in Germany during the past year over the previous 12 months. This increase amounts to 845, the number of applications received at the German Patent Office during 1900 standing at no less than 21,925. The subjects in respect of which this augmentation is particularly noticeable include the electro-technical, lighting, printing, and metallurgical industries. As regards the patents granted during this period the figure is put at 8,784, as against 7,430 in the previous year and 5,570 in

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1898. After the cancellation of 19 patents, there remained still in force at the end of the year 25,115 patents. A large number of the applications for new patents to the German authorities came from abroad—viz, 1,734 from the United States, 1,307 from France, 1,034 from Great Britain, and 1,029 from Hungary. The average life of a patent in 1900 was 4·7 years. At the present time, however, there are no less than 114 patents in existence which were granted in 1886. In the course of the present year these will expire. It will be seen from the above figures that the number of patents granted to inventors in Germany is continually on the increase.

The Development of Cuba.—With the conclusion of the war between Spain and the United States, the development of the island of Cuba was energetically begun. While, on account of the policy of the United States Government, American investors have been discouraged in this work, English, German, and companies of other nationalities are carrying out plans for public improvements in Cuba, recognising, as they do, that satisfactory terms will sure to be granted to them before long. The *Street Railway Review*, dealing with the subject, refers to the reports from Cuba concerning the progress made by Sir Wm. Van Horne in carrying out his electric railway enterprises in the island. An old law provides that the owner of land may build such railways as he sees fit thereon, and, owing to the general franchise law being suspended, Sir Wm. Van Horne has purchased whole farms contiguous to each other along the routes of the proposed lines, thus getting rid of the difficulty of obtaining the consent of the United States Government. The Cuban municipal authorities, on the other hand, have been very ready to grant rights over their streets, and the only obstacle is as to crossing the highways between plantations, which highways are under the control of the United States War Department.

New York Tramways.—The cable tram in New York has had its day, and last week saw the whole system of cable trams on the Broadway route supplanted by the more modern and popular electric cars on the conduit system. The effect of the sudden change on the public was one more of surprise than anything else, for the whole transformation was all effected in one day, whereas the general opinion was that the cars could not be put on the road for a week. New Yorkers are, therefore, loud in their praise of the skill and energy which has been shown by the tramway company on this occasion. While this is generally admitted, however, we find that in the technical Press of New York the change, as a change, is regarded as being rather late in the day. The *Electrical World*, for example, informs us that some 10 years ago, when the cable was going in, they entered a vigorous protest on the ground that it would soon have to come out and be replaced by electricity, and the editor maintains that an electric conduit system could have been successfully put in at that time on this route. Referring to the trials now being made with compressed-air cars in New York, the editor regards them as an even worse failure than the cable cars, and ends up by deploring the fact that time and money should be wasted in the effort to substitute them for electricity, which is emphatically the "all-conquering, all-sufficient agent of modern traction."

American Engines.—According to some information which has been collected by our enterprising contemporary, the *Daily Mail*, the Midland Railway Company have not found that the American locomotives compare at all favourably with those of English make. The local superintendent of the line, Mr. S. W. Johnson, has reported that American engines consume at least 20 per cent. more fuel and 50 per cent. more oil than engines of English make doing the same work. Mr. Johnson also states that the repair bill is some 60 per cent. higher for the American locomotives. The first two items, of course, are serious matters on any line, but we should not be surprised to find that with regard to the repairs, the extra cost is partly due to the fact that they have to be made on a locomotive the parts of which are made, not to English standard, but to American. This would certainly increase the cost of making such repairs. The other point, however, in connection with engine repairs may be that the American manufacturers are not using the same care as their English contemporaries in the selection of the materials used in the construction of locomotives. Central-station engineers who have had experience with stationary engines made in America have in certain instances already found that this is the case, and that while they can get more prompt delivery by sending their orders across the Atlantic, there is evidence that for length of life English-made engines have a great advantage over those made in America.

Teneriffe Electric Tramway.—The United States Consul Berliner, writing from Teneriffe, Canary Islands, announces the inauguration of an electric tramway line connecting the port of Santa Cruz with the town of La Laguna. In addition to passengers, it is anticipated that considerable traffic will be forthcoming in connection with the carriage of fruit, which is the main export from the island. The power house is situate at La Cuesta, about halfway between the two towns, and at an elevation of 960ft., La Laguna being 1,804ft. above the sea-level. The tramway, which consists of a single track, is on the overhead trolley system, both wood and iron poles being used in the country. In the towns span wires are strung over the street from house to house. The concession for the line includes the whole of the road between Santa Cruz and Oratava, and from the present terminus there will be a regular service of automobiles to the town of Oratava until the extension is completed. The total length of the line will then be some 27 miles. The company having the work in hand is the Compania Electrica de Tramvia de Teneriffe, and has a capital of over £61,760. Another Belgium company has also obtained a concession for an electric double-track system between the ports of Luz and Las Palmas, in the island of Grand Canary. This road will run along the seashore, and extend from four to five miles. In a way, this line, when constructed, will be the more important of the two, as Las Palmas is practically the principal town in the Canary Islands, and is doing considerably larger business than Teneriffe.

A Successful Railway Swindler.—The *Street Railway Review* for May tells of a notorious railway swindler who has just been sent to prison in the States for practising a number of successful frauds on the steam and electric roads and accident insurance companies in America. For the past 10 years this man, who bears the name of Moffett, has carried on an ingenious system of swindling by pretending to get hurt on a train and then compromising with the railway company, or by taking out an accident policy, claiming to be hurt and collecting on the policy. The curious fact in connection with this man's career is that he himself once filled the position of manager of a large insurance office in the States. With the assistance of an accomplice, he has practised these frauds on very nearly all the railways in the States, as well as succeeding in swindling as many as 21 insurance companies. Both men were aided in these swindles by the fact that each had an ununited fracture of the ribs, and thus could always get a doctor to certify that they found broken ribs. One of the many different schemes Moffett practised was that

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if he heard of a runaway or a train wreck he would at once go to bed, summon a doctor, and pretend to have been injured in the accident. He had a complete list of all the railway claim agents and insurance adjusters in the country, and he lost no time in notifying them when he chose to get hurt. He always made it a point to get the best doctors to attend him, as he stated in a confession made after his conviction that they were the easiest deceived, and insurance offices were quite willing to accept their statements without question.

Motorcar Demonstration.—The policy adopted by the Automobile Club of giving practical demonstrations of the powers, advantages, and possibilities of motorcars to public authorities who would reduce the speed to 10 miles an hour, etc., is certain to win in the long run. Our readers may remember that some short time ago the club arranged a demonstration in Essex solely for the benefit of the county councillors and representatives of the local authorities, and that in several quarters the invitations were refused on the ground that they "wished to preserve an open mind on the subject." This, however, would not seem to be the feeling on the occasion of the last invitation sent out by the Automobile Club. The result was that some 250 county councillors from all parts of the country have, during the last three days of the past week, been indulging in rides from the clubhouse, in Whitehall-court, to Sheen House, Richmond, on motorcars lent for the purpose by members. From the tenor of the speeches at the luncheon which followed the drive to Sheen House on Saturday, it seems pretty clear that many of the prejudices which have heretofore governed the minds of the various county councils in this matter have been to a great extent removed. The company of 300 members and guests of the Automobile Club included Earl Grey (in the chair), the Duke of Northumberland, Sir Arthur Arnold, and others, and it was generally admitted that the drivers of the motorcars had proved themselves to have complete control over their vehicles. Some pleasant rides through Richmond Park were afterwards enjoyed, and the day's proceedings concluded with the drive back to town.

Army Reform — Proposed Advisory Board.—Major-General Webber, C.B., read an interesting paper on Monday night before the United Service Institution on the vexed question of army reform. In an address which lasted over an hour the lecturer advocated in the strongest way the necessity for the establishment of a Board, the members of which should be selected from the services, be appointed by the Crown, and be as independent and as permanent as the members of the judicial bench. The object of such a body would be to enable a standing joint committee of both Houses of Parliament, for instance, appointed to consider all questions of offensive defence, to have direct access to the best and most experienced sources of advice without the intervention of Ministers who are members of a party Cabinet; the ultimate object of it all being to bring the mind of the British public in direct contact or connection with the mind of a group of selected professional sailors and soldiers, placed so as to be outside all questions of party politics. The only portions of the Admiralty and War Office administrations which General Webber would transfer to the control of this new body are their respective intelligence departments. There was no question in his mind that the conditions of the armie in France, or America, or Germany, or Russia, produced the only real business-like results as regards the efficiency in everything for which an army exists. General Webber proceeded to show how traditional and contemporaneous parliamentary procedure gave no precedents conflicting with his proposals, and how the Government of the day would be relieved of responsibility which at present is always interfering with the true functions of the advisers of the Crown. He dwelt on Colonial defence, and the confidence which such an Advisory Board would give to men's minds throughout the Empire. It should be remembered that General Webber's proposal does not conflict with Mr. Brodrick's proposals now before the country. On the contrary, the existence of a permanent Advisory Board would, in General Webber's opinion, subject those proposals to instructed criticism, and help to safeguard the continuity of the application of all that is best in those proposals.

A Water Rheostat.—The *Electrical World* of New York in its issue for June 1 devotes an article to the description of a water rheostat now in use at the Pan-American Exhibition for bringing gradually up to candle-power the 200,000 8-c.p. incandescent lamps which furnish the decorative lighting at the exhibition. This is the first attempt, it is said, to bring up slowly or gradually reduce in candle-power such an immense body of lights simultaneously. The location of this big rheostat is at the western edge of the grounds, where the 11,000-volt Nigara transmission line enters. The rheostat-house, which is built on stilts about 15ft. high, contains three tanks of water, one for each leg of the circuit. The transmission line supplying the exhibition, it may be stated, consists of two three-phase circuits. The water-tanks referred to are all mounted on porcelain insulators such as are used on the line. Into each of these tanks a cast-iron plate operates to vary the resistance in circuit. The plate is pivoted in such a manner as to describe the arc of a circle while being lowered into the water. When quite in the water the tip of the plates strikes a submerged clip, or switch jaw, which short-circuits the rheostat. The increase of candle-power of the lamps from the dullest red to full brilliancy is said to be very steady, except that there is a sudden rise just before the plate, which is lowered by an electric motor working on a worm gear, strikes the submerged clip. To bring the lamps up to full candle-power occupies only 45 seconds, while in shutting down some 75 seconds is taken. From the appearance of the lamps the voltage at the start is said to be not over 20 per cent. of the full voltage. Calculations show that, assuming the 200,000 25-watt lamps take one-fifth their normal current and voltage at the start, the rheostat takes 800 kw. The lip at the pivot end of the cast-iron rheostat plate is always under water, and the circuit is broken by the main oil switch in the electricity building. It was found impracticable to break the arc at the rheostat, or even to allow the plate to come the least bit out of the water, as the resultant arc would stream all over the neighbourhood. The rheostat is used only for turning on the lights at the grand illumination at 8 p.m., and for turning them off for the night later on.

A Steam-Driven Transmission Plant.—An article by Mr. J. R. Cravath in the *American Electrician* for June has considerable interest, in view of the information given with respect to the transmission of energy for electric lighting over a considerable area with steam-engines as the prime mover. The plant in question is situated at Santa Monica, and the generating station is connected up by transmission lines to Long Beach, Terminal Island, San Pedro, and Redondo. The voltage used in the transmission is 22,000. In each of these four places small steam plants were previously used for electric lighting, and by supplying them from a common transmission scheme a saving in fuel and labour of 50 per cent. has been made. The large generating station is placed on the Santa Monica beach, and serves the North Beach bath-house with hot salt water

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from its condensers, in this way gaining an additional source of income. The electricity is generated at 60 frequency and 2,200 volts, and then transformed up for the transmission lines by means of oil-cooling transformers. The whole of the power is now used for electric lighting, but we understand that there are some irrigation works on the line of route which employ some 800 h.p., which are almost sure to come on to the mains. The longest distance over which the current is transmitted is 35 miles. The transmission line consists of three No. 6 medium hard-drawn copper wires on "Provo No. 1" glass insulators furnished by the Hemingway Glass Company, of Covington, Ky. These insulators get their name from the 40,000-volt transmission plant at Provo, Utah, where they were first employed; they are 7½in. in diameter. There are also some Locke insulators. The insulator pins are 12½in. long over all, 8½in. from the top to the shoulder, and raise the insulator 4in. from the cross-arm. They are made high to prevent leakage from the edge of the insulator to the cross-arm. The cross-arms and pins are boiled in linseed oil. The cross-arms are 44in. long, and carry a pin on each end; the distance between wires is 34in. The top of the pole is bound with iron wire, and bored to receive a pin which carries the top wire of the three-wire triangle. The line is transposed every mile. The poles are spaced 130ft. apart; they are 35ft. long in the country and 40ft. long in the towns. The line is designed to transmit 300 kw., and is now carrying 150. The apparent energy required to charge the line is 34 kw. The voltage is 16 per cent. higher at the far end than at the Santa Monica power-house, due to the capacity of the line.

Municipal Supply in Bulk.—In our issue for May 24 we gave the gist of the resolutions passed at the conference held between the representatives of the various local authorities in Greater London and the London County Council to consider the general question of the legislation affecting generating stations for the supply of electricity in bulk. It was decided at this conference, among other things, to draft a Bill to confer certain powers on the County Council, and we now gather from the agendas of the various local authorities concerned that the following are the lines upon which it is proposed to draw up the Bill. In the first place, a clause is suggested to the effect that "Where a company or person is authorised under the Electric Lighting Acts, confirmed by Parliament, to supply electricity within any area extending into the district of more local authorities than one, such authorities may combine for the purpose of purchasing the undertaking of such company or person, whether by agreement in anticipation of the date at which powers of compulsory purchase may be exercised, or compulsorily at such last mentioned date, and in any such case the London County Council, with the consent of the local authorities of the districts concerned, may either by agreement in anticipation of the date of compulsory purchase, or compulsorily at the date of compulsory purchase, purchase the undertaking of such company or person." In the second place, it is proposed that "Where either by agreement or compulsorily the London County Council shall have purchased the undertakings of any such company or person, the Council may by agreement with the local authorities concerned, either manage and carry on the undertakings or any part thereof, or transfer the same wholly or in part to any such local authority or authorities." Thirdly: "Where a company is constituted for the purpose of holding lands or providing a station for generating electrical energy and for supplying electrical energy to any other company, body, or person, and such first mentioned company is not a company supplying energy directly to persons consuming the same, the undertaking of such first mentioned company shall become subject to purchase at the times and upon the terms prescribed by Section 2 of the Electric Lighting Acts, 1882 and 1888, provided that in lieu of the period of 42 years from the date mentioned in Section 2 of the Electric Lighting Act, 1888, there shall be substituted a period of 42 years from Aug. 26, 1889." And, fourthly: "Where the London County Council shall have purchased the undertakings of any such first mentioned company, the Council may either manage and carry on the undertakings or any part thereof or transfer the same wholly or in part to any local authority or authorities."

South Wales Power Scheme.—An interesting review of the progress made and the work yet to be carried out in connection with the South Wales Electrical Power Distribution Company's scheme appeared in a recent issue of the Cardiff *Western Mail*. Mr. G. L. Addenbrooke, managing director of the company, who is responsible for the article, first refers to the position of the company in relation to the Rhondda Urban District Council. A satisfactory agreement between the two bodies has been come to, the outline of which is that the Council allow the company to supply electrical energy for power purposes throughout the Rhondda district, but the company are prohibited from applying for a provisional order for lighting purposes without the consent of the Council. At the same time, in the event of the Council determining to supply their own electric light, a schedule of rates has been agreed upon, under which the company are to supply the current wholesale for distribution by the Council. With regard to those local authorities who obtain provisional orders this year, the position is equally beneficial to the company. Although these councils may erect their own generating stations, this will not prevent the company bringing mains into their respective districts, so that the users of power will be certain of getting the cheapest possible supply. Turning to the work which the company have in hand, the ground has now been sufficiently cleared to enable them to get on with the engineering part of their project. After careful consideration, and on the advice of Messrs. Bramwell and Harris, the consulting engineers, it has been determined to erect, in the first place, a large station in the neighbourhood of Pontypridd. Plans and estimates have been prepared for this station, which it is intended shall have a capacity of 12,500 h.p. to commence with. Excluding spares, this will permit 10,000 h.p. to be used at once for supply. The voltage on the trunk mains proceeding from the station will probably be about 10,000 volts, which will practically enable any point to be reached in the company's area, though as soon as the load grows and circumstances warrant steps will be taken to commence operations on the other sites which were scheduled in the company's Act, near Pontypool and Neath, so as to relieve the load on the central station. As far as can be predicted, the work of erecting the station and laying the mains will take about a year from the date of the sanction of the Board of Trade being received. This is expected within the next two months. Mr. Addenbrooke then goes on to refer to the several other power schemes which are in progress or projected, with a view to showing that there is now a general movement in this country to initiate electric power supply over all the great industrial districts. He concludes with the hope that the people of South Wales seeing the advantages which such a supply of power over their area will give, and wishing to be in the forefront of the districts in the United Kingdom in which such facilities can be obtained, will do all that reasonably lies within their power to help the legitimate enterprise of the company and facilitate its progress.

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THE COMING VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

(Continued from page 815.)

The Cable Works of Messrs. Siemens and Halske on the Nonnendamm.

The new cable works of the Siemens and Halske Company, which were put into active operation on August 1, 1899, is situated between Charlottenburg and Spandau, on the northern shore of the Spree, and can be reached in about 20 minutes from the Jungfernhaide depôt of the Berlin Ringbahn. Goods are brought to the works by water as well as by railway. For this purpose a canal has been cut which extends from the Spree to the factory. Fig. 2 shows this canal, whose dock is equipped with an electrical travelling crane. The railway traffic between the freight depôt, west end, and the works is effected by a steam ferry, which transports simultaneously two railway cars (see Fig. 1). After their visit at the dynamo works at Charlottenburg, the British guests of Messrs. Siemens and Halske will be conducted on board a special steamer placed at their disposal for the purpose of going down the Spree, which here passes through a lovely landscape; and after having partaken of lunch on board, they will be landed at the cable works at Nonnendamm.

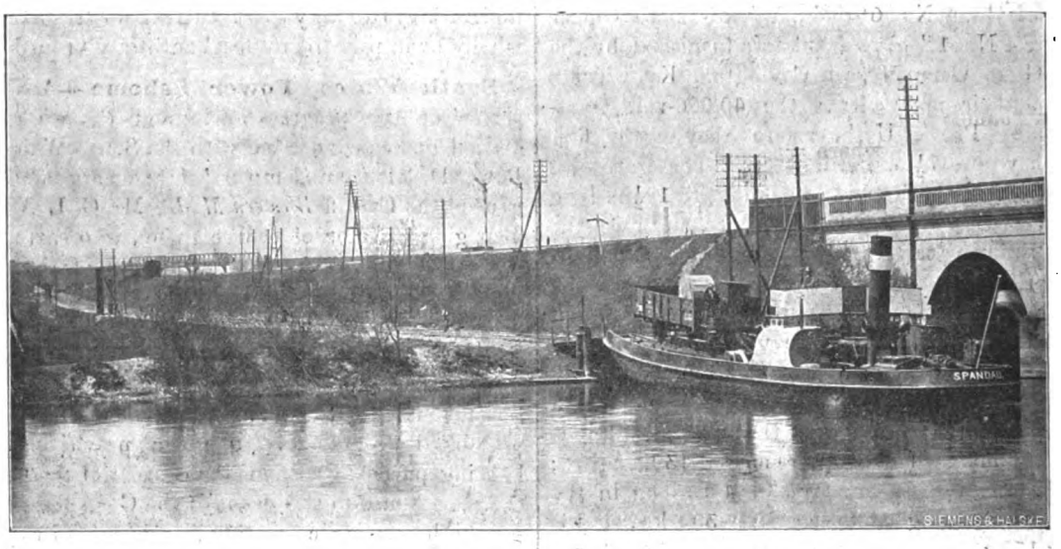

Fig. 1.—Steam Ferry.

The cable works, constructed on piles, consist of a horseshoe-shaped edifice, which in its inner open yard contains a number of extended halls connected with the whole building. The workshops, sample-rooms, and offices are also in close touch with each other, which is especially valuable in a cable works, as the transport of half-finished cables over an open court exposed to the weather is thereby avoided. An extension of the works is possible by adding a western addition to the establishment. The manufacture takes a course from north to south, and each north-southerly extending field of pillars in the halls forms in some measure a little cable works of its own. It is, therefore, possible by the addition of one or more rows of pillars to enlarge the works as far as is desired. The cable works is used for the manufacture of lead-covered fibre cables, produced principally in the halls and connecting rooms. In addition, guttapercha and rubber covered cables are made in the main building, and for telephone purposes cables insulated with paper are also manufactured. Covered and braided wires of different kinds for installation purposes and for the building of machines and apparatus are also largely manufactured.

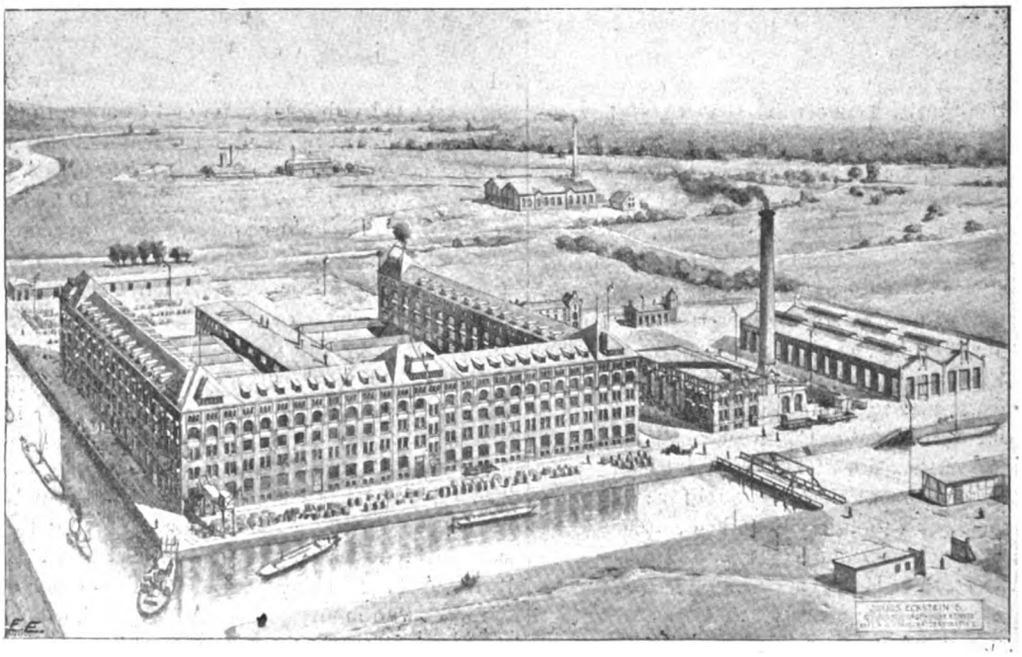

Fig. 2.—View of the Cable Works.

Manufacture of Heavy Cables.—The manufacture of heavy cables begins in the hall. After the wires have been given out from the stores they are taken to the wire-winding drum, where they are put on coils—the so-called bobbins which fit into the cable machines. Then in the stranding department the copper wires are united on the

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cable-stranding machine (see Fig. 3 and Fig. 3A), and finally are covered with the insulating material, jute usually being used. Next to the stranding department are the impregnating and lead-pressing rooms, situated in

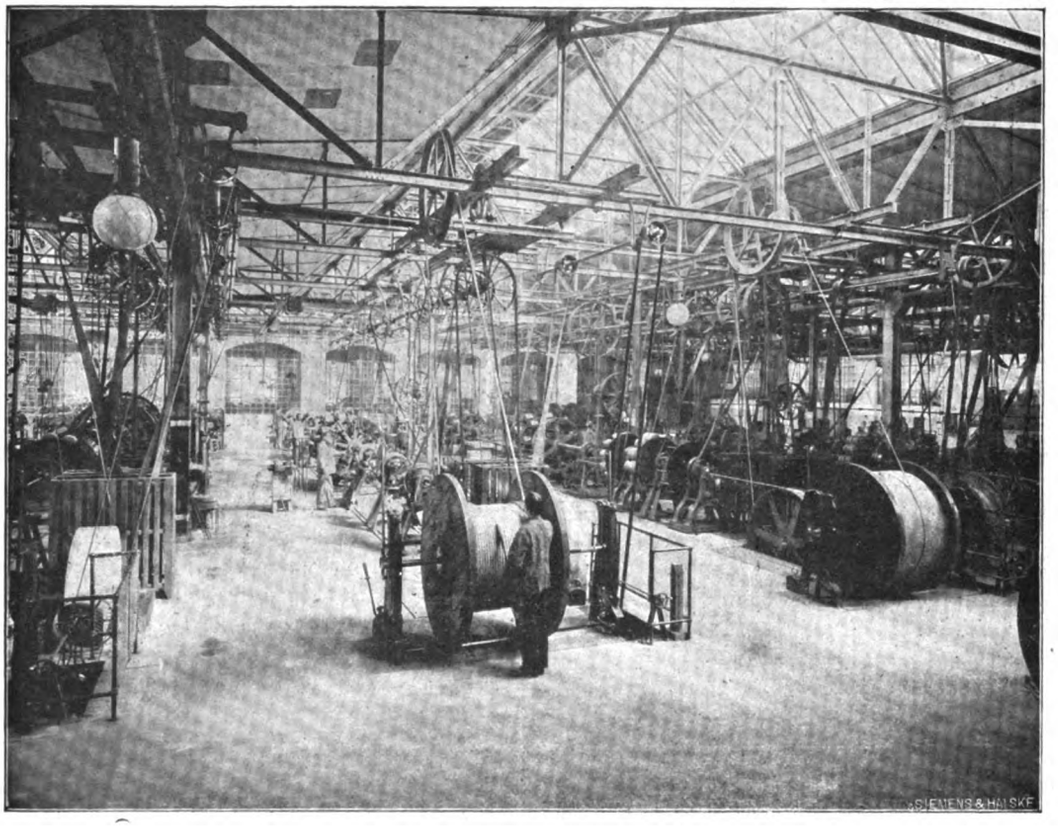

FIG. 3.—Stranding Machine.

the middle part of the halls. Here the cables covered with jute in vacuum drying boxes are cleared of moisture, and then in large kettles most thoroughly impregnated and insulated. Fig. 4 shows in the background such drying

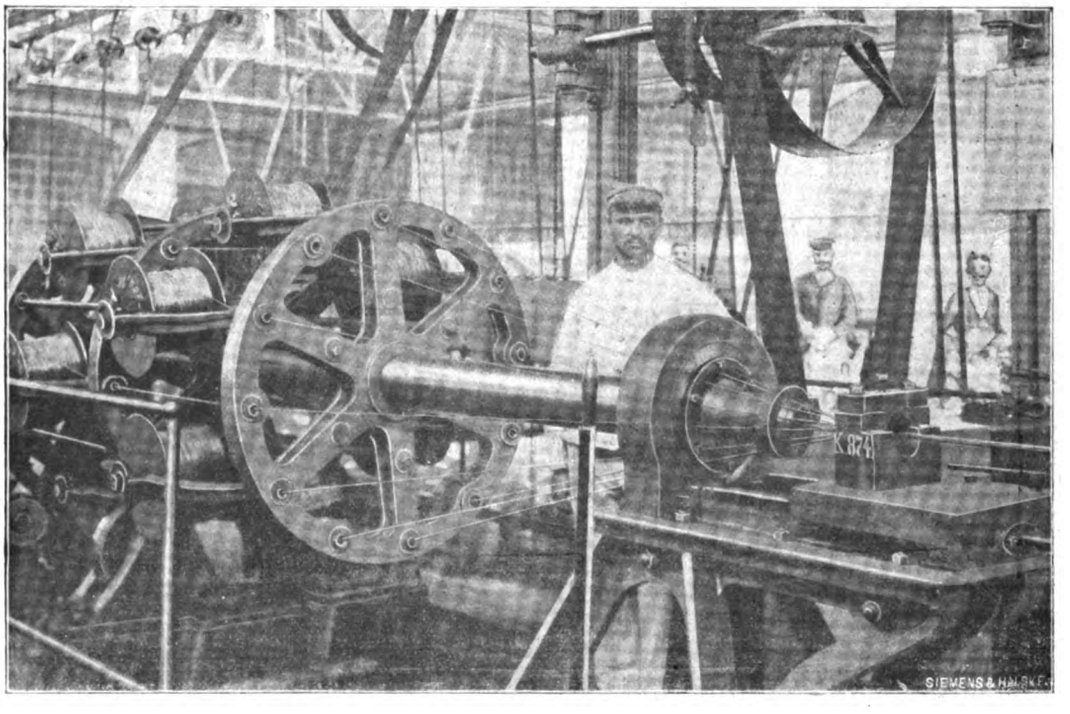

FIG. 3A.—Stranding Machine.

apparatus, while in the foreground the round impregnating vessels are observable. From the kettle and the melted insulating mass the cable rises direct to the lead press, and is covered there with a seamless lead mantle. Fig. 5 shows a lead press, in which the lead has been warmed in such a way so as to be in a plastic condition. Besides a number of cold-lead presses, there are hot presses which, under pressure, squirt the lead out of a cylinder round the cable. After the cable has been thoroughly lead covered, it is carefully tested in the testing-room to make sure that the insulation is complete and effective. By these measurements the fact is thoroughly established whether or not the lead covering has been made totally tight—*i.e.*, capable of withholding the entry of moisture into the insulating fibre. The cable during testing is placed into a tank. If the testing proves the perfectness of the cable, that shows the satisfactory working. Furthermore, in order to protect the armature against damaging

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influences of the earth wherein the cable is to be placed, it is covered with fibre and insulated, as shown in Fig. 6. After the cable finally, in order to prevent sticking, has been drawn through a bath of lime-water, it is wound on large wooden drums, and taken to the southern end of the hall, where the different lines of manufacture are brought for shipment. The production of the heavy cable department includes, of course, the manufacture of heavily protected cables, such as submarine and subfluvial cables, and also mine cables on a very large scale. Messrs. Siemens and Halske have supplied a considerable number of mines on the Continent of Europe with these latter, as well as in South Africa and Asia, where they have been called upon to erect many complete electrical mine plants.

Manufacture of Guttapercha and Rubber Cables.—Since it was discovered that guttapercha was a very suitable insulating material for earth cables, its use for subterranean and submarine cables has assumed enormous proportions. Guttapercha cables are manufactured in the following manner: The guttapercha, by heating and by the use of a kneading machine, is softened to a plastic condition. The soft guttapercha goes into a press, which has a strong resemblance to the lead press previously mentioned, and by the use of suitable mouthpieces the guttapercha is pressed around the wire. Fig. 7 shows such a machine. After the wires have received a coating from the press shown standing in the background, they are run over pulleys partly through the air and partly through water, in order that the

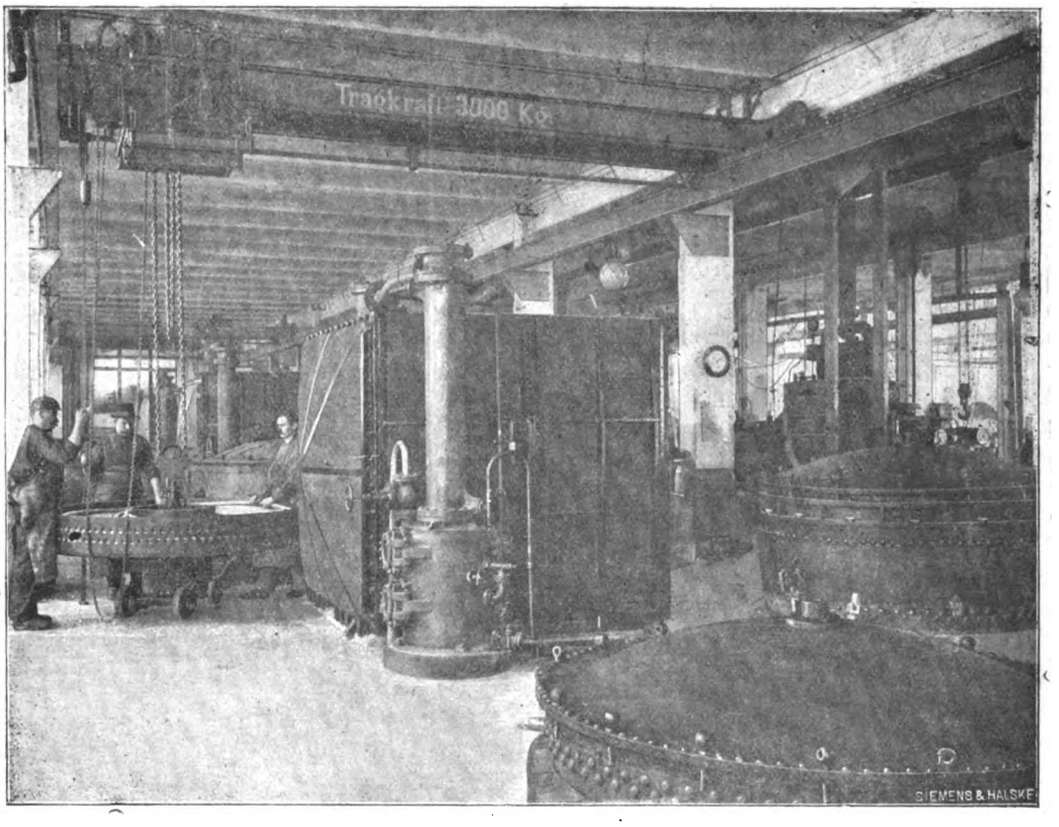

FIG. 4.—Drying Boxes.

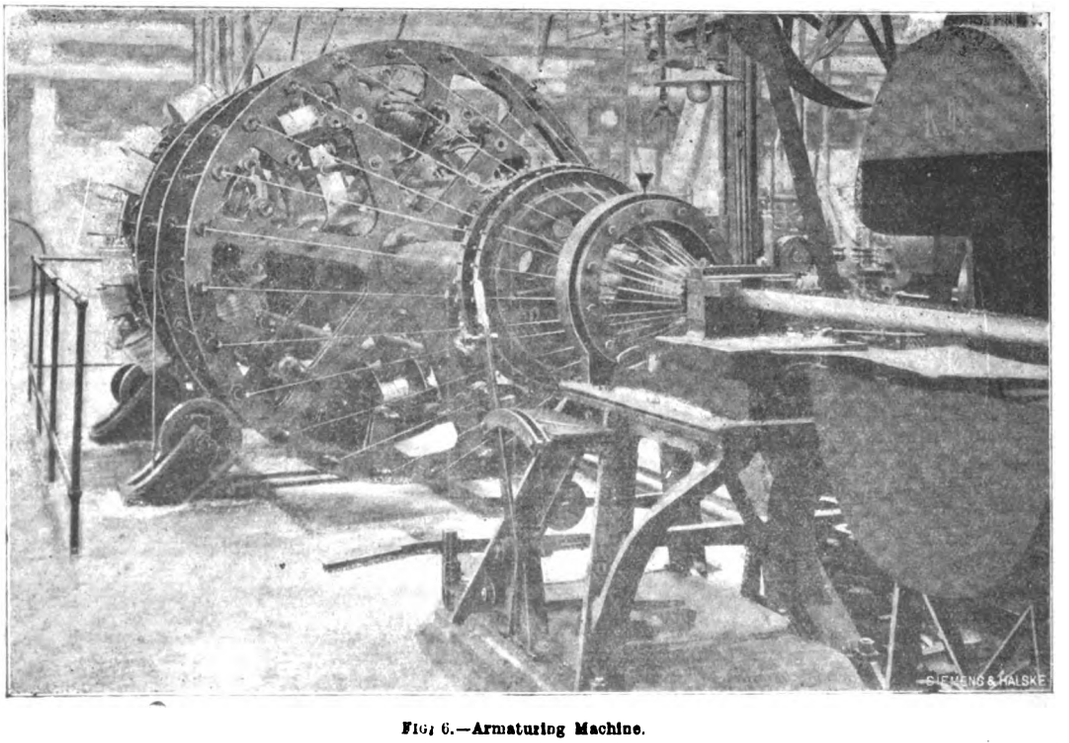

FIG. 6.—Armaturing Machine.

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guttapercha may be hardened. Owing to the high price of guttapercha, other substances of the rubber kind, especially indiarubber, are used in the manufacture of cables. In the production of cables of indiarubber, vulcanising the rubber is necessary. For this purpose the rubber is kneaded together with sulphur or sulphur-holding material. In the later course of production, by proper heating the sulphur is united with the rubber, taking from the latter its sticky properties, and giving to the manufactured article many of the valuable qualities possessed by guttapercha. The indiarubber cables, just as the guttapercha cables, are made by pressing the material around the wires. The wires, by special machines, are often put between two indiarubber bands and rolled in a mould. Sometimes the wires are covered with rubber bands, just as would be done with silk or other insulating material.

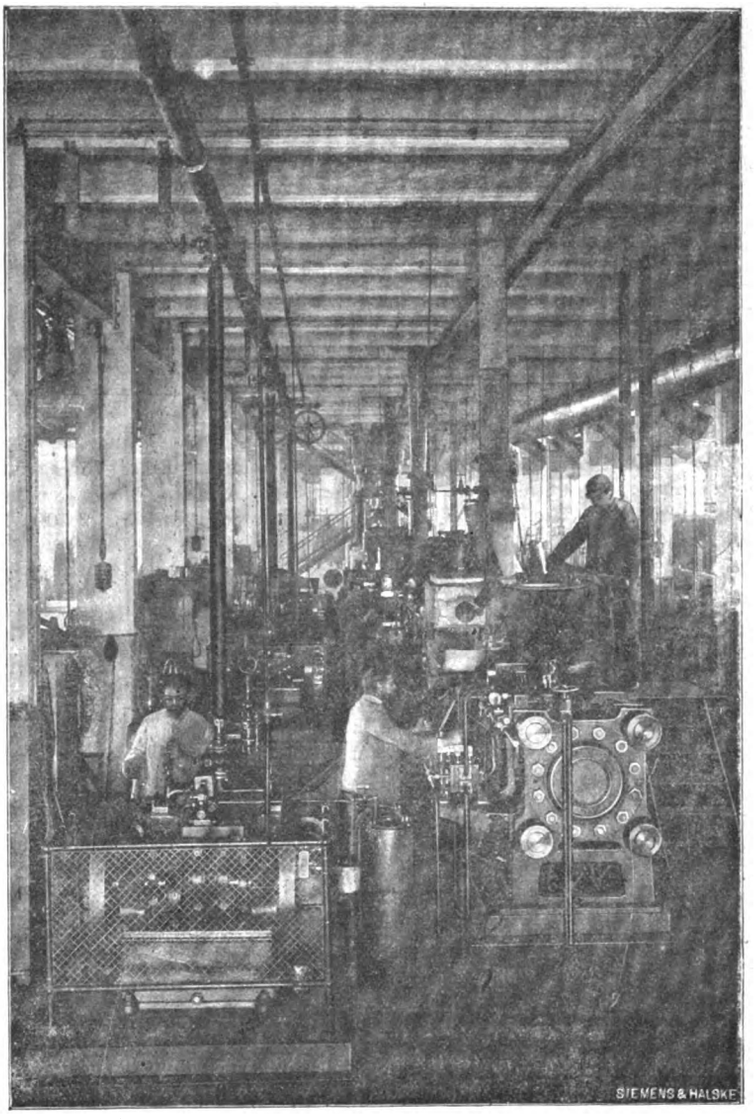

FIG 5.—Lead Press.

After the conductors have received a rubber or guttapercha casing, the further treatment depends on whether the wire is to be covered by spun, braided material or by a pressed mould of lead.

Manufacture of Spun and Braided Wires.—In the main building, as already mentioned, the manufacture of spun and braided wires goes on. Silk and cotton are used for this class of insulation. On spinning machines the dynamo wires are covered with the insulating material. In addition, braiding machines are used, which cover the wire with a hoselike casing, and work in the same manner as weaving machines. By a combination of spinning or braiding, in connection with impregnations of insulating material, many kinds of goods are produced.

Manufacture of Paper-Covered Cables.—The manufacture of telephone cables is carried on from the point of view that the capacity of the cable, even at great lengths, is to remain as low as possible. For this purpose an insulating material with the least dielectric constant is chosen. Dried paper has been found especially suitable, and the telephone wires are therefore covered with paper bands, wound in discs, and placed in the spinning machine, as shown in Fig. 8. After the single wires have been insulated with paper, they are spun on stranding machines to form multiple cables. Thereon the cables receive a protection against dampness by a covering of lead, as previously described, and are further protected by an armouring depending on the place where they are to be used.

Metal Foundry.—For Messrs. Siemens and Halske's own requirements a brass and copper foundry has been erected at the Nonnendamm flanking the cable works. The plant at present has a capacity of 800 to 1,600 tons per year. To begin with, four furnaces on the Piat-Baumann system and four crucible furnaces have been mounted. The moulding is done partly by hand and partly by machine. Next to the foundry are the drying-rooms. The casting takes place before the furnaces, and near the casting department are the sand and cleaning rooms. The different operations in the foundry take their course from east to west, while an extension of the foundry buildings would take a northerly direction.

(To be continued.)

HOYLAKE AND WEST KIRBY ELECTRICITY WORKS.

Hoylake and West Kirby are two residential districts favoured by Liverpool merchants, and are situated in Cheshire close to the mouth of the estuary of the River

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Dee. Hoylake is best known for its famous golf links. There are no industries other than what is represented by the demands of the health-seeker. The district is a long narrow one, following the coast-line for about four miles, and hence best adapted for a high-pressure alternating system, as recommended by Mr. T. L. Miller, the consulting electrical engineer. The Local Government Board having sanctioned the spending of £30,000, a site for the station was selected at Hoylake close to the railway. To obtain foundations on the sand a bed of concrete 12in. thick was laid down, on which the works were built. For the chimney, which is 125ft. high, a satisfactory clay foundation was found. The boiler-house is 53ft. by 54ft., and is fitted with three Lancashire boilers made by Messrs. Tetlow, of Hollinwood. The engine-room is 33ft. wide and 50ft. long, and has ample room for considerable extension of the present plant. It contains three direct-coupled sets. The engines are compound, of 125 l.h.p. at 500 revolutions per minute, by Messrs. Belliss. The generators are Crompton-Brunton alternators, of 75 kw. at 2,400 volts, periodicity 50 ⁓. A motor-alternator is provided, designed on the alternating side for 2,400 volts and 14 amperes at 1,000 revolutions per minute, and on the direct-current side for 160 volts and 260 amperes. The alternator can be run as a synchronous motor to charge the cells or for excitation. At times of light load the direct-current side will act as a motor on the cells for supplying power to run the alternater. The switchboard is by Messrs. Cowans, of

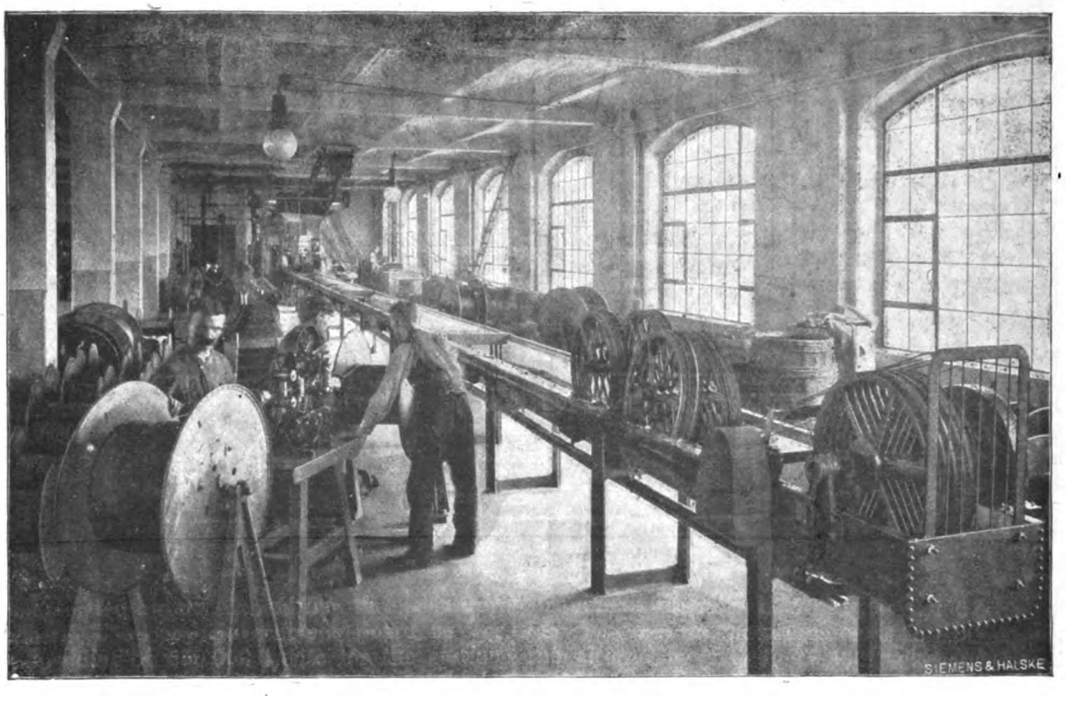

Fig. 7.—Guttapercha Press.

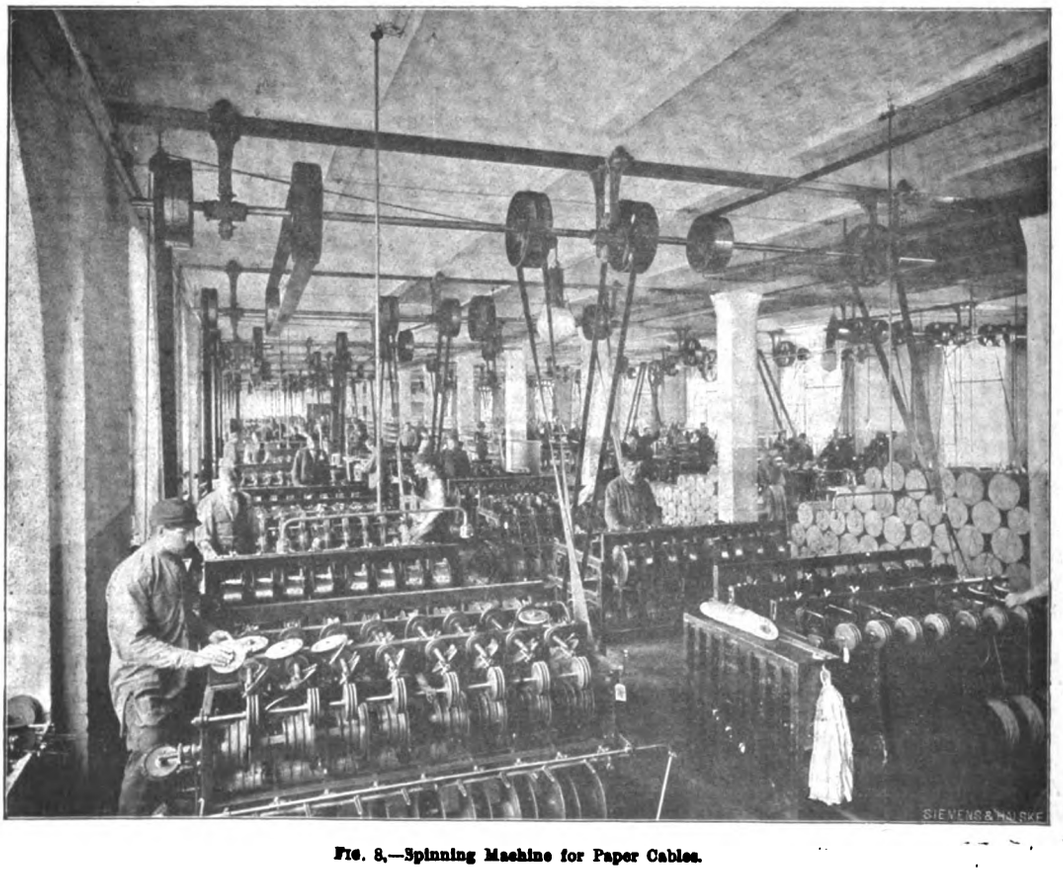

Fig. 8.—Spinning Machine for Paper Cables.

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Salford. The battery is of the Chloride type, and consists of two sets, each of 60 cells, with a normal discharge rate of 100 amperes for five hours. The electrical engineer is Mr. E. Marples, who acted as clerk of the works; he was formerly of the Liverpool District Lighting Company. His assistant is Mr. E. H. Rhodes.

The works were formally opened last Saturday, June 8, by Mr. Wall, the chairman of the Urban District Council, and a luncheon was afterwards provided at the Royal Hotel, Hoylake. The usual toasts of "The King," "The Urban District Council and the Electric Lighting Undertaking," "The Consulting Engineer and the Architect," "The Contractors," and "The Press," gave opportunity to the chairman and the other speakers to express their satisfaction at the completion of the undertaking. The statement of the chairman with regard to the undertaking was particularly satisfactory. He said there were already applications for 6,000 8-c.p. lamps, which was not far short of the available supply, and the Local Government Board had been asked to sanction the expenditure of an additional £13,500, and it was expected that during the winter 10,000 lamps would be connected. The light that would be given would be "free from smell, free from dirt, and free from danger." Mr. Miller made the interesting statement that the new houses in the district were being wired for the electric light by the builders, who intended electricity to be the only method of lighting. Mr. Callender, as one of the contractors, congratulated the Council on being able to place extension orders before a wheel had been turned round. Dr. Smith, who was described as the pioneer of the district, reminded the company that "gas was not dead yet," and although he was associated with the gas company he did not fear the new light, for he always found that its rivalry with the electric light resulted in additional gas being used.

A few additional points of importance with reference to this latest electric supply undertaking may be added. The price is to be 7d. per unit for the first hour and 3d. for the second hour, the Wright system of charging being adopted. The price of gas is 3s. 9d. per 1,000 cubic feet. Street-lighting is to be undertaken at 9d. per lamp less than at present charged for gas. The supply is at 230 volts. There are two sub-stations, one at Hoylake and one at West Kirby; in other cases the transformers are in pits. This equipment has been supplied by Messrs. Cowans, of Salford. One of the sources of revenue will be the use of radiators in private houses. There will be no meter charges. Regulations for installation work have been drawn up by Mr. Miller. These do not call for any special remark, as they embody the usual rules as required for good wiring.

PERTH ELECTRICITY WORKS.

The Perth municipal electricity supply undertaking (the formal opening of which we described in our last issue) has been laid down on thoroughly up-to-date lines, and while the design of the plant does not introduce any outstanding novelties in design, the following short description of the plant will, we hope, prove of interest.

Perth is one of the numerous municipalities which have procured a provisional order more as a protection against the incursions of companies than from any great desire to instal the electric light. On obtaining the order the Commissioners received offers from no less than nine different companies, but on consideration of these tenders they decided upon putting down the works themselves. Mr. W. C. C. Hawtayne was chosen by the Commissioners as consulting engineer for the work, and the scheme which he recommended was a low-tension three-wire supply, with 460 volts across the outers. Contracts were placed as follows: buildings (local firms); boiler-house plant, Messrs. Babcock and Wilcox; pipework, Messrs. Babcock and Wilcox; surface-condensing plant, Messrs. J. H. Carruthers and Co., Glasgow; steam dynamos, Messrs. D. Bruce Peebles and Co.; storage batteries, the Electrical Power Storage Company, Limited; main switchboard, Messrs. Lowdon Bros. and Co., Dundee; overhead travelling crane, the Southgate Engineering Company, Limited; underground mains, etc., Callender's Cable and Construction Company, Limited; arc lamps and posts, Messrs. Lucy and Co., Limited; station lighting, Mr. Peter Campbell, Perth.

The total cost of the scheme has been about £30,000, which represents nearly £1 per head of population. The site chosen is on the "shore"—*i.e.*, on the banks of the River Tay. The ground was obtained on very reasonable terms, and the station is well situated as regards coaling facilities, while there is an ample supply of good water for feeding the boilers and for condensing purposes. The buildings have been erected to plans by Mr. McKillop, burgh surveyor, with the direction of Mr. Hawtayne. They are of red facing brick, and are designed to give plenty of room for extension of the lighting plant, and for the probable accommodation of traction plant. The principal dimensions are as follows: boiler-room, 115ft. by 42ft.; engine-room, 115ft. by 38ft.; accumulator-room, 48ft. by 31ft. There are also the testroom, workshop, store, lavatory, and offices, while above the latter there is a house for the charge engineer.

The chimney is of large proportions, being 150ft. high by 7ft. internal diameter. It is afterwards intended to erect a refuse destructor near the electricity works, and the chimney has been utilised to be used for both. The boiler-room at present contains three water-tube boilers of Babcock and Wilcox's well-known make. They are each rated for an evaporative duty of 6,000lb. per hour at a working pressure of 200lb. per square inch. The grates are of the ordinary pattern, and are hand-fired from the boiler-room floor. No superheaters are provided with the boilers, but as there is a large steam space provided and a very short and direct passage for the steam passing to the engines, there should be no difficulty in maintaining a supply of dry steam. The steam-piping is arranged on the simplest possible plan, the boilers being connected to a main header running along the wall, while the steam-piping to the engines are run right through the wall of the boiler-house to the engines, which are immediately on the other side of it. Only a single steam-pipe is taken to each engine, which we think preferable to the complicated arrangements of duplicate steam-pipes which used to be considered a *sine qua non* in an electricity central station. Isolating valves are provided for separating the boilers from each other. The steam-piping is of lap-welded mild steel with wrought-steel flanges, while the exhaust piping is of cast iron. Each boiler is fitted with a high-pressure injector, which is used to feed the boiler when the feed pumps are not in action. The latter comprise a direct-driven steam feed pump, capable of supplying 2,000 gallons per hour, and an electrically-driven pump for the same duty. The latter is a three-throw pump driven through spur gearing by a J. H. Holmes and Co.'s enclosed four-pole motor. This motor is arranged to work at two different speeds, either across the outers of the three-wire system or off the storage battery. A throw-over switch is provided for effecting this. The feed water is taken first from the River Tay to a wrought-iron feed-water tank under the boiler-house floor capable of holding 2,000 gallons. From this tank it passes through the pumps and thence through a Green's economiser to the boilers. Duplicate feed pipes are laid from the two feed pumps to the boilers.

The engine-house is finished off inside with a lining of brown enamelled tiles to a height of 5ft. from the floor; an overhead hand-power crane (10 tons) runs the whole length of the engine-house. The steam dynamos at present installed are three in number, and consist of two sets each of 200 kw. output, and a smaller set of 75 kw. output. The engines are of Willans and Robinson's make, and are direct coupled to Bruce Peebles's multipolar dynamos. The larger dynamos run at 350 revolutions per minute, while the 75-kw. set runs at 460 revolutions per minute. The voltage of all machines can be varied from 460 to 550 volts. All the dynamos are compound wound, with a view to their being used for traction purposes. A plug on the side of the frame is provided for short-circuiting the series coils when these are not required. The engines are compound, and are all fitted with Willans

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and Robinson's patent steam-actuated variable cut-off gear, which provide for altering the cut-off to suit varying conditions of load, thus conducing to increased economy in working. The engines exhaust either into the air or into a surface condenser, which is placed at one end of the boiler-house. This condenser is capable of dealing with 18,000lb. of exhaust steam per hour. It is of the ordinary marine pattern, with direct steam-driven reciprocating circulating pump underneath the condenser body. The circulating water is obtained from the Tay. The switchboard is of the usual three-wire type, with circular pattern accumulator regulating switches. Provision is made for charging the regulating cells of the battery apart from the other cells. Duplicate fuses are provided for all feeder circuits, while the dynamos are protected by automatic cut-outs. Ample provision has been made for future extension, while the main generator switches are made of the throw-over pattern, one side for lighting and the other side for traction. For battery charging and balancing a booster-balancer combination has been laid down. This consists of four machines in line, all on the same spindle and bed-plate. The boosters are capable of giving out 175 amperes at 120 volts, while the motors (which also act as balancers) run at 250 volts, and take 100 amperes at full load. The whole combination runs at 900 revolutions per minute.

The storage battery is in two halves, one on each side of the three-wire system The cells have an output of 600 ampere-hours, discharging at 200 amperes for three hours. There are 135 cells in each battery, 29 of which are regulating cells. The total output of the battery is rated at 517,800 watt-hours. The connections between the different tiers and sections of the battery, and between the regulating cells and the back of the switchboard, are of solid bare copper rod, which is run on porcelain insulators and protected by enamel acid-proof paint.

We now come to the street mains, which are all of the Callender Company's vulcanised bitumen type. There are four concentric feeders laid, three double and one triple. They are lead covered, armoured, braided, and laid direct in the ground. On certain parts of the system porcelain tubes have been laid for drawing-in additional feeders or extending those already laid. The distributing cables are laid on the solid system, and consist of three separate cables run in solid with bitumen in a wooden trough. Up to the present 5,700 yards of feeders and pilot wires and 7,250 yards of distributors have been laid. There are in all 67 arc lamps of 1,000 nominal candle-power of the Crompton-Pochin enclosed long-burning type, and they are run four in series across the outers. On each arc-lamp pillar are placed two brackets supporting two 32 c.p. incandescent lamps, while about 84 of the existing gas-lamp pillars are being adapted for incandescent lamps. About 5,200 yards of cable have been laid for the arc lighting, while the incandescent lamps are controlled from four different points, about 2,200 yards of cable having been laid for this purpose. Up to date about 20,000 8-c.p. lamps (equivalent) are wired in the town, exclusive of the public lighting, so that good progress is being made.

Both lighting and power are charged on the maximum demand system, the charges being 7d. and 3d. for lighting purposes, and 7d. and 1½d. for power. It should have been said that no manholes are used for connecting the feeders to the distributors. These connections are all brought up into section pillars, where the necessary connections are taken off 'bus bars mounted on marble or porcelain slabs. No fuses are placed in these pillars. The arc-lamp posts cannot be described as being very artistic in design, but we have no doubt the citizens of Perth will in time become used to their somewhat harsh outlines. Judging from the good start made by the Perth undertaking, it should become a commercial success in a comparatively short time, and with this hope expressed we will close our description of the undertaking, which has necessarily been a short one

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Crewe.—The Town Council have decided to oppose the application of the British Electric Traction Company for an order to construct electric railways in Crewe and Haslingden, on the ground that an order should be granted to the Corporation in preference to outsiders.

THE CONSUMER'S DEPARTMENT OF A CENTRAL STATION.

(Concluded from page 686.)

Before bringing this short series of articles to a conclusion, it would, perhaps, be as well to write a few lines with reference to the various complaints which are received from consumers, and also about the disputes which are likely to arise from time to time.

However well a system of supply might have been designed, and no matter how much care is exercised in order to ensure the consumers having a full and uniform voltage, there are almost certain to be some individuals who will find fault and grumble about their light for some reason or another. It might be mentioned, in passing, that, as a rule, the notifications which are received at the station upon matters of this kind, whether they be in the form of a letter or whether the consumer honours the engineer with a personal call, are by no means as polite as one might wish them to be, and very frequently the assistant to whose lot falls the investigation of these matters has an experience very far removed from being pleasant. Let us suppose that a consumer has reason (imaginary or otherwise) to find fault with the light he is getting. He generally sends off a letter to the works in which he says that his lamps do not give as much light as he would get from a farthing candle. The author does not know whether the farthing candle is a standard of light according to the views of the ordinary individual, but it has been his experience to find that it is very often looked upon as a basis for comparison. To continue, however, this letter generally contains a threat to discontinue the use of the electric light unless something is immediately done to put matters right. Not only does he say that he himself will stop using it, but he will advise a great number of his friends who are about to put in an installation to abandon the idea, as the electric light is a failure, etc. No doubt the gentleman thinks in his own mind that by assuming this attitude he will cause the engineer to tremble in his shoes, and think that his undertaking is about to receive its death-blow. Little does the irate gentleman think that communications written in this strain are generally received with a quiet smile on the part of the engineer. Do not let it be thought for one moment that the author is disposed to take no notice of complaints of this kind, for it is his opinion that every complaint, however trivial it might appear to be, should receive proper attention, and if there is found to be no cause for complaint, it will not be a difficult matter to demonstrate the fact to the consumer.

After a considerable experience in this department of station work, the author rather enjoyed the prospect of having to deal with a gentleman who would write a letter similar to the one described above, as the fact of him comparing the light given by his lamps to that of a farthing candle at once demonstrated that he was not particularly truthful, which in itself was something to be going on with. The first thing to do in a case of this kind is to go round and visit the consumer at the time of heavy load, or at the time during which the light is alleged to be bad. After trying to calm the gentleman down as far as possible, the voltage at the service mains should be taken. If the voltmeter shows that the pressure is up to that declared by the undertakers, or within the limit allowed by the Board of Trade, and in spite of this the lamps do not give a proper light, it is obvious that the cause must be looked for upon the premises. In almost nine cases out of ten the fault will be found in the lamps themselves, the consumer having burnt them so long and not having the sense to see that the blackened globe was absorbing most of the light. A very good way of impressing this condition of the lamps upon the consumer is to lay one upon a sheet of white paper, when the strong contrast will at once be seen. It seems impossible to make the consumer understand that it is not always advisable to burn a lamp until the filament actually breaks. If the lamps themselves appear to be in fairly good condition, all main connections to switches and fuses should be carefully

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examined to see whether proper contact is being made. The meter leads should also be looked to, as these are very liable to work loose at the terminals, as owing to the situations in which meters are generally fixed they are very often subjected to a certain amount of vibration. In some cases it may be found that the consumer has been increasing the load on his mains, either by changing the candle-power of his lamp, or some enterprising plumber might have carried out some extensions and tapped on to a main which was already fully loaded. If the consumer states that the light is all right at the time of the inspector's visit, but that its behaviour is very erratic during various times of the day, the only thing to do is to fix a recording voltmeter on the premises for a few days and obtain a record of the pressure throughout the 24 hours. This instrument should always be connected on to the service mains, and not on any account should it be connected to any portion of the consumer's apparatus, such as the main switch or fuse. If, upon taking this record, the voltage is found to be lower than it should be, and the system of supply is a three-wire one, the voltmeter should be connected for a few days on to the other side of the system. If this particular consumer is supplied from two service mains only, as would be the case if it was only a small installation, the instrument should be removed and fixed in another consumer's place whose supply is taken from the other side of the middle wire, and it should be as near as possible to the point on the mains at which the first records were taken. If the records obtained on this side of the network show the pressure to be as much above the proper value as the previous ones were below it, the cause of the bad light in the first case is owing to the uneven balancing on the mains, and immediate steps should be taken to rearrange the balancing of that particular street; and when this has been done the light will be found to be all right, and the consumer made happy once more. If, however, both records are bad, it will probably be found that the mains are overloaded, and the complaint, together with the records which have been taken, should be handed over to the mains engineer for further investigation, as this work is outside the province of the installation department. When a consumer sends round to the station to say that his lights are out, someone ought to be sent immediately, for there is nothing worse for an undertaking than allowing such complaints to be neglected, and it is most important that the consumers should have every consideration shown to them, and be put to as little inconvenience as possible. It is well worth while, in the case of a large undertaking, for someone employed in the installation department to be kept at the station after the usual office hours, say until 11 o'clock, so as to be in readiness to attend to any complaints which might come in. It is very often left for the shift engineer to send someone out of the station, but this is not an advisable course to adopt, as very often, especially during the winter months, a suitable man cannot be spared. It would only be necessary to keep a youth for this purpose, and it could easily be arranged for him to take duty in turns with one of the other boys in the department.

It is the general custom to render the accounts to the consumers once a quarter, but the meters should be read every month, and then any meter which has stopped, or appears to be recording incorrectly, can be changed at once, and if it has actually stopped, the estimated consumption will only have to be obtained for a month, instead of for a whole quarter, as would be the case were the meters only read for the purpose of charging. The monthly readings should be compared roughly with the readings during the corresponding month of the previous year, and if any great difference in the consumption be observed, the matter should be looked into to see whether the meter has not been read properly or whether it is out of order. Every quarter is sure to bring in a considerable amount of work for the installation department, as there are almost certain to be some people who will dispute their accounts, and these people will have to be seen, and if they cannot be convinced that everything is right, the offending meter will have to be removed for testing, the consumer bearing the expense if the meter is found to be inaccurate. It would be a good thing if meters which are disputed could be tested on the premises under the exact working conditions, but it is impossible to do this with any degree of accuracy owing to the unsteadiness of the current if taken off the ordinary supply mains. In the event of a meter stopping, the simplest way to do, if one can obtain the consent of the consumer, is to render the account on the readings during the corresponding period of the previous year. It is not often, however, that this arrangement can be made, as the customer will invariably say that he has not used anything like the same amount of light that quarter. Whatever arrangement is made, however, it should be done with the consumer himself, or with some person duly authorised by him, as if an estimate is arrived at by the aid of anyone without authority, and the account is rendered accordingly, the chances are that the account will not be agreed to. After some experience in this department, the inspector will be able to estimate an account pretty well by looking over a building, and taking into consideration the class of business which is carried on, he will be able to judge as to what the probable hours of burning will be, and knowing the number of lamps installed, the consumption in Board of Trade units can easily be arrived at. Of course, to some extent, one is at the mercy of the consumer, but so long as electricity meters will get out of order we must be prepared to stand to lose a little, and it is only human nature on the part of the customer to make his bill as little as possible. In bringing these articles to a close, the author hopes that some of the points mentioned will be of use to some of the junior assistants in central stations.

THE YORKSHIRE ELECTRIC POWER BILLS.

The last of this session's Power Bills has passed through committee, and it is a matter for congratulation that only in the case of rival schemes has any Bill been rejected this year. The Yorkshire electric power scheme is by far the most gigantic and important of any promoted in this session of Parliament, not only on account of the large area which it proposes to serve—1,860 square miles—but mainly because of the vast importance of the district as one of the biggest manufacturing centres in the United Kingdom. The measure embraces practically the whole of the West Riding of Yorkshire, in which the collieries alone have an annual output of 15 million tons of coal. The coalfields, too, are rapidly being developed, and it is thought that the supply of electric power in this district will be of the greatest value for the new boring and sinking operations. When the Bill came before the Select Committee of the House of Commons presided over by Sir Wm. Houldsworth, it was opposed for the first few days by a competing scheme—the South Yorkshire Electric Power Bill—but towards the end the proceedings were greatly simplified by an agreement between the two sets of promoters, the main provision of which is that three of the directors of the South Yorkshire Company shall join the Board of the successful Yorkshire Company. The Bill promoted by the former company was accordingly withdrawn. The Yorkshire scheme is promoted by the principal representatives of a countryside teeming with manufacturing industries, and the list of 63 persons who form the syndicate include well-known names such as Armitage, Blackhouse, Baynes, Brotherton, Crawshay, Fox, Green, and Holliday. Among the industries represented we may mention engineering, cloth manufacturing, curriers, timber, mining, coal, etc. Some 13 of the 63 firms mentioned employ about 55,000 odd hands and use machinery of just upon 42,000 h.p. So there can be no fear as regards consumers. The maximum charges which the company are entitled to enforce for supply of energy are: for the first 5,000 units consumed in any quarter, 3d. per unit; between 5,000 and 10,000, 2¾d. per unit; between 10,000 and 20,000, 2½d. per unit, etc. Under this measure it is proposed to have four generating stations—one at Methley, one at Wath, one at Thornhill, and one at Bingley—and a radius of 16 miles from each of these places practically covers the whole area. There are in this area five county boroughs, 13 ordinary boroughs,

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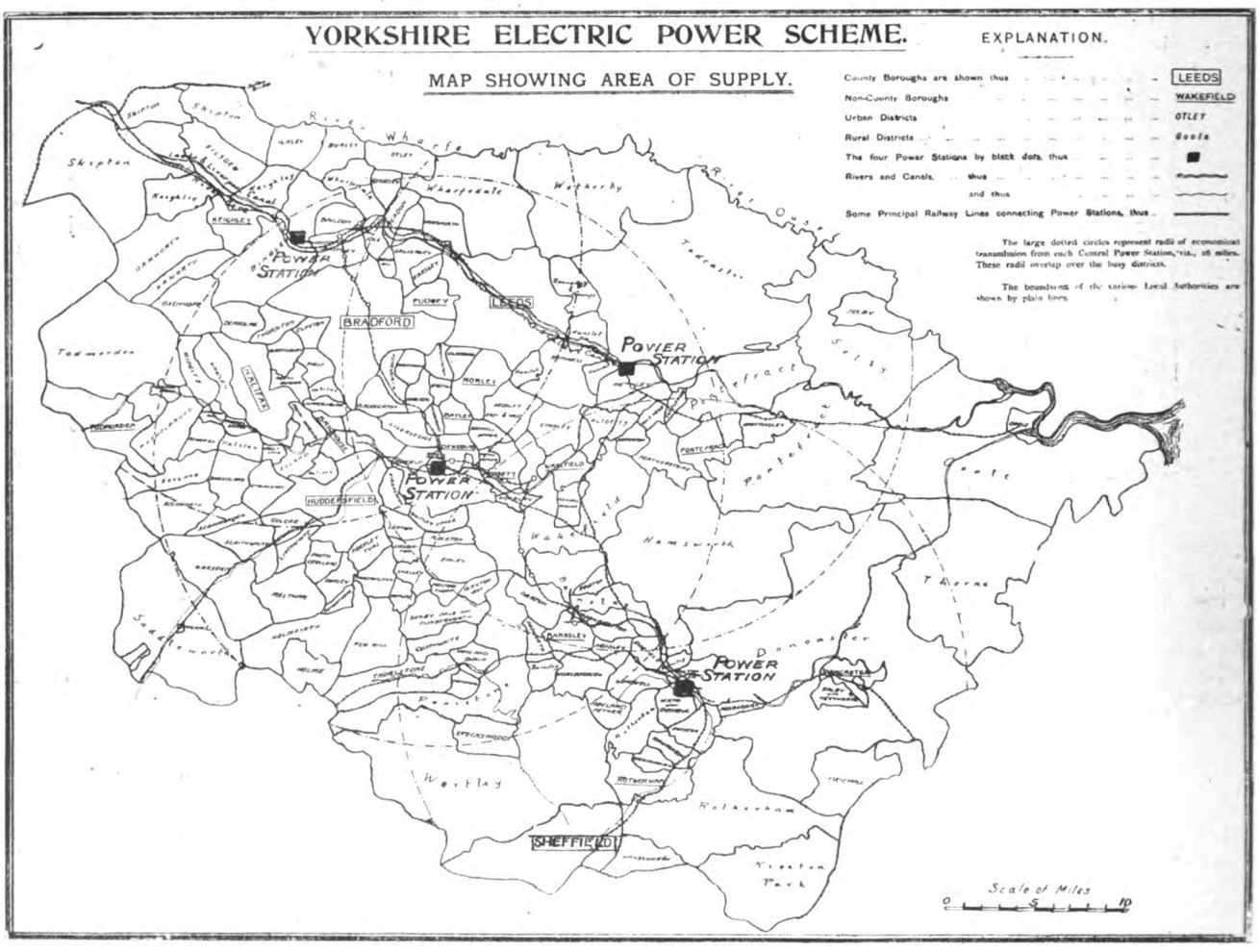
140 urban and rural districts, and these only administer electricity to 130 miles out of 1,800 miles. At the present time only a small fraction of these authorities provide a supply of electricity, and such supply as there is is used practically only for tramways and lighting. It must be remembered, however, that some 11 of the larger boroughs have got works either commenced or in operation, while about 16 hold provisional orders. The capital of the company will be £2,000,000, of which £10,000 has already been raised for engineering purposes, etc. On the withdrawal of the South Yorkshire Bill, the chief opponents to the other scheme were the Corporations of Leeds, Bradford, Sheffield, and Barnsley, who strongly objected to having the areas under their jurisdiction included in the area of supply, and also protested against interference with their roads by the company. The Corporation of Leeds stated that they had spent £600,000 on their electric works, and were now incurring large additional expenditure. They added that they were able and



willing to meet all the requirements of their city so far as the supply of electricity was concerned, and they thought it unfair that a profit-making company should be allowed to enter into competition with them. Similar views were expressed by the other petitioning corporations. A great mass of evidence, expert and otherwise, was called on both sides, and after an enquiry lasting for some days the chairman announced that the committee had decided that the preamble of the Yorkshire Bill was proved. With regard to wayleaves, they would not exclude Bradford, Leeds, or Sheffield, but they desired to express the opinion that they would like to see a prohibited area in each of these places agreed upon. With regard to the railways and canals, they passed the Bill as it stood. After this intimation the three county boroughs mentioned by the chairman gave notice that they would withdraw from the enquiry altogether, reserving themselves to oppose in the House of Lords. The question of prohibitive areas was then considered by the committee, with the result that the chairman announced that in the case of Huddersfield, Halifax, and Barnsley prohibitive areas had been agreed upon by the parties, and with regard to Sheffield, Leeds, and Bradford the committee wanted from the promoters a clause undertaking that there should be a prohibitive area of a mile from some specified place. In accordance with this direction a clause was agreed to by which it is provided that "the company shall not, without the consent in writing of the local authority, break up any street or allow any electrical line or other works along any streets in the respective cities of Bradford, Leeds, or Sheffield which is included within a certain specified area delineated on the plans." In respect of Leeds and Bradford, the prohibited area constitutes a mile radius from the municipal buildings. In the case of Sheffield, however, the density of the population makes an absolute circle impracticable, and the promoters have accordingly drawn a circle with a radius of 1½ miles from the Jubilee Obelisk. By this arrangement a sparsely-populated district, which would otherwise have been included in the mile circle, has been left out of the prohibited area, and, as was pointed out before the committee, the promoters will be able to join up with the Derbyshire and Nottinghamshire Power Company without touching the prohibited area of Sheffield. With these additions and alterations the Bill will be reported for third reading. The engineers to the Yorkshire scheme are Messrs. Gibbings and Baker, of London and Bradford; and the parliamentary agents Messrs. Rees and Frere, of Westminster.

WIRELESS TELEGRAPHY AT RATHLIN ISLAND AND THE SKERRIES.

Some interesting experiments are now being made in connection with induction telegraphy between the mainland, North of Ireland, and Rathlin Island, on which Lloyd's have a signalling station. The experiments have been going on practically the whole of the year, but the system was officially inaugurated only on Friday week. The two points actually in communication are the Bally-

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castle Post Office and Lloyd's signalling station. As is the case with other installations of this induction telegraphy, the Post Office, we are informed, have erected two parallel lines. It will be seen from the accompanying sketch (Fig. 1) that the first of these runs between Ballycastle and Murtough Bay on the mainland. The other wire

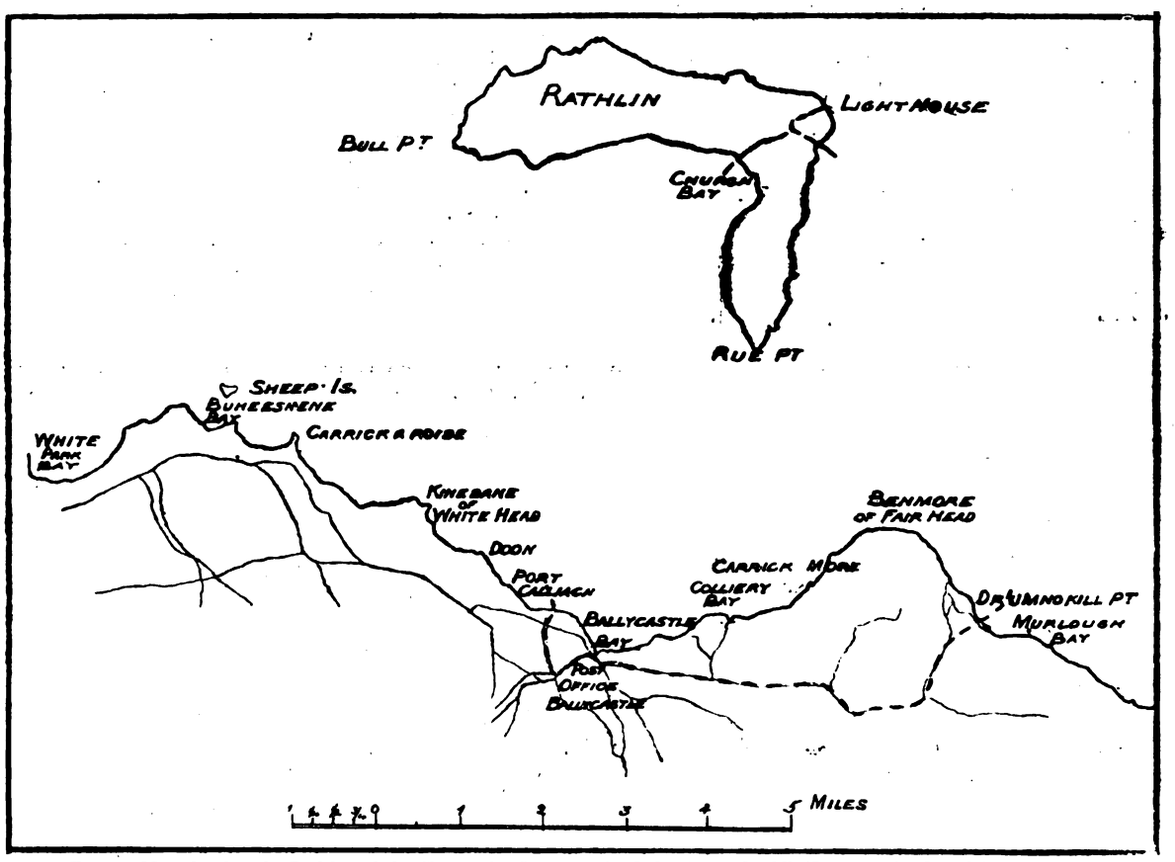

FIG. 1.—Map showing the Position of the Circuits for Signalling by Induction to Rathlin Island. The dotted lines represent the overhead telegraph wires which are earthed at either end in the sea.

connects Church Bay on Rathlin Island with the north-east corner of the island. The ends of each of these wires terminate in the sea. The wire on the island is about 1½ miles in length, while the length of that erected on the mainland is just about six miles. The average width between the parallel portions of the wires may be taken to be 6½ miles. The signalling current is obtained by means of a small Cuttriss motor, which gives a current with a frequency of about 300 complete periods per second. This current is interrupted by means of the ordinary telegraph key using the Morse code. At present the authorities are working with a maximum of two amperes in each of the primary circuits. At the receiving station the operator has only to listen at a telephone in the receiving circuit. We understand that the Post Office have not got a successful calling apparatus yet. Experiments are, however, being carried on with apparatus designed by Prof. Lodge and Mr. Sydney Evershed, but no final decision has up to the present been come to. As it is now, the operators have to listen at fixed intervals for the signals. These intervals in the ordinary way would be half an hour. The experiments are said to have been most successful, and the system is now open for public use. The system of induction telegraphy was first experimented with by Sir Wm. H. Preece in 1894, across Loch Ness, in the Highlands, but the installation in question has been carried out under

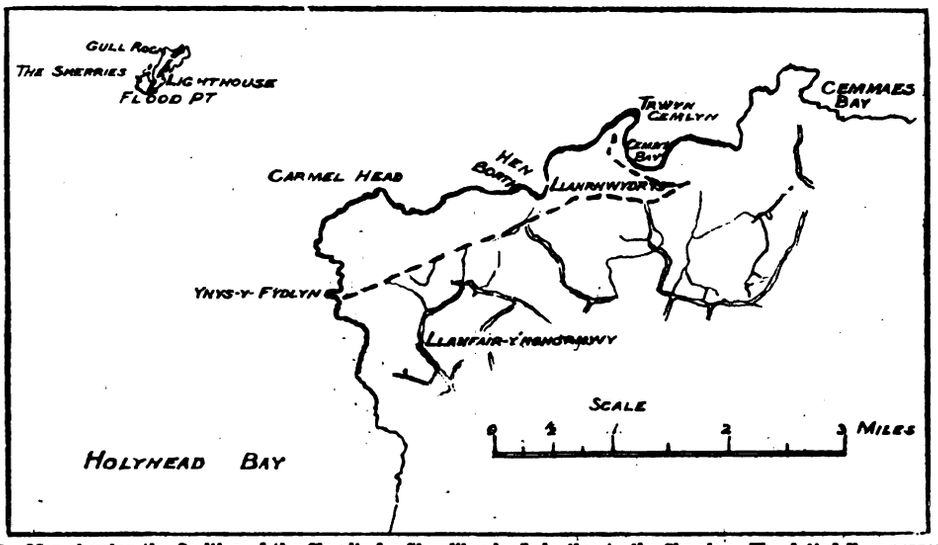

FIG. 2.—Map showing the Position of the Circuits for Signalling by Induction to the Skerries. The dotted lines represent the overhead telegraph wires which are earthed at either end in the sea.

the supervision of Mr. Thomas Patterson, the sectional engineer of the district. Other gentlemen who have worked in connection with the same are Mr. J. Walby, superintendent engineer for the North of Ireland, and Mr. Davies, Prof. Lodge's principal assistant.

We are also informed that further experiments have resulted in the establishment of wireless telephonic

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communication between the Skerries and the mainland of Anglesey, as shown in Fig. 2. The lighthouse on the Skerries was wanted to be in communication with the coastguard station at Cemlyn, which is connected with the Post Office system. A wire 750 yards in length was erected along the Skerries, and on the mainland a wire of 3½ miles from a point opposite the Skerries to Cemlyn. Each line terminates by an earth-plate in the sea. The average distance between the parallel portions of the two wires is 2·8. The conditions of this communication, with these exceptions, are practically the same as those in the case of Rathlin Island, and a good service of telephonic communication is being well maintained.

A 500-KW. PARSONS STEAM-TURBINE TRIAL.

We have received a copy of a most interesting report by Prof. J. A. Ewing of a series of trials made by him on a turbo-alternator at the works of the Cambridge Supply

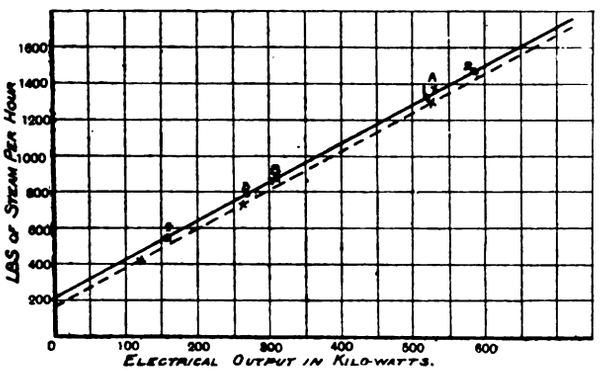

FIG. 1.—Two Curves of Total Steam Consumption.

Company. This machine was supplied by Messrs. C. A. Parsons and Co., and was erected in January, 1900. It has been in regular use since then on the station load, and the object of the test was to see if any appreciable falling off in the efficiency of the steam-turbine would be found after a year's work. The 500-kw. alternator on which the test was made is driven by a compound turbine of the parallel-flow type, running at about 2,700 revolutions per minute and governed electrically to give constant volts, with its shaft directly coupled to the armature of a four-pole alternator generating 250 amperes at

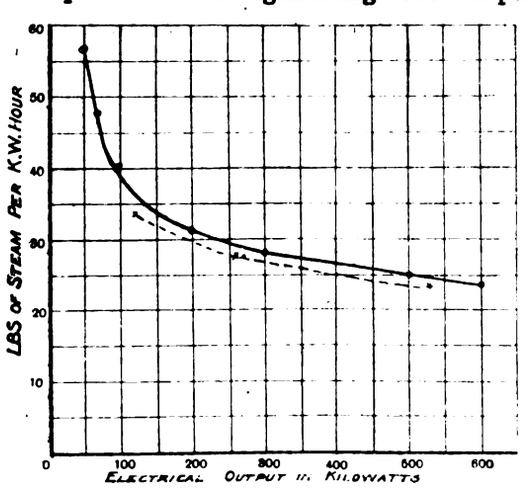

FIG. 2.—Curves of Steam per KW.-Hour. The full lines in each case are from Prof. Ewing's tests, and the dotted lines from tests taken a year before, when auxiliary plant was not driven by the turbine.

2,000 volts. The exciter armature is on a prolongation of the same shaft. Steam was supplied at 150lb. per square inch from a pair of Lancashire boilers, through about 140ft. of a steam-pipe, for the most part 6in. in diameter. The steam was not superheated, and there was no separator, but water which collected in a pocket under a vertical limb of the steam-pipe leading to the engine was from time to time blown off. This, however, was insufficient to keep the steam dry, for the velocity of steam in the pipe was too great to allow much of the moisture to be deposited in the pocket. Evidence that the steam was, in fact, wet on admission to the turbine was given when an indicator was applied to record the variation of pressure in each of the successive blasts by which the steam was admitted. This wetness would, of course, affect unfavourably the results of the tests. The turbine is furnished with a surface condenser, and drives its own air-pump and circulating pump (the latter lifting water 12ft.), by means of a shaft carrying a screw wheel which is driven by a worm on the main turbine shaft. The measured consumption of steam, therefore, includes what is required to drive these auxiliaries. The discharge from the air-pump was delivered, for the purpose of the test, through a two-way valve into tanks which were filled alternately. The discharge into each was continued until the tank was filled up to an overflow lip in a narrow neck, and the valve was then thrown over to fill the other tank, any overflow from the lip being collected in a can and emptied into the other tank. The time at which each tank in turn was filled was noted to the nearest second, and the times were taken continuously from tank to tank during each run in the trials.

The output of the alternator was measured on a Kelvin watt-balance, which was recalibrated after the trial in order to get exact results. Readings were also taken on other instruments to serve as additional check. The artificial loads used on the trial consisted of two iron plates immersed in the River Cam. By altering the depth of the one plate the load was varied from 586 kw., which was one-sixth overload, down to zero. The two curves which we reproduce herewith record graphically the results obtained. The actual figures of the trials are given in the accompanying table:

No. of trial.	1.	2.	3.	4.	5.
Electrical output in kw.	518	586	273½	160½	—
Volts at terminals of generator	2,100	2,150	2,250	2,290	2,280
Speed in revolutions per minute	2,670	2,740	2,630	2,590	2,580
Air-pump discharge, lbs. per hour	12,970	14,320	7,730	5,320	1,850
Air-pump discharge, lbs. per kw. per hour	25·0	24·4	28·3	33·1	—
Pressure at stop-valve, lbs. per square inch	148	145	151	151	121
Vacuum in condenser, inches	27·8	27·9	28·2	28·3	28·3
Vacuum in turbine cylinder, inches	25·7	25·4	27·2	27·8	28·1
Temperature of air-pump discharge, deg. F.	74	76	57½	56	54
Temperature of circulating water, inlet deg. F.	40	40	38	39	36
Temperature of circulating water, outlet deg. F.	71	72½	60	57	46
Barometer, inches	—	—	29·93	—	—

These figures are compared on the curves with others obtained at Newcastle-on-Tyne, when the air and circulating pumps were not in use. It will be seen that the difference between the two is practically what would be expected from this fact. Prof. J. A. Ewing concludes by expressing his opinion that the results of the trials show that no deterioration due to wear has taken place. In a note at the conclusion of the report the makers refer to the fact that the type of turbines has been improved since the Cambridge machine was made. They give particulars of two turbo-alternators, also of 500 kw., in which lower steam consumptions were obtained. Thus, in the one supplied to the Cheltenham Corporation, and tested by Mr. Hamilton Kilgour, the steam consumption was only 21·7lb. per kilowatt-hour. A Scarborough, tested by Mr. F. G. Holden, took 22·7lb. of steam per kilowatt-hour. It was running at a speed of 2,400 revolutions per minute, whereas the Cheltenham machine was driven at 3,000 revolutions per minute. In neither case was the steam superheated. These figures are most interesting as showing how economical these steam-turbines are, and that they do not lose their good qualities in consequence of wear.

It may interest our readers to hear that Messrs. Parsons and Co. have recently taken an order for a turbine engine for delivery to Milan capable of giving power to a 2,000-kw. dynamo being built by Messrs. Brown, Boveri, and Co., of Baden, Switzerland. The contracted time for

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delivery is 10 weeks from receipt of order. It is good news to find such large machines being ordered for export.

ATKINSON DEAD-BEAT AMMETERS AND VOLTMETERS.

Through the kindness of Messrs. L. B. and C. W. Atkinson, we are able to give a short description of a new type of ammeter and voltmeter which is now being manufactured in large quantities at the Atkinson Testing Works, Cardiff. This type of instrument, of which Fig. 1 represents the ammeter and Fig. 2 the voltmeter, is designed with the special object of providing instruments to be used in power distribution schemes. It is justly pointed out by the makers that in all power works in which electric motors are used, it is of importance that the operators should know how much current is being taken by each motor, as often a slight alteration in the arrangements will result in a considerable saving of power. In far too many instances electric motors are installed and started to work without even a preliminary test being made of how much current the motors are taking. If, then, the load be more than the motor is designed for, trouble ensues, and the whole of the blame is put down to the design of the motor, which is most unjust. The moving part of these ammeters and voltmeters is illustrated in Fig. 1. It consists practically of a hydrometer floating in a sealed tube. The liquid used is a saturated solution of a certain salt, which has a constant density at all temperatures. By having a few crystals in the liquid, the makers ensure that the solution shall always be a saturated one independent of the temperature. Up the middle of the hydrometer is placed a thin iron wire, and this is acted upon by a solenoid placed higher up the tube. The illustrations which we give show how the divisions vary at different parts of the scale, and that an exceedingly open scale can be obtained at that part of the range where it is required. The great advantage claimed for this type of construction is that by using a hydrometer as the moving part, all the costly and delicate jewelled pivots required in the usual types of instrument are avoided. Also the movement of the indicator is exceedingly dead-beat, as the passage of the liquid round the bulb of the hydrometer speedily damps down any tendency to oscillation when there are sudden variations in either the current or voltage which is being measured by the instrument. The claim is also made on the information sent to us that the instruments are not affected by external magnetic fields, but on this point we should like to see some experiments made before endorsing the claim. Reverting to the hydrometer, the float is made to fit the outer tube fairly closely, but three small projections on the bulb are made which prevent it from adhering to the side of the glass tube. The great advantage of the instrument from the commercial point of view is that it is exceedingly simple, and can hence be manufactured at exceedingly low rates without prejudicing its accuracy. We understand that special rules have been laid down for the manufacture of these instruments in large quantities, and from the list prices which we have seen they should command a ready sale. Although it might seem rather extravagant to put an ammeter on each motor in a workshop, yet the introduction of such an instrument would frequently save more than its own cost in a year in keeping down the repairs to the motor only; while if the instrument be read frequently, the saving in the current required will exceed many times the first cost of the instrument used to indicate the consumption at any instant. The general appearance of the ammeters and voltmeters is exceedingly neat and workmanlike, and the connections for the ammeters can be made on the front or the back of the switchboard at the wish of the purchaser. On each scale an indicator is provided, which can be fixed opposite the correct current or voltage at which the circuit should be worked, so that the operator can see at once if the normal conditions are varied.

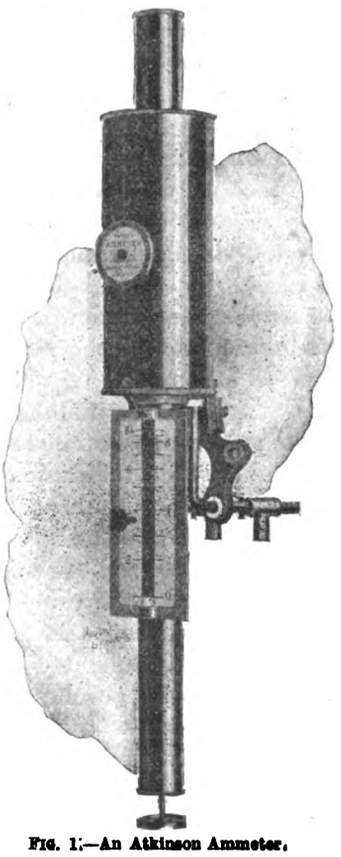

FIG. 1.—An Atkinson Ammeter.

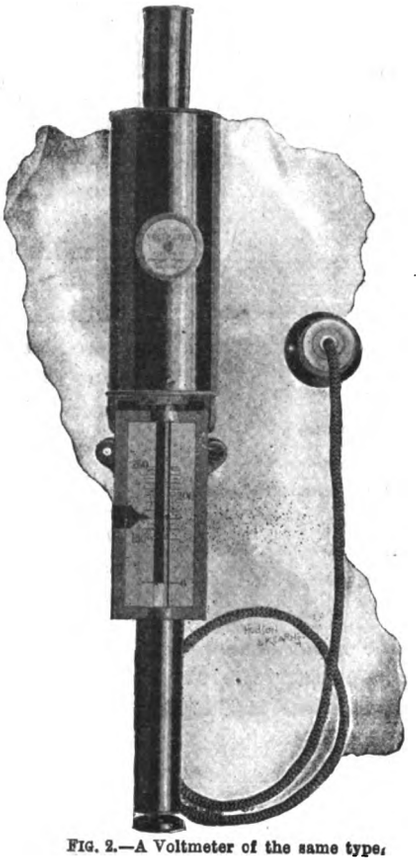

FIG. 2.—A Voltmeter of the same type.

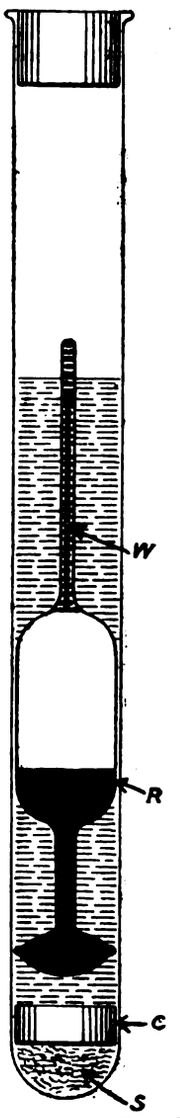

FIG. 3.—Detail of the Hydrometer and Tube. W, iron wire; R, recording line; C, cork to receive end of bulb; and S, undissolved crystals.

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TO CORRESPONDENTS.

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AUTOMOBILISM.

Quite recently the long-distance race for mechanical motors on common roads was extensively noticed in both the political and the technical Press. It seemed to strike none of the reporters that such a race was calculated rather to retard than advance the general introduction of such motors. Neither the man who desires to replace his carriage horses, nor the man who would replace the horses of his drays and wagons, wants to use a forty or fifty horse-power motor or run at a speed of forty or fifty miles an hour. The Automobile Club of this country is doing excellent work among our local legislators in showing the completeness of control the driver has over his vehicle, and in striving for the relaxation of a too rigid rule relating to "miles per hour." We have always striven to show that there are at least two ways of looking at most questions. In this there is the view of the driver and passengers on the vehicle, while, on the other hand, we get the view of all other users of the roads. The acme of civilisation is that every man should have all the freedom compatible with the least interference with the freedom of all other men. A man's actions may well be likened to the motion of a molecule. Each gets interfered with in every direction, yet under certain restrictions is perfectly free over a somewhat undefinable path. Using this illustration in regard to automobile travelling, the moral to be evolved is that the automobilist should have as few restrictions placed upon him as possible, and these only such as prevent interference with the freedom of the rest of the community. If the automobilist likes to take his machine into the Sahara and commit suicide by fast driving, who will say him nay; and why should anyone say him nay here provided his recklessness is harmless to all other parties? In a thickly-populated country, however, it is impossible to permit absolute freedom of driving, yet too great a strictness is just as bad in one way as too great laxity is in another. There is a point made much of by the opponents of automobilism—the frightening of horses. We do not think this should be allowed a moment's consideration. Horses *must* be taught by their owners to meet or pass any kind of vehicle. The same clamour was raised upon the introduction of railways, of traction engines, and even of reaping and mowing machines. But even if the horse be unteachable—which it is not—the introduction of mechanically-propelled vehicles generally, means the gradual suppression of the horse as the main user of our roads and streets. That statement brings us back once more to the text we have so often laboured to drive home into the minds of those who control the motorcar industry. What is their object, or haven't they one? At present they seem to be in the clouds, striving after nothing definite. Do they wish to compete against trunk lines of railway? It would seem that the object in France is something of the kind, otherwise why try to run from one end of the country to another at breakneck speed? None but a pack of fools think that the general public can be served by motor carriages carrying a dozen passengers

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or so from Paris to Bordeaux. Neither passengers nor mercantile needs will be served by anything of this kind. The Liverpool association has shown a much better appreciation of the needs of the times, and has paid particular attention to the mechanical propulsion of heavy weights. There cannot arise the same difficulties with motor work in regards to the local authorities as arises with tramway companies. The latter use the public roads for private gain, and were they to construct their tramways upon their own ground, as railway companies have to construct their lines, there would be no clashing between them and the local authorities. But this is an aside. The Automobile Club and the owners of motorcars are fast enlightening the members of councils to the value of such means of locomotion; and it was a happy thought of the president-elect of the Association of Municipal Engineers to invite an exhibition of automobilism at Leicester the last week of this month, in order to further bring home to municipal engineers the merits of the vehicle of the immediate future.

WANTED, A NAME.

Max Müller and other philologists have written learnedly upon the degradation of words. Up to a quite recent period the term "electrician" was applied to highly-trained scientific men; nowadays it is applied as frequently to an unskilled labourer employed in digging a trench as it is to the scientific student. The weekly annals of our police courts continually record street and other brawls in which an "electrician" figures. The bricklayer's labourer is not a bricklayer, nor the navvy an engineer; and the profession would be benefited sentimentally, if not actually, by the substitution of another name than electrician for the man who is no more an electrician than the man before the mast is an officer.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PERPETUAL MOTION.

SIR,—I note Mr. Arthur E. Gilbert's letter in your issue of June 7, and am surprised to find that he is still hammering away at "perpetual motion." He accuses you of stubbornness in disbelieving what he says, but the accusation is more appropriate to himself, and I suggest that he is just as likely to be mistaken now as he was when he sent you drawings of his inventions, about 15 months back.

Mr. Gilbert writes: "I have overcome the laws of gravity (you say nature), by utilising the whole weight of the wheel to drive itself by a scientific arrangement of levers and driving weights." Mr. Gilbert has not yet shown that the laws of gravity are not natural laws. The whole weight of the wheel cannot be utilised at once to drive itself. If the shaft is horizontal, what about the ascending half of the wheel? If Mr. Gilbert's apparatus will work at all, it will do so equally well on either a horizontal or vertical axis. In the latter case, it should be evident even to Mr. Gilbert that no arrangement of levers and weights, whether scientific or otherwise, can impart to itself motion in a horizontal plane.

The fact that Mr. Gilbert has not succeeded in producing an arrangement which works is significant. Let him provide sketches and a short description of his design that we may have another opportunity of criticising, and, I hope, of convincing him of the folly of persisting further. May the matter be thrashed out for good this time. I should feel inclined to look for stagnation rather in Mr. Gilbert's apparatus than about the editor of the *Electrical Engineer*. Nothing would give me greater pleasure than to see the arrangement, the uselessness of which I do not think there would be any difficulty in demonstrating.—Yours, etc.,

G. EVANS.

Aberdare, June 8, 1901.

BRIGHTON CABLES.

SIR,—Mr. Gibbings, of the Liverpool Silver and Copper Company, suggests, in his letter to you, that I am wrong in assuming the conductor resistance of the Cable Makers' Association cables should be measured at a temperature of 60deg. F., and endeavours to show that there is practically no difference between the conductor resistance of the cable offered by the Cable Makers' Association and that of the Union Cable Company, Limited, and that, therefore, the cables of all the tenderers are of the same value, because the resistance of the Cable Makers' Association "was most probably based on a standard temperature of 75deg. F."

It is possible he is right, but what better claim has he to his assumption of 75deg. than I to mine of 60deg.? I think if he will look up any cablemaker's catalogue, he will find he is "most probably" wrong. Perhaps the Cable Makers' Association will in its own good time enlighten us as to the temperature.

The latter part of Mr. Gibbings's letter is beside the question.—Yours, etc.,

J. A. BLACKWOOD,
Secretary, Union Cable Company, Limited.

FORTHCOMING EVENTS.

FRIDAY, JUNE 14.

Institution of Electrical Engineers.—At 9 p.m., annual conversazione at the Natural History Museum, Cromwell-road, S.W.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On Herr Jahn's Measurements of the E.M.F. of Concentration Cells," by Dr. R. A. Lehfeldt; "Exhibition of a Set of Specimens of Jena Glass," by Prof. S. P. Thompson, F.R.S.

WEDNESDAY, JUNE 19.

Meteorological Society.—At 4.30 p.m., ordinary meeting. Papers: "The Eclipse Cyclone, the Diurnal Cyclones, and the Cyclones and Anticyclones of Temperate Latitudes," by Mr. H. Helm Clayton; "The Seismograph as a Sensitive Barometer," by Mr. F. Napier Denison.

Municipal Electrical Association.—Sixth annual convention at Glasgow opens. Among the papers which will be read on this and the following three days for which the meeting is called are: "Uninsulated Returns in a Tramway System," by Mr. J. H. Rider; "Street Electric Lighting," by Mr. W. Maclay; "Braking Apparatus for Electric Cars," by Mr. A. L. C. Fell; "The Equitable Allocation of Costs in Combined Lighting and Traction Stations," by Mr. W. H. Tittensor; "Refuse Destructors in Combination with Electric Power Stations," by Mr. J. S. Highfield; and "Coal and Ash Conveying Gear," by Mr. R. A. Chattock. Saturday, the 22nd, is the last day of the convention.

Institution of Civil Engineers.—Annual conversazione, Great George-street, S.W.

SATURDAY, JUNE 22.

Institution of Electrical Engineers.—Visit to Germany.

IMPERIAL THEATRE.

The lighting of this beautiful house marks a new departure in electric lighting. Instead of the usual number of bright points giving out a white and cold light from various candelabra suspended from the ceilings, aided by others fixed on brackets, we have here a remarkably warm effect of diffused light closely resembling the genial sunlight, agreeable to the eye, and most efficient as far as quantity of light is concerned. The main supply of light streams through delicately-tinted amber glass plates from the ceiling, and from battens concealed behind the cornices. A very few metal torches, columns, etc., bearing lamps, uniform in design with the whole idea, are distributed along the walls.

The architectural design of the auditorium, with its coating of light Pavonazza marble, relieved by pilasters and

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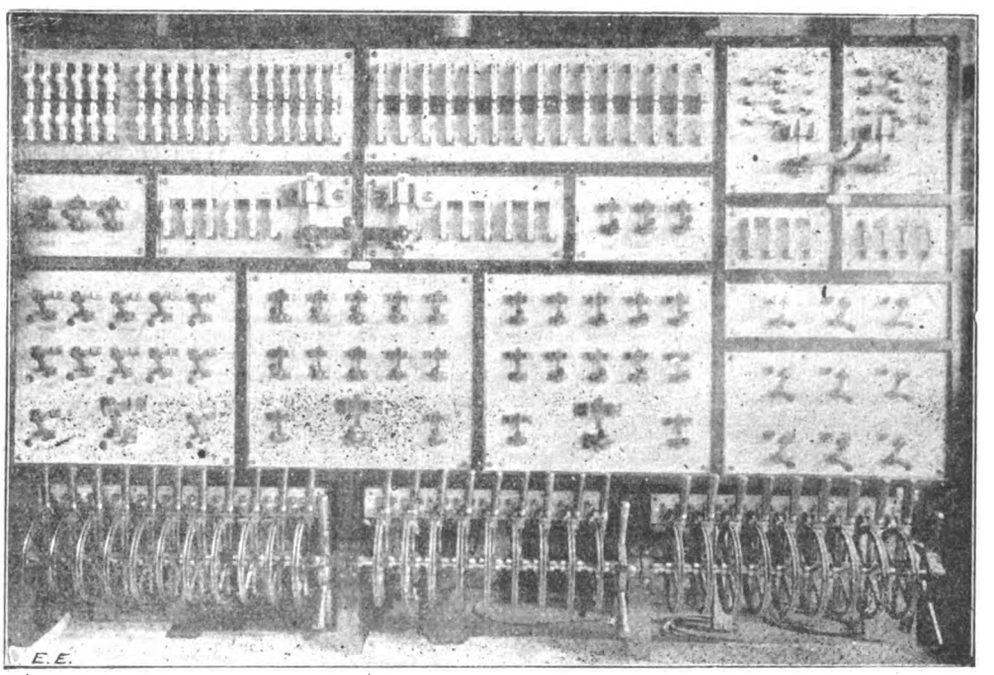
columns of Sienna and darker Chipolini, and its burnished metal ornaments with silk hangings and jewelled embroideries, is thus shown to its best advantage. The stage-lighting is so perfect that an opera glass becomes a superfluity. The scheme includes about 1,650 lamps, varying from 8 c.p. to 32 c.p. each, of which 960 belong to the stage-lighting, and 25 arc limelights of 8, 12, 15, and 20 amperes respectively. There will be three arc lamps of 15 amperes each fixed outside the street entrance. All but two of these arcs are automatic. The stage-lighting has the usual red, white, and blue gamut, a number of hanging battens which can easily be connected to plugs fixed into the flooring of the stage, and various other ingenious contrivances, of which more anon.

As regards the credit due for the electric lighting of the theatre, the idea was Mrs. Langtry's, the designs being executed under her constant personal supervision by Mr. F. T. Verity, F.R.I.B.A., the architect, and Mr. G. C. I. Vaughan, A.M.I.E.E., of Messrs. Vaughan and Brown, Limited, who supplied the fittings and carried out the whole of the work. Going behind the scenes one's attention is drawn to the switchboard, which is faced with 1¾in. white marble. Liquid resistances are used, which are placed in two rooms below the stage. The switchboard is on an elevated gallery in the corner formed by the P. side and the back of the stage, and the operator has an uninterrupted view of the movements on the stage and in the flies. The board is divided by a vertical partition in the two independent sections—the smaller one controlling a 200-volt alternating current, the other a 100-volt alternating current, supplied both from the London Electric Company—one connection being with the Trafalgar-square and the other with the Victoria railway station sub-stations. There are two banked transformers in the basement of the theatre. Another supply is obtained from the Westminster Electric Supply Company. The whole supply can be cut off by means of a capstan switch, occupying the central position amongst the levers at the base of the board. In order to obviate any breakdown which might occur on account of a resistance jar becoming heated after having been in use for a considerable time, a resistance cut-out switch is provided, which allows of any variations being made. In the centre of the upper part of the board there is an 800-ampere throw-over switch for the stage lights. The orchestra and stage lights can be controlled independently of the general supply, so that when the house, and maybe the stage, is in darkness, moonlight and other effects can be worked. The switch fuses are interchangeable, and the whole is so arranged that either they or the brushes of the lever switches can be easily replaced. A separate board controls the arc lights; it is constructed for a 200-volt continuous current supply from the Westminster Company. All the lime arcs can be cut out at once by pulling one lever. There are two automatic arc lamps placed underneath the Royal boxes, which play on the stage, and have the effect to kill the shadows on the faces produced by the light from above. The other arcs are worked from a hanging bridge, which can be moved to any place above the stage by means of centre weights. These arcs have achromatic lenses tested to withstand the heat of a 20-ampere arc, and by an arrangement of switches they can be connected with either the continuous or the alternating current supply. All the fittings in the staircases and passages are of the bulkhead or watertight kind of ship fittings. There are no open fittings and no gas supply whatever. Everything is done by electricity, even the heating of the coffee-urns in the bars. All the battens work on winches, and the work is directed in quite a novel way. A number of lamps are fixed in various parts of the flies, etc., and all scene shifting is controlled silently by means of signals consisting of a number of coloured flashes. These lamps are connected in series with others fixed inside the prompter's desk, so that he can easily meet any excuse as to the light not having shown by confronting the workmen with the counterpart of the signal. Two boards (police circuit), one for alternating and one for continuous current, are placed 6ft. apart in the corridors of each tier. The back of the balcony and the ceilings of the pit and gallery are also lit by bulkhead lights. The ceiling of the main hall consists of an iron framework, into which a number of amber glass plates are let in. Above the same about 400 incandescent lamps are placed. There are battens carrying incandescent lamps behind the cornices. A unique mirror is placed in the dressing-room forming one of Mrs. Langtry's suite of rooms. It is framed by 75 16-c.p. lamps, which can be arranged in any colours so as to match with the corresponding effect of the stage-lighting.



Switchboard at the Imperial Theatre.

THE EDISON STORAGE BATTERY.

The following description of the new type of accumulator invented by Mr. T. A. Edison was given by Dr. A. E. Kennelly at the annual meeting of the American Institute of Electrical Engineers. We are indebted for it to the editor of the *Electrical Review* of New York, who kindly sent us an advance copy of his report of the meeting. Dr. A. E. Kennelly said:

I take pleasure in bringing to the notice of the institute this evening a novel type of storage battery, recently invented by Mr. Edison. It is well known that the history of the storage

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cell is essentially that of the lead cell discovered by Planté in 1860, in which lead peroxide is the depolarising substance. An enormous amount of labour has in the aggregate been expended upon the improvement of this cell in the hands of experimentalists. As a result of that labour the storage battery has at last become a recognised adjunct to direct-current central stations, but it has limitations that seem to withstand further attempts toward improvement. Of recent years hardly any success has been met with in the direction of reducing its weight for a given energy-storage capacity, without detriment to endurance, and this weight is the great drawback of the storage battery in electric storage traction, and has been the principal obstacle to its advance in this direction for the past 20 years. In practice, the storage energy per unit mass of the modern lead battery is from four to six watt-hours per pound of battery (8·8 to 13·23 watt-hours per kilogramme). Expressed in another way, a battery weighs from 124·5lb. to 186·5lb. per horse-power hour at its terminals (75·5 to 113·4 kilos per kilowatt-hour), or, if its stored energy available at terminals were all expended in gravitational work, a battery could raise its own weight through a vertical distance of from two to three miles (3·2 km. to 4·8 km.). While it is possible to increase the energy per unit mass by making the electrodes very light, yet this is always found to be followed by a very heavy deterioration. Many attempts have also been made to perfect storage cells of the alkaline-zincate type, but the great difficulty of depositing zinc in coherent form from the solution, as well as the lack of a depolariser that shall be insoluble in the electrolyte, has stood in the way of this cell's success.

Mr. Edison set himself the task of finding a cell which should possess the following advantages: (1) absence of deterioration by work; (2) large storage capacity per unit of mass; (3) capability of being rapidly charged and discharged; (4) capability of withstanding careless treatment; (5) inexpensiveness. He believes that the cell here shown may claim these advantages in a very satisfactory degree. The negative pole or positive element, corresponding to the zinc of a primary cell or the spongy lead of a secondary cell, is iron. The positive pole or negative element, corresponding to the carbon of a primary cell or lead peroxide of a secondary cell, is a superoxide of nickel believed to have the formula NiO_2. The cell is therefore a nickel-iron cell, a name which suggests the structural material—nickel-steel. The electrolyte is potash—viz., an aqueous solution containing from 10 to 40 per cent. by weight, but preferably 20 per cent. of potassium hydroxide, the freezing temperature of which is 20deg. below zero Fahrenheit, or 30deg. C. The initial voltage of discharge, after recent charge, is 1·5 volts. The mean voltage of full discharge is approximately 1·1 volts. The normal discharging current rate per unit area of active element (positive or negative) is 60 $\frac{\text{milliamperes}}{\text{square inch}}$, or 8·64 $\frac{\text{amperes}}{\text{square foot}}$, or 0·93 $\frac{\text{amperes}}{\text{square decimetre}}$. The storage capacity of the cell per unit of total mass of the cell is 14 watt-hours per pound, or 30·85 watt-hours per kilo. Expressing the same statement in another way, the weight of battery per unit of electric energy at terminals is 53·3lb. per electrical horse-power hour, or 32·4 kilos per kilowatt-hour. Or the battery gives energy at its terminals sufficient to lift its own weight through a vertical distance of approximately seven miles, or 11·26 km. The mean normal discharging power rate per unit mass of total cell is four watts per pound, or 8·82 watts per kilo, corresponding to a normal discharge period of 3½ hours. The cell may, however, be discharged at a relatively high rate in approximately one hour, corresponding to a discharging power rate per unit of total cell mass of 12 watts per pound, or 26·46 watts per kilo. Charging and discharging rates are alike—that is to say, the cell may be charged at the normal rate in 3½ hours, or it may be charged at a relatively high rate in one hour, with no apparent detriment beyond a somewhat lowered electrical charge efficiency. In other words, the cell does not appear to be injured by over-charging or discharging, and only suffers in electrical efficiency under such treatment. The positive and negative plates are mechanically alike, and can scarcely be distinguished by the eye. They differ only in the chemical contents of their pockets. For automobile batteries each plate is formed of a comparatively thin sheet of steel, 0·024in. (0·61mm.) in thickness, out of which rectangular holes are stamped, so as to leave a grid or frame somewhat resembling a window-frame. Each opening or recess is filled with a pocket or shallow box containing the active material. These boxes correspond to the panes of glass in the window-frame analogy. The panes, instead of being thinner than the frame, as in an actual window, are thicker than the frame, or project slightly beyond the surface of the steel grid. They are perforated with numerous small holes to admit the electrolyte, but entirely conceal the contained active material from view. All that meets the eye, therefore, in any of the plates, is the steel frame, and its embedded "windows" of perforated steel.

The active material is made in the form of rectangular cakes or briquettes, and one such briquette is lodged in each pocket or "window-pane" of the plate. Each briquette is placed in a shallow, closely-fitting nickel-plated box of thin perforated crucible steel, cut from a long strip of that material 0·003in. (0·075mm.) thick. A cover or lid of the same material is then laid over it, so that the briquette is closely enveloped by the sides and walls of its perforated steel box. The boxes are then placed in the openings or holes in the nickel-plated steel grid, and closely fit the same. The assembled plate is then placed in a hydraulic press, and subjected to a total pressure of about 100 tons. This pressure not only tightly closes the boxes, bu it also forces their metal sides over the adjacent sides of recesses in the steel grid, thus clamping the whole mass into a single solid and rigid steel plate with the hollow "window-panes" full of active material. The nickel plating of both grids and boxes aids in securing good permanent electric connections between them. The finished plate has a grid thickness of 0·024in. (0·56mm.), and a "window" or pocket thickness of 0·1in. (2·5mm.). This is the maximum thickness of the plate at any point, but being of steel the plate has ample rigidity. The positive briquettes (zincs of a primary cell) are made by mixing a finely-divided compound of iron obtained by a special chemical process with a nearly equal volume of thin flakes of graphite. The graphite does not enter into any of the chemical actions, but assists the conductivity of the briquettes. The graphite is divided into very thin laminæ by a chemical process, and these are passed through sieves or screens so as to leave a size or area of flake that is much larger than the area of the perforation in the steel windows. The mixture is then pressed into briquettes in a mould under a hydraulic pressure of about two tons per square inch. The briquettes have a surface area of nearly 3in. by ½in. on each face. The negative briquette (carbon of a primary cell) is made by similarly mixing a finely-divided compound of nickel, obtained by special chemical means, with a nearly equal bulk of fine flakes of graphite and solidifying the mixture in a mould into briquettes of the same size as above. A suitable number of positive and negative plates are assembled together, being separated from one another only by a thin sheet of perforated hard rubber.

The assembled plates are placed in a vessel or external containing cell of sheet steel containing the potash solution, which, of course, does not attack steel. There was, however, much difficulty from the action of the potash on the soldered seams of the steel containing vessel. After many trials, however, Mr. Edison found a solder which seems to be entirely unaffected by the alkali. In charging, the current is, of course, sent into the positive pole and its attacked negative nickel plate, through the electrolyte, and into the positive plate of the iron compound which carries the negative pole. This current deoxidises or reduces the compound to spongy metallic iron and carries the oxygen through the film of electrolyte to the nickel compound, oxidising it to the hyper-oxide of nickel, NiO_2, a higher oxide than the peroxide; in other words, the charging current simply carries oxygen in the opposite direction against the forces of chemical affinity from the iron to the nickel, and stores the energy in the reduced iron, which is, of course, unaffected and passive in the presence of the potash solution. On discharge the current passes from the positive pole through the external circuit to the negative pole and its attached iron or positive plate, and then through the solution to the negative or superoxide plate. In so doing the oxygen moves back against the current and partially reduces the nickel superoxide, NiO_2, while oxidising the spongy iron. The energy of burning of the iron and oxygen which would be developed as heat in the ordinary chemical process is now liberated in the circuit as electrical energy.

The cell is an oxygen lift. Charging pulls the oxygen away from the iron and delivers it temporarily to the nickel. The condition is then stable until the circuit of the cell is completed. Discharge then allows the oxygen to fall back from the nickel to the iron with the natural affinity of iron and oxygen. This action is very different from that which takes in the lead storage cell. Here, neglecting complication, the action is usually regarded for practical purposes as being represented by the equation

$$PbO_2 + 2H_2SO_4 + Pb = PbSO_4 + 2H_2O + PbSO_4 + 100 \text{ watt-hours},$$

where the left-hand side represents the condition of charge and the right-hand side the condition of discharge. Here oxygen is not simply transferred in discharge from the peroxide to the spongy lead, but the solution is changed (theoretically) from an aqueous solution of sulphuric acid to plain water. Of course the discharge could not practically be carried to the point of denuding the solution of all sulphuric acid, and a surplusage of acid must be used. The equation gives a mere theoretical outline of admittedly very complex reactions. In other words, the specific gravity of the sulphuric acid solution falls during the discharge, and the solution enters into the chemical combination. Theoretically, for every 445 grm. of active material on both plates, 196 grm. of sulphuric acid are required to effect the combination, or 44 per cent. by weight of the active elements,

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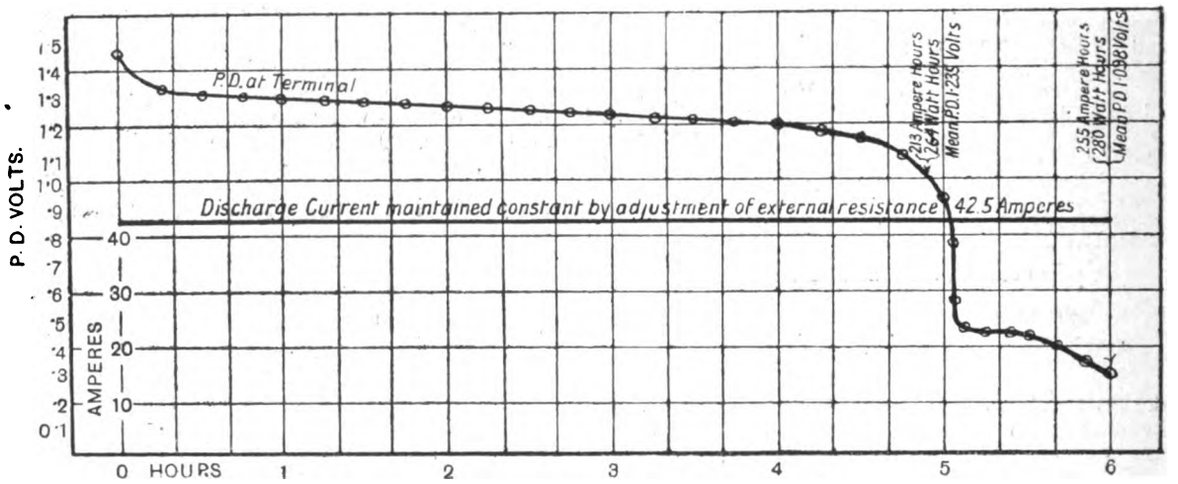
and in practice it is usual to allow a weight of sulphuric acid nearly equal to half the weight of the elements, or about one-quarter of the total weight of the cell.

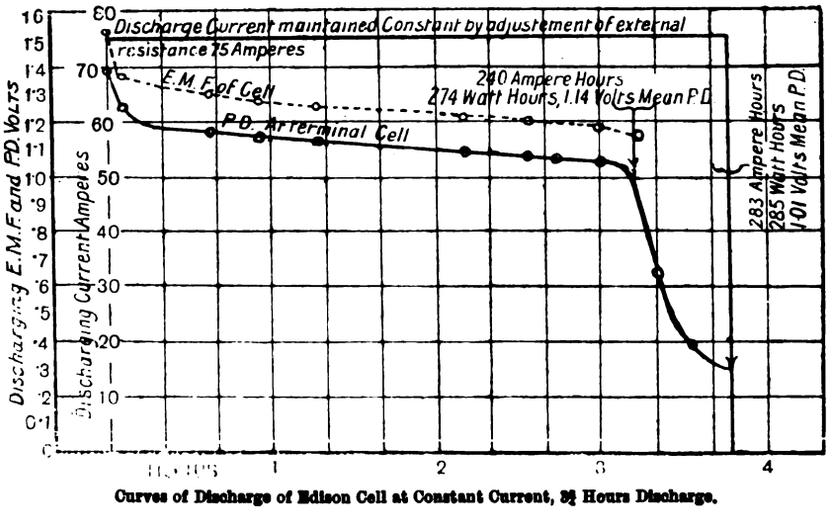
In the new Edison cell, on the other hand, the theoretical action of the potash solution is merely to provide the proper channel through which the oxygen ions may travel in one direction or the other—positive plate to negative plate in charge, and negative plate to positive plate in discharge. Consequently, the amount of solution needs only to be sufficient to fulfil mechanical requirements. It is believed that the weight of solution will in practice be only about 20 per cent. of the plate weight, or about 14 per cent. of the cell weight. In fact, the cell may be worked in the same manner as the so-called primary "dry cells." Moreover, if the solution should escape, the energy would be entirely that due to the energy of combination of oxygen and iron, stated to be 79·7 watt-hours, and representing an E.M.F., theoretically obtainable, of 1·47 volts. If the combination of oxygen with the nickel compound be exothermic, or energy releasing, then the watt-hours delivered (and the E.M.F.) will be lessened by the energy necessarily paid back to break up the combination. If, on the other hand, the combination is endothermic, or energy absorbing, then the watt-hours delivered (and the E.M.F.) will be increased by the energy restored on breaking up the combination. Since the superoxide seems not to have been known hitherto, no information concerning its energy of combination is obtainable. The E.M.F. of the cell seems to be so near to that of the union of iron and oxygen as to suggest that the nickel superoxide is



Curves of Discharge of Small Multiple Edison Cell Weighing 2lb.

or be carried away by gasing in charging, the only detriment seems to be the loss of active surface thereby occasioned, and it will only be necessary to fill up the cells to the proper level with water from time to time as evaporation or gassing may lower the level. For the same reason the specific gravity of the electrolyte does not appreciably vary during charge and discharge. The briquettes of active material slightly expand on receiving oxygen, and slightly contract on delivering it—that is to say, the iron briquettes contract and the nickel briquettes expand during charge, while on discharge the iron briquettes expand and the nickel briquettes contract. The level of the solution is in this way scarcely affected. The expansions and contractions of the briquettes appear to be well within the elastic limits of the spring-steel containing boxes, and consequently the electric contact is always not far from being neutral, or that the nickel compound has but little affinity for oxygen, although the superoxide appears to be quite stable in the cell.

The new cell does not seem to be appreciably influenced by changes of temperature, and should stand a very low temperature without detriment. The electrolyte—potash—does not attack any of the ingredients of the cell, nor are any of the ingredients soluble therein. No local action occurs in the cell so far as has yet been observed, since the E.M.F. is below that necessary to decompose water. The cell may be fully discharged to the practical zero point of E.M.F. without detriment. In fact, a cell has not only been completely discharged, but recharged in the reverse or wrong direction, and after bringing it back to its originally charged state by proper restoration of the direction of charging current, the storage capacity remained


Discharging E.M.F. and P.D. Volts
Discharging Current Amperes
Discharge Current maintained Constant by adjustement of external resistance 75 Amperes
E.M.F. of Cell
P.D. at terminal Cell
240 Ampere Hours
274 Watt Hours, 1.14 Volts Mean P.D.
283 Ampere Hours
285 Watt Hours
1·01 Volts Mean P.D.
HOURS

Curves of Discharge of Edison Cell at Constant Current, 3½ Hours Discharge.

secure. The covers or sides of the window pockets merely approach to or recede from each other slightly during charge and discharge. Fortunately, steel is a metal which possesses this mechanical elasticity in a marked degree. The action of the charging and discharging current upon the briquettes seems to be transferred from their external surfaces inwards in a manner similar to the transfer of carbon and oxygen in the process of making malleable cast iron in the furnace on the principle of cementation. No active material has been found to be ejected from the briquettes through the window perforations, even under deliberate overcharging and discharging. Such gas as is thereby produced makes its appearance on the external surface of the windows. If the nickel compound had no affinity for oxygen, so that energy was neither developed nor absorbed in the deoxidation or further oxidation of that substance, then unaffected. It would seem, therefore, that the cell should be capable of withstanding much abuse. Diagrams are appended giving the curves of discharge of experimental cells.

Mr. Edison states that "the negative plate (nickel) either charged or discharged can be removed from a working cell and dried in the air for a week without appreciably injuring it, and when the plate is finally replaced in the cell its charge is practically undiminished." The positive (iron) plate, if similarly removed from the cell, will be likewise uninjured, but it soon loses its charge by the oxidation of the spongy iron with accompanying liberation of heat and appreciable rise of temperature extending over a period of several hours. On replacing the electrode, however, in the cell the storage capacity is unaffected on recharge. As regards cost, Mr. Edison believes that after factory facilities now in course of preparation have

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been completed, he will be able to furnish the cells at a price per kilowatt-hour not greater than the prevailing price of lead cells.

Having now considered the action and properties of the cell, a brief description may be given of the difficulties encountered in developing it. The phenomenon of passivity has probably kept inventors from finding this cell in the past. Mr. Edison believes that of all the very numerous compounds of iron, and of which he has tried many hundreds, the particular compound which he prepares is perhaps the only one capable of being used. If the dried hydrates or oxides of iron, native or artificial, are subjected to electrolytic reducing action in any alkaline solution, they may remain inert and unaffected. On the other hand, if finely-divided iron obtained by reducing a compound of iron under the action of a reducing agent, such as hydrogen or carbonic monoxide, is subjected to electrolytic oxidation in an alkaline solution, it is inert, and cannot be oxidised. It assumes the well-known passive state. The same difficulty of passivity affects the use of nickel or the negative element. Finely-divided nickel, reduced from a nickel compound, remains inactive when subjected to electrolytic oxygen in an alkaline solution. The monoxide and the black oxide or peroxide are also inert. No oxide of nickel is active or can be made active by electrolytic action, and the peroxide does not act as a depolariser.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

385. In a house-lighting installation with three-quarter mile distance between the power-house and the house, would it be feasible to regulate the voltage on the lamps automatically by means of an adjustable resistance placed at the house and regulated by an electromagnetic device, and if so, what would be the best and most reliable arrangement? Has a similar arrangement been used at any existing installation which you know of, and with what success? The voltage at the power-house is assumed to be kept constant, but the lamp load is assumed to vary from 5 to, say, 100 16-c.p. lamps.—R. M. W.

386. Describe and illustrate the method of distribution adopted in three-phase currents, the high-tension current being transformed down to 220 volts. Arc and incandescent lamps are to be used, and, if possible, on the same circuits or phases. Explain the method of dividing the load amongst the three phases.—R.

ANSWERS.

Question No. 379.—What is considered the best form of gearing on electrically-driven pumps for silent running and durability? Has chain gear met with any success?

Best Answer to No. 379 (*awarded* 10*s.*).—Pumps are of many kinds, and gearing which is quiet and durable enough for one pump is quite unsuitable for others. For instance, a centrifugal pump runs with a steady load which does not vary during a revolution of the fan. A single-acting, single-plunger pump, on the contrary, has a load varying from zero to a maximum and back to zero on the inward stroke, and may even have a negative load on the outward stroke. Double and treble plunger and double-acting pumps have a more constant load at various phases of the revolution, but it is this variation of load causing change of stress on the gearing which is the cause of noise and wear. Driving by means of ropes, with V-grooved pulleys, or by belts is the best method to adopt where possible, but as electric motors run at a fairly high speed, say 500 to 1,000 revolutions per minute, and reciprocating pumps run at a speed of 40 to 70 revolutions per minute, a single reduction (using belts or ropes) is not possible, as the arc (of the small pulley) embraced by the belt is insufficient to prevent slipping with a reasonable belt tension. Owing to the amount of floor space required, a double reduction by means of belts or ropes is seldom advisable. Ordinary spur gear is noisy, and spur gear with cut teeth soon becomes nearly as bad owing to the teeth of the spur wheel wearing unequally, due to the turn of the stroke of each crank. Double helical spur gear is satisfactory as to durability, and is a great advance upon ordinary spur gear as regards quiet running. For moderate sized pumps, up to say 30 b.h.p., rawhide pinions gearing into cut cast-iron or steel spur wheels leave little to be desired. The pinions are most quiet when the gunmetal flanges, which hold the rawhide blanks together, are not carried up to the points of the teeth, but stop short at the roots. If carried up, the gunmetal teeth wear unequally with the hide, and cause noise and grinding. These pinions must be run dry, or blacklead lubricant only used, as oil or tallow softens the hide. The writer had occasion to try a rawhide pinion for driving some machinery by electric motor some time ago. The motor and gear were carried at the top of the main walls of a large office building, and cast-iron spur gear with cast teeth was at first used. Complaints of vibration were so frequent that the writer was called in to effect a remedy, and by substituting a rawhide pinion, while retaining the cast spur wheel, the noise was greatly reduced. The gear has been in almost constant use for 18 months with very little wear. In ordinary cases, rawhide pinions and cut cast-iron spur wheels are most suitable. Where expense is a secondary consideration and freedom from noise and vibration most essential, the best results are obtained with worm gear having a steel worm carefully cut from the solid gearing into a gunmetal wormwheel, which is also accurately cut from the solid, so mounted in a closed oil bath that the worm gears with the wheel below the surface of the oil. The motor should be coupled to the worm by a rigid, not a flexible, coupling, and the only noise will be the knock in the connecting rods of the pump and in the valves. The worm gear will be noiseless. The durability of this worm gear, when well constructed, is astonishing. The writer has had under his observation for the last seven years a worm gear (as described above) driving a three-throw pump, which starts and stops automatically, keeping a hydraulic accumulator charged. It has worked continuously night and day for the period mentioned, actually running probably one-half of the time, and the worm gear, though worn, will probably last two or three years longer, and the noise is trifling—in fact, the motor makes more noise than the gear. For centrifugal pumps any gear will be fairly quiet and durable, but a motor direct-coupled to the pump is the ideal arrangement. Chain gear has been used, chiefly for very small pumps, but it has not been successful, owing to the jerk on the chain as the cranks turn the centre. Sparking at brushes is apt to be caused by this.

Answer to No. 379 (*awarded* 5*s.*).—No type of pump is specified in this question, and as there are two forms commonly used in a modern electric generating station, both will be considered here. The two types of pumps are the centrifugal and the two or three throw plunger pump. With the first named, it is undoubtedly best to dispense with all gearing by coupling the armature spindle of the motor direct to the spindle of the centrifugal pump. If for any cause this cannot be done, then the power should be transmitted by belting. In the case of large centrifugal pumps two belts are often used, one being at either end of the pump spindle. For the two and three throw plunger pumps a different arrangement has to be adopted. These pumps are run at too slow a speed to be able to couple the motor direct to the crank axle. They are usually sent out by the manufacturers with a spur wheel attached to the end of the crankshaft, this gearing into a pinion on a countershaft, at the other end of which a place is provided for a belt pulley or spur wheel. The most compact way of driving is to gear direct from the motor into a spur wheel on this countershaft. It is, however, sometimes done by belting, which has the advantage of comparative silence in running, but is not so efficient as gearing, and is always

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liable to give trouble. This method is, in fact, being rapidly superseded by gearing. For gearing, the best method is to make all pinions of rawhide, and to use cast-iron spur wheels with machine-cut teeth. This should give fairly silent running, though not as silent as belt driving. The rawhide pinions will probably not be as durable as the belt, but, on the other hand, will be very much cheaper to replace.

Another form of gear (chiefly used for pumps of large size) is that in which the spur wheel is made with a cast-iron frame, with hardwood teeth tenoned in. The pinion in this case is of cast iron, and should have machine-cut teeth. This form is slightly more silent than that with the rawhide pinion. The wood-toothed spur wheels are, however, very expensive to replace. It is also not quite so efficient as the rawhide pinion.

Still another form of gear is the worm and wormwheel. This gives very silent running, and all intermediate gearing may be dispensed with; but, nevertheless, it is not as efficient as the spur and pinion, nor as durable. It also has the disadvantage that the pump cannot be moved either way for the purpose of making any adjustment except by running the motor, or by putting the worm out of gear. Cast-iron, in place of the rawhide pinions mentioned above, may, of course, be used. They will be slightly more efficient, but noisier.

For silent running, the different methods of gearing may be placed as follows: (1) worm and wormwheel; (2) belting; (3) wood-toothed spur wheel and cast-iron pinion; (4) cast-iron spur wheel and rawhide pinion; (5) cast-iron spur wheel and pinion. There is very little, indeed, to choose between (3) and (4), and belting (2) will not be very much more silent than these.

For durability, they may be placed in the following order: (1) cast-iron spur wheel and pinion; (2) belting; (3) cast-iron spur wheel and rawhide pinion; (4) wood-toothed spur wheel and cast-iron pinion; (5) worm and wormwheel.

Chain gearing has not been found successful. There is much trouble caused by stretching and breaking of links. It is also by no means silent running. A further objection is that the chain must be kept well lubricated, and throws the oil or grease to a considerable extent.—E.M.R.

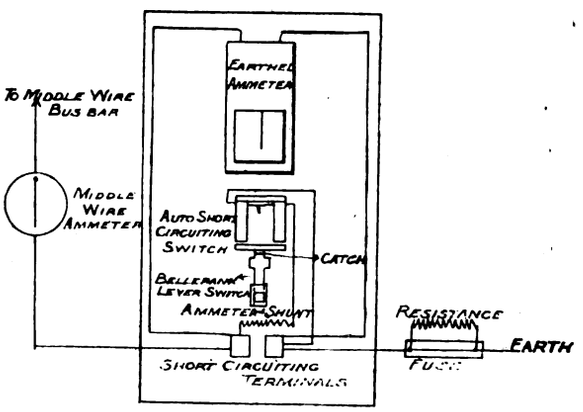
Answer to No. 379 *(awarded* 5*s.).*—It would be hard to say which is the best form of gearing for pumps. The form most favoured by makers (for positive driving) is spur gearing; it runs well, is efficient, and, if the pitch speed is not high, fairly silent, and could be made more so by using a rawhide pinion and cut teeth or hardwood teeth in one of the wheels. It is better to put the wood teeth in the larger wheel, as the life of a tooth will be longer under these conditions, not coming into gear so often. A good ratio for spur gearing is 4 : 1. In practice, a double reduction is usually used, thus adding to the noise and reducing the efficiency. Yes; chain gearing is used for electric pumps, and if well designed, chain speed low, etc., would be very suitable. Those the writer has seen were old, with a high chain speed, and some of the rollers missing. They were naturally noisy. A good form of chain for low speeds is made by Hans Renolds, called the "flat-back chain," and although the writer has not seen it employed for pump work he thinks it would be suitable. Fig. 1 gives

Fig. 1.

the form of a few links. For higher speed the bicycle form of chain might be used with this form. Speeds from 1,000ft. and 1,500ft. per minute may be used. The great objection to chain gearing is the altering of the pitch, no matter how good the chain. It is a question of time, and when the pitch alters chains begin to be noisy and dangerous, and they are liable to mount the teeth and so snap. Although modern practice seems to have forgotten belting for this sort of work, it can be found in some of the Scotch mines running well at this moment, one of the great objections to it being the space necessary for the drive. Worm gearing is also much used for pump work, and is very suitable. The reduction may be 8 : 1. Thus a single reduction only is necessary, thus bringing its efficiency up to the spur gearing. It is also silent and takes up small space. Touching the durability, allowing all forms to have the best material, workmanship, and running under the same conditions, spur gear would have the longest life, worm gearing makes a good second, chain a bad third, unless it has a very low speed; this not being suitable for electric motors, it may be counted out of the running. In worm gearing, one phosphor-bronze and one steel wheel is usually employed, the reason being the low coefficient of friction between these two metals.—T. W. S. H.

Question No. 380.—Give a sketch and discuss the merits and demerits of an earthing panel for the middle wire of a three-wire continuous system of distribution.

Best Answer to No. 380 *(awarded* 10*s.).*—An earthing panel consists of a recording ammeter reading from 0 to 5 or 10 either way, usually of the Elliott type, and an automatic short-circuiting switch, which short-circuits the ammeter if the current to or from earth rises beyond the range of the instrument. A fuse is often placed in circuit with the earth connection, but this is, I believe, against Board of Trade rules. A good way is to place a substantial resistance across the fuse, so that in event



of a dead earth on the mains the fuse would blow, leaving the resistance in, thus preventing damage to plant. If the supply is at 450 volts across the outers, about 10 ohms would allow 22 amperes to flow to earth, which, I think, will satisfy the Board of Trade for a small station. The advantages and disadvantages of earthing the middle wire were dealt with at some length in this paper a month or so ago, and need hardly be dealt with again; and it need only be said that as the Board of Trade require the middle wire to be earthed, it is desirable to know a little of what is taking place with regard to earth leakage. Unfortunately, the ammeter does not tell us much, for if the leakage from both outers is equal the ammeter will register zero. In practice, however, the negative main always falls below the positive, as the negative attracts moisture and the positive repels it. The negative main always has a downward course, but the positive generally keeps up to the mark pretty well. As the ammeter is over to the negative, if an earth occurs on the positive it will fetch it back again, and some idea can be got of the insulation. If an earth occurs on the middle wire, the earthed ammeter will follow to a certain extent the middle-wire ammeter, for the out-of-balance current will flow through the earthed ammeter to earth, through earth to the leakage, and on to the middle wire.

CATALOGUES RECEIVED.

From the General Electric Company we have received their new instrument list, in which we find everything—ammeters, voltmeters, electricity meters, automatic cut-outs, etc.—most clearly described. Our special attention, however, is drawn to the firm's "Stanley" instruments, the "Stanley-d'Arsonval," and the portable and automobile instruments, and the Aron meter, which is so well known that it calls for no comment on our part. In this list the firm devote a special space to automatic cut-outs, and also to an automatic time switch described further on in the list.

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LEGAL INTELLIGENCE.

VIBRATION NUISANCE.

An interesting action, Kite *v.* New Grand (Clapham Junction), Limited, came before Mr. Justice Joyce in the Chancery Division of the High Court this week, the plaintiff seeking an injunction to restrain the defendants from causing an alleged nuisance by so using their engines which generated the electric light for the theatre as to produce vibration in the plaintiff's house.

The plaintiff stated that although there was a row of houses between his domicile in Severus-road and the theatre, the engine caused his windows and furniture to rattle, and prevented him and his family securing refreshing sleep. Unless a person had the hide of a rhinoceros, he alleged, he must feel the annoyance.

Another witness, described as a musician, complained that the noise so irritated his wife that she worried his life out, while the beating of time by the engine did not quite synchronise with the time to which the music he was practising was set. He had to plug up his windows and take down his pictures.

Another lodger, who in his leisure hours does a little amateur photography, alleged that the vibration caused the bottles in his dark-room to rattle and annoy him. It also shook his lamp-shade, his windows, his chair, and his venetian blinds.

A fourth witness said there was "no earth tremor, but the atmospheric concussion from the exhaust steam rattled the windows" both at the front and back of his house, especially when the wind was blowing his way.

Witnesses for the defendants stated that they never noticed any vibration.

His Lordship said this was not a case in which, when the matter had been brought to the attention of the defendants, they had immediately taken steps to remedy it, and it was only last Friday that they had taken any effectual precautions. An injunction must be granted, and he would give the plaintiff £5 damages and award him his costs.

Judgment accordingly.

AN ELECTRIC BATH.

In the King's Bench Division an action brought by Mr. and Mrs. John Gwynne against the Medical Electro-Thermic Generator Company, Limited, and another, to recover damages for personal injuries caused, as alleged, by the negligence of defendants' servants while administering an electric bath to Mrs. Gwynne, resulted in a verdict for the plaintiffs, with ½d. damages.

ELECTRICITY SUPPLY AT KEIGHLEY.

An application was made at the Bradford County Court on behalf of the Fleece Mills Company Limited, of Keighley, last week for permission to alter their articles of association.

Mr. Richard Watson, who appeared for the company, said that they were the owners of mills and other premises in the centre of Keighley, and they had the power to supply gas both as an illuminant and as a motive power. They now wished to have their articles of association so altered as to enable them to supply electricity for the same purposes.

Mr. T. R. D. Wright opposed the application on behalf of the Keighley Corporation, contending that by a strict interpretation of the articles of association the company were entitled to supply gas to their tenants only.

In giving judgment, the learned **County Court Judge** pointed out that there was nothing to prevent the attainment of the object desired by the company if they wound up the present company, and formed a new one; and he could not understand how the interests of the Corporation could be affected by allowing the company to do the same thing by the simple and easy process of altering their memorandum of association. As for supplying electricity to persons other than their own tenants, they would have to get special powers to pass under streets; but there was no reason why they should be prevented from applying for such powers. He therefore confirmed the alterations in the memorandum of association. Judgment accordingly.

SMOKE NUISANCE AT HALIFAX.

The Halifax Corporation were summoned before the borough magistrates this week at the instance of the Health Committee for an alleged smoke nuisance at the electricity works.

Mr. Terdoff, for the prosecution, said the Health Committee were charged with the duty of seeing that these smoke nuisances were abated, and they felt that they could not take proceedings against other persons whilst a similar nuisance was created by another department of the Corporation. In consequence of complaints having been made by other people than those in the Corporation, observations were taken by the inspectors. On Dec. 7 the chimney was watched from 1.50 to 2.30 during which time black smoke issued for 10 minutes. On Dec. 10, from 2.45 to 3.45, black smoke issued for 19 minutes. On the matter being reported to the Health Committee, they ordered the usual notice to be served, calling attention to the nuisance, and requesting that it should be abated. After the time specified in the notice had expired further observations were taken, and for some little time there was an improvement. On April 8, from 2.10 to 3.10, black smoke issued for eight minutes. On May 14, from 2.20 to 3.20, the duration was 13 minutes, and from 3.29 to 4.29 five minutes. The limit allowed by the committee was five minutes.

The defendants were not represented, but a letter from Mr. Street, the manager, stated that they had several times tried various so called smoke preventing appliances, but without good results. About two months ago £320 was spent on one, but it was not satisfactory. They were doing their utmost to meet the difficulty, and other methods were being adopted, but they were handicapped by the constantly varying load.

The **Chairman** said the Bench considered this a very gross case. It was one of the worst brought before them for a long time. The Health Committee had done a very proper thing in taking these proceedings. If they had not proceeded against the Corporation, it would not be much good proceeding against anyone else. The excuse in this matter was just the same as was generally given by other firms. The smoke nuisance was very great, and ought to be put down more severely. There was no more excuse why the Corporation should not put their chimneys right than why other people should not put theirs right. The Corporation would be fined £5 and costs, and an order made for abatement.

CLAIM FOR ELECTRICAL WORK.

In the Westminster County Court on Friday, before his Honour Judge Lumley Smith, the case of Wells *v* Chator was tried. It was was an action by the plaintiffs, a firm of electrical engineers carrying on business at 56, Paddington-street, W., to recover the sum of £21. 13s. in respect of electrical work carried out to his order.

Mr. A. B. Raynes, a member of the plaintiff firm, said that in the ordinary course of business the defendant asked for an estimate for certain electrical work which he desired to have carried out. An estimate was supplied and approved, and in due course the work was completed, but the defendant had disregarded all applications for payment, and consequently this action was brought.

Mr. Frank Hills, second engineer to the borough of Hammersmith, said he had inspected the plaintiff's work in order to see that it was done to the satisfaction of the Council. He found that it was well done in every way, and that the charges were reasonable.

His Honour gave judgment for the plaintiff firm for the amount claimed, with costs.

TELEPHONES.

In the Debts Recovery Court, Scotland, last week the National Telephone Company, Limited brought an action against a local solicitor for payment of £3. 18s. 2d. for trunk dues and £8. 15s. of rent payable at March 29 last for use of telephones for the ensuing year. The defender admitted the claim for trunk dues, but objected to pay the rent on the ground that the company had on April 15 cut off his connection with the exchange, and that it was not competent for them to sue for the forehand rent of a subject of which they had deprived him the use. He would have had no objection to pay if the use of the telephone had been continued to him.

The **Sheriff-Substitute**, however, was of opinion that if a customer of the company did not pay his forehand rent the company could both sue him for it and disconnect him from the exchange till he paid. He therefore granted the decree asked for with costs.

Another action brought by the National Telephone Company against Mr. E. G. Fletcher to recover £8, one year's subscription in advance for connection with the telephone system, was disposed of in the Southend County Court.

His Honour eventually gave judgment in favour of the plaintiffs on the ground that although the defendant doubtless intended to terminate the agreement of £8, he had, in fact, not done so.

COMPANIES' MEETINGS AND REPORTS.

NORWICH ELECTRICITY.

The directors in their report for the year ended Dec. 31, 1900, state that, notwithstanding a great advance in the price of coal, and the fact that a considerable sum which has been spent in renewals has been charged to revenue, the directors are able to maintain the same rate of dividend as that declared for 1899, without having had occasion to advance the rates charged for current. During the year many new customers have been acquired, and the number of lamps wired and motors worked from the Company's mains is now much larger than at any former time. The constantly increasing demand for current and the extension of mains during the last two years have involved a considerable expenditure on capital account, for which the directors have obtained a temporary loan from Barclay and Co., Limited. In order to discharge this, and to provide the further capital which will be necessary for the development of the Company's business in 1901, the directors propose to offer to the shareholders, *pro rata*, in the proportion of one new to every four old shares held by them, 1,750 of the 3,000 £16 shares still unissued, at a premium of £4 per share. Including £125. 9s. 10d. brought forward from last year, and allowing for interest on debentures, bank interest, and depreciation, the revenue account shows a credit balance of £4,457. 4s., out of which the directors

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propose to pay a dividend of 6 per cent. (free of income tax), absorbing £4,200, and to carry forward the balance of £257. 4s.

Dr.	Revenue Account.	£	s.	d.
Working expenses—Coal, etc.		5,054	19	7
Salaries and wages		1,638	19	6
Repairs and maintenance		2,241	6	4
Rates, taxes, and insurance		1,112	18	1
Management expenses—Salaries		1,180	4	11
Stationery, etc.		298	9	10
Rents		18	2	6
Auditor's fee		21	0	0
Managing director		250	0	0
Fees payable to Board of Trade		38	15	10
Law expenses		17	14	8
Directors' fees, 1900		300	0	0
Interest—Debenture interest		1,182	16	7
Bank interest		235	19	10
Depreciation (1900)		3 000	0	0
Balance		4 331	14	2
		£20,923	1	10

Cr.	£	s.	d.
Sale of current, meter rents, and installation work	20,884	5	4
Rent of portion of Duke-street property	37	4	0
Transfer fees	1	12	6
	£20,923	1	10

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
7,000 £10 shares	70,000	0	0
Debentures	35 000	0	0
Sundry creditors	3,450	6	1
Balance, net revenue account	4,457	4	0
Loan from bankers	13,000	0	0
Depreciation account	15,000	0	0
Reserve fund account	10,000	0	0
	£150 907	10	1

Cr. Assets.	£	s.	d.
Expended on properties and buildings	22,496	9	6
Expended on machinery	43 265	2	6
Expended on mains and meters	65 361	2	4
Expended on free wiring and motors	5,006	14	1
Stores in hand—Coal, oil, etc.	1,532	7	4
Stock in hand, installation work	2 575	5	0
Outstanding debtors' accounts	10 437	13	1
Cash in hand	7	5	2
Cash at bankers	225	11	1
	£150,907	10	1

TELEGRAPH MANUFACTURING.

The ordinary general meeting of the shareholders in this Company was held on the 7th inst. at Liverpool, Mr. James Taylor (chairman) presiding.

The Chairman, in moving the adoption of the report, said that last year they made a profit of £41,284, whereas this year it was £35,183. The difference had been caused by two reasons. In the first place, last year they had an exceedingly good contract, which did not extend to the year now closed. In the second place, last year was one of great difficulty in making their goods, for during that time they practically reorganised the whole factory. Where they used to drive with steam-engines, they now used electric power, and the machinery had had to be altered to have that power applied. They therefore thought it better to put forward their best endeavours to get the works into thorough working order before beginning to tender. They were now in a position to do so, and they had every right to expect a share in some of the large contracts which were being given out by various corporations. Out of the profits they had paid a preference dividend, also the small expenses of issuing the new shares. They had paid an interim dividend on the ordinary shares at the rate of 8 per cent. per annum, and out of the balance they transferred £6,500 to the reserve fund, £4,442 to depreciation account, and they proposed to pay a further dividend of 6s. per share, with a bonus of 2s., making in all for the year a dividend at the rate of 12 per cent., the same as last year. Turning to the balance-sheet, their property with machinery and buildings had been increased by some £16,374. The stock-in-trade was very much larger this year, but it was all good stock, and a large portion of it was some raw material which they bought for a special order in hand. On the other side of the balance-sheet the reserve account now stood at £55 000. In the report it was stated that the telephone industry would become a most important branch of the Company's business, and in view of that and the fact that the Liverpool factory was being worked to its utmost capacity, they were taking the necessary steps to meet the increased demand. A great many towns had gone into the question of providing their own telephone exchanges, and for some years the Company had made a speciality of equipments for the big central switchboards used by telephone companies. He believed they were the only firm in England who had made these to any extent. Previously they all used to come from America. They had fitted up a very large number of exchanges for the National Telephone Company, and when two towns, Glasgow and Tunbridge Wells, gave out their orders for central boards, he was glad to say that they secured both. In addition to that, only last night he had heard that another important town had given a contract to the Company, so that they were in the unique position of having secured the only orders for these boards which had been given. They were fearfully pushed for space, and they had, therefore, in Liverpool practically negotiated for the necessary land upon which to put a proper factory. He moved the adoption of the report.

Mr. J. S. Harwood Banner seconded the motion, which was ultimately adopted unanimously, a vote of thanks to the chairman concluding the proceedings.

NEW COMPANIES.

The following new companies have been registered since our last issue:

J. Stenner and Co., Limited.—Capital, £15,000 in £5 shares. Object: to acquire the business of Messrs. J. Stenner and Co., and to carry on the business of manufacturing and electrical engineers, etc.

Priory Motor, Limited.—Capital, £5,000. Object: to adopt agreements (1) with Arthur Hallet and Co., Limited; (2) with C. L. Loveridge; (3) with the Crawford Gear Company, Limited; and (4) with the Hamilton Motor Patents Syndicate, to carry on the business of engineers, makers and repairers of motors, motor-carriages, etc.

Magnus Volk, Limited.—Capital, £10,000, in £1 shares. Object: to acquire, undertake, and work the electrical tramways on the beach in the borough of Brighton, east of the west entrance of the Aquarium, now worked by Magnus Volk, under the sanction of the Brighton Town Council, and any additions to and extensions of the said tramway; to carry on the business of tramway proprietors, electrical and general engineers, etc.

Ham, Baker, and Co., Limited.—Capital, £40,000, in £1 shares. Object: to acquire the business of Messrs. Ham, Baker, and Co., 13, Grosvenor-road, Westminster, and the Municipal Engineering Works, Langley, Worcestershire, and to carry on the business of ironfounders, mechanical, sanitary, water supply, and electrical engineers, manufacturers of electric and steam motors and machinery, contractors for public works, promoters, etc.

APPOINTMENTS VACANT.

Tramways Manager, South Lancashire Tramways Company. Details in our advertisement columns.

Charge Engineer, city of Bristol electricity department, £3 per week. Details in our advertisement columns.

Instructor in Electric Wiring Classes, two evenings per week, Battersea Polytechnic, £35 per session. Details in our advertisement columns.

Meter Inspectors, borough of Nelson, 30s. per week, June 15; Bradford, accustomed to Ferranti, Thomson, and Bastian meters preferred, 30s. per 50-hour week. Details in our advertisement columns.

Student Demonstrator in Mechanical and Electrical Engineering, for session September to July, part time only, Battersea Polytechnic, £50. Details in our advertisement columns.

Resident Engineers, Grays Urban District Council and Epsom Urban District Council, not exceeding £3 per week.

Electrician, for meter testing department. Details in our advertisement columns.

Private Assistant to manage small electrical installation. Details in our advertisement columns.

Partner to invest in well-established electrical engineering business. Details in our advertisement columns.

Salesman-Traveller with good electrical connection. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Brighton.—The Guardians require tenders for the wiring of the workhouse.

Taunton.—The Corporation invite tenders for free wiring. Tenders by July 1.

Stepney.—The Borough Council invite tenders for supply of arc lamp carbons for the year ending June 30, 1902. Tenders by June 26.

Wigan.—The Electric Light and Tramway Committee invite tenders for 12 double-deck single-truck electrical cars. Tenders by June 18. Details in our advertisement columns.

Blackburn.—Tenders are invited for the supply of wrought-iron tubes, and for the supply of steam coal required during the next 12 months. Tenders by June 21. Details in our advertisement columns.

Nelson.—The Electricity and Tramways Committee invite tenders for supply, etc., at their electricity works of a travelling crane. Particulars may be obtained from Mr. W. Alan Fraser. Tenders by 25th inst.

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Whitehaven.—The Water and Lighting Committee invite tenders for the purchase of about 20 tons of second-hand rubber-covered cables. Tenders by June 24. Particulars in our advertisement columns.

Leigh.—The Tramways and Electricity Committee invite tenders for the supply of electricity meters for a period of 12 months ending June 30, 1902. Tenders by June 22. Details in our advertisement columns.

Barking.—The Urban District Council invite tenders for the supply and delivery of 50 cast-iron street lamp columns. Particulars may be obtained from Mr. C. F. Dawson, surveyor to the Council. Tenders by June 19.

Nelson.—The Electricity and Tramways Committee invite tenders for supply and erection of a generating set. Particulars may be obtained from Mr. W. Alan Fraser, borough electrical engineer. Tenders by 18th inst.

Poplar.—The Electricity Committee invite tenders for the supply of multiple-core lead-covered feeder and network cable and accessories for mains extensions. Tenders by July 2. Particulars in our advertisement columns.

West Ham.—The Council invite tenders for two 500-kw. continuous-current tramway generators, coupled direct to three 850-i.h.p. steam engines, and 11 water-tube boilers. Tenders by June 25. Details in our advertisement columns.

Christiania.—The Government Railways invite tenders for 37,660 ko. 4mm. galvanised iron wire, 9,300 ko. 3mm. galvanised iron wire, 12,800 insulators, etc. Tenders by June 26. Particulars, etc., at the office, Jernbanetorvet 8-9, Christiania.

Madrid.—The Public Works Department of the Department of Agriculture, Madrid, invite tenders for the construction and working for 60 years of an electric tramway from Santiario de la Yedra to Balza. Tenders by July 26. Particulars at that office.

Rotherham.—The Corporation invite tenders for the wiring of the police buildings preparatory to a supply of electricity from the Corporation mains. Specification, etc., may be obtained from the borough electrical engineer, Mr. E. Cross. Tenders by 20th inst.

Leith.—Tenders are invited for one Lancashire boiler, with Galloway tubes (similar to the present installation), and additional steam-piping, at the electricity works. Specifications, etc., may be obtained from the Burgh Electrical Engineer. Tenders by 19th inst.

Amsterdam.—The South Holland Electric Railway Company invite tenders for the supply of 3,600 tons of steel rails with appurtenances. Specifications, price 2fl. (3s. 4½d.), may be obtained from the engineers, Beversen and Van Heurn, The Hague. Tenders by June 15.

Barking Essex).—The Urban District Council invite tenders for the supply and erection of condensing plant, comprising surface condenser, cooling tower, electrically-driven air and circulating pumps, steam grease extractor, pipework. Full particulars, etc., may be obtained from the Engineer, Electricity Works, East-street. Tenders by June 19.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

Epsom.—The Urban District Council invite tenders for supply of meters (direct-current) and cut-outs. Specifications, etc., can be obtained from Mr. E. G. Wilson, clerk, High-street, Epsom, on deposit of £2. 2s. for each specification, returnable on receipt of a bona fide tender. Specifications may be seen at, but not obtained from, the offices of Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C. Tenders by 12 noon on 22nd inst.

London, N.E.—Tenders are invited for the erection and construction of mechanical coaling apparatus for the municipal electricity works, for the Electric Lighting Committee of the metropolitan borough of Hackney. Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W., on payment of £1. 1s. Tenders by 4 p.m. on July 4.

London, S.E.—The Borough Council invite tenders for the supply of electricity meters, demand indicators, and main fuses. Specifications, etc., can be obtained at the Town Hall, Spa-road, Bermondsey, on payment of a fee of £3. 3s., which will be returned on receipt of a bona fide tender. The specification may also be inspected (but not obtained) at the offices of the engineers, Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by noon on July 1.

Manchester.—Tenders are invited for the supply, delivery, and erection at their Stuart-street generating station of five electrically-driven overhead travelling cranes, for the Electricity Committee. Specifications, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester, on payment of fee of £2. 2s., and may also be inspected, but not obtained, at the offices of the engineers, Messrs. Kennedy and Jenkins, 17, Victoria-street, Westminster, S.W. Tenders by 20th inst.

Mansfield.—The Corporation invite tenders for the supply and erection of—boiler-house plant: three Lancashire boilers, mechanical stokers, steam pumps, economiser, and motor; engine-house plant: three 200-kw. high-speed steam generators, motor transformer, balancing motor transformer, and accessories; Korting condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains; public lighting: arc lamps, posts, and accessories; meters, and workshop equipment. Tenders by July 12. Details in our advertisement columns.

Erith.—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, economiser, feed pumps, etc.; pipework, etc., in engine and boiler house; surface-condensing plant, three steam alternators (vertical enclosed high-speed engines direct coupled to three-phase alternators), main switchboard and connections, 10-ton engine-room travelling crane, transformers, sub-stations, and equipment, underground mains, conduits, roadwork for private and public lighting, arc lamps (open type), posts, and station lighting. Tenders by June 24. Details in our advertisement columns.

Cleckheaton.—The Urban District Council invite tenders for the supply and erection of the following plant: (Section C) engines, dynamos. Tenderers must tender for the whole of the section, and not for part of it. Specifications, etc., may be inspected at the offices of Messrs. Gibbings and Baker, Piccadilly-mansions, 17, Shaftesbury-avenue, London, W., and Old Bank-chambers, Cheapside, Bradford, on and after 8th inst., and may be obtained on application to the Clerk of the Council, Town Hall, Cleckheaton, on payment of the sum of £2. 2s., which sum will be refunded on return of specification with bona fide tender. Tenders by 22nd inst.

RESULTS OF TENDERS:

Aston.—The District Council have accepted the tender of Handley and Shanks, at £400, for wiring in connection with the destructor.

Swindon.—The Corporation have sealed a contract with Siemens Bros. and Co. for the supply of two steam dynamos for the generating station.

Rhyl.—The Hart Accumulator Company, Stratford, E., have secured the order for the supply of storage battery required for Rhyl electric lighting.

Colchester.—The Town Council have accepted the amended tender of J. A. Kuner of £45 for adapting the installation at the Military Hospital to take current at the higher pressure.

Battersea.—The Lighting Committee have accepted the offers of Geipel and Lange and the Schattner Electricity Company to supply 12 prepayment meters each at £58. 13s. 5d. and £41. 11s. respectively.

Doncaster.—The Corporation have accepted the tender of Mr. H. Gielgud, 140, Leadenhall-street, London, for steel grooved girder tramway rails for eight miles of tramways in the borough of Doncaster and neighbourhood.

Walsall.—The tender of T. Parker, Limited, Wolverhampton, for supplying and erecting the new transformer required for the Freer-street sub-station, at £780, and for supplying a spare armature for such transformer, at £266, has been accepted.

Fulham.—The following tenders have been accepted: C. Cooper and Co., for the installation of an electrically-driven fan, 18in. in diameter, at £22. 15s.; Boult Bros., for the supply of engine oil for the twelve months ending March 31, 1902, £135. 9s.

Kirkcaldy.—The Town Council have agreed to accept the following tenders in connection with the tramways and electric lighting for the town: Laurence, Scott, and Co., Norwich, engines and dynamos, £6 620; Tudor Accumulator Company, London, storage battery, £1,364, with £80 annual charge for maintenance; Carrick and Ritchie, Edinburgh, overhead travelling crane, £370.

Hornsey.—The District Council have received the following tenders for erection of an electric lighting station in Tottenham-lane, Hornsey:

F. G. Minter, Page-street, Westminster	£16 970
Lole and Lightfoot, Chelsea	16 941
G. Munday and Sons, Trinity-square, E.C.	16,658
C. G. Hill, Coventry	16,500
J. Christie, Richmond-road, W.	16,360
W. Gregar and Son, Stratford	16 183
W. Lawrence and Son, Waltham Abbey	15,999
J. Willmott and Sons, Tottenham-lane, Hornsey	15,990
Wilkinson Bros., Finsbury Park	15 951
F. and E. Davey, Southend-on-Sea	15,495
Braid, Pater, and Co., Bow-churchyard, Cheapside (accepted)	13,777

Hull.—The Electric Lighting Committee have received the following tenders for 12 direct-current street arc lamps, erected complete with cast-iron posts and spare parts and accessories:

Oliver and Co., Burrage-road, Woolwich (accepted	£368	6	6
Verity, Limited, Hardman-street, Manchester	348	14	0
Improved Electric Glow Lamp Company, Limited, 11, Victoria-street London, S.W.	351	0	0
Siemens Bros. and Co., Limited, Woolwich, Kent	352	8	0
New Century Arc Light Company, Limited, Iliffe-street, London, S.E.	354	12	6
Walsall Electrical Company, Limited, 57, Bridge-street, Walsall	361	13	9
Crompton and Co., Limited, Mansion House-buildings, London, E.C.	380	0	0
Johnson and Phillips, Old Charlton, Kent	382	4	6
General Electric Company, Queen Victoria-street, London, E.C.	409	14	6

Newcastle.—The Tramways Committee have accepted the following tenders: Dick, Kerr, and Co., Edinburgh and London;

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1,000 tons of rails and fishplates, £6. 8s. 9d. and £12. 10s. per ton respectively; J. F. Miller, North Shields, erection of pumping station in connection with the power station, £2,668; Simpson, Newcastle excavations and laying of pipes to pumping station, about £1 681; Electrical Power Storage Company, car-sheds and storage battery, £2,117 3s.; J. H. Holmes, Shieldfield, battery for sending the electric current along the rails, £380; Veitch, Barrack-road, alterations to the Haymarket car-sheds and the Gosforth car-sheds, £5,178. 14s. 1d. and £3,646. 18s. 11d. respectively.

BUSINESS NOTES.

TRACTION.

Dundee.—The Secretary for Scotland has passed the Corporation's tramway provisional order.

London County Council Tramways.—In the House of Commons this Bill has been read a third time.

Leeds.—It has been decided to equip the whole of the Corporation tramcars with the Tidswell lifeguard.

Broadstairs.—An inspection by the Board of Trade of the town portion of the electric tramway line has been made.

Ilford.—Colonel von Donop has held an enquiry into the Urban District Council's application for sanction to borrow £106,737 for tramways.

Coseley.—The British Electric Traction Company have commenced breaking up the roads at the Fighting Cocks to lay down the electric tramway system.

Lowestoft.—The Town Council have approved a draft agreement with the National Electric Traction Company with reference to the proposed electric tramways.

Northfleet (Kent).—The British Electric Traction Company have commenced the work of construction in connection with the proposed local electric tramway scheme.

Cleator Moor.—The District Council at a special meeting have decided that a petition be presented to the House of Lords against the West Cumberland Electric Tramways Bill.

East Molesey.—With regard to the London United Tramway Company's scheme for the district, the Council are advised there will be no difficulty in obtaining 40ft. bridges and the 9ft. 6in.

By-laws.—The by-laws and regulations of the East Ham Urban District Council tramways, the Bolton and suburban tramways, and the borough of Bolton tramways have now been published.

Motor Vehicles for Heavy Traffic.—There are rumours of the formation of a strong company having for its object the popularising of the heavy motor wagon for ordinary purposes of commerce.

Private Bills.—In the House of Commons the following Bills, received from the Lords, have been read a second time: Chester Corporation Tramways, South Lancashire Tramways, and Tyneside Tramways and Tramroads.

Birmingham.—A petition praying to be heard has been deposited at the Private Bill Office of the House of Commons against the Birmingham (City) Tramways on behalf of the Handsworth Urban District Council.

Stockport.—It having become necessary to widen the Tiviot Dale end of Heaton-lane for tramway purposes, an agreement has been arrived at between the Corporation and property owners by which the property will be set back.

Taunton.—In further reference to the strike among the men engaged in preparing the roads for laying the lines for the proposed electric tramways, the men resumed work last week, having accepted the contractor's offer of 5d. per hour.

Sedgley.—The British Electric Traction Company have given notice to the Council of their intention to commence work on the Sedgley section of the tramway at two points, the first working towards Coseley and the second towards Sedgley.

Beverley.—The town clerk has been requested to enquire of the North Eastern Railway Company whether they desire to work the North Holderness light railway by electricity, assuming terms could be arranged with the Council for the supply of the same.

Auchland.—The Urban District Council have agreed, in respect to electric trams, to extend the time of agreement with the promoters of the scheme to 42 years, on the understanding that the streets belonging to the Council included in the scheme are paved with wood blocks.

Nottingham.—Another step in the electric tramway undertaking has just been entered upon by the commencement of work on the Trent Bridge section. On the Bulwell section the work is being pushed vigorously forward, and in a few weeks it is hoped that cars will be running.

Manchester.—The receipts from the first day's running of the electric cars between Albert-square and Cheetham-hill and Hightown amounted to £166 19s. 7d. The Corporation have decided to petition against the Manchester-Liverpool Electric Express Railway Bill in the Lords.

Glasgow.—We understand that good progress is being made at the Pinkston power station. The first American engine has been supplying power for the cars for some time, and the second engine is now in complete working order, so that an increased service of electric cars is to be given.

West Bromwich.—The Corporation have completed the arrangements for the purchase of the portion of the tramways belonging to the South Staffordshire Company within their district, and the same will be transferred shortly and worked by electricity under the control of the municipal authority.

Rochdale.—The actual construction of the new tramway lines of the Corporation has been commenced on the Norden section. The ceremony of "breaking the ground" was performed by the Mayor, accompanied by several members of the Council and the borough electrical engineer, Mr. C. Atchison.

Batley.—The Town Council have decided to apply to the Board of Trade for a prolongation of the time allowed for the commencement and completion of the works authorised by the Batley Tramways Order of 1900 to Feb. 6, 1902, in the first instance, and Aug. 6, 1903, in the second respectively.

Morecambe.—At the last meeting of the Urban District Council a letter was read from Messrs. Heape and Ledworth, who proposed to seek parliamentary powers to convert the present horse tramway at Morecambe into an electrically-propelled system. The communication was referred to the Electric Lighting Committee.

Sunderland.—At a meeting of the Tramways Committee called for the purpose of considering the question of extensions, it was stated that it would cost £5,000 to alter the road levels, and it was agreed that a joint meeting of the Tramways and Highways Committee should be held to settle the cost between the two.

Pontypridd.—The Tramways Order Confirmation Bill, the object of which is to authorise the Urban District Council to construct electric tramways in the district, came on before the House of Lords Examiner for proof of compliance with Standing Orders. The Bill will be reported for second reading in due course.

Automobiles.—The Automobile Club, feeling that the dust raised by fast motorcars constitutes a more serious annoyance to other users of the public roads than mere quick travelling, has, we understand, offered a prize of 100 guineas to stimulate inventors to devise some means by which this objection may be obviated.

Hampton Wick.—It was stated at the last meeting of the District Council that no definite information could be obtained as to the date of the commencement of the construction of the tramway lines along the Hampton Court and Upper Teddington roads. At the present time the company are constructing the Ealing section of the line.

Edinburgh.—A meeting of the Lord Provost's Committee has been held, at which the letter of the tramway lessees regarding the discontinuance of the circular route was again under consideration. A draft reply was generally approved, and it is understood that the committee ask the tramway lessees to resume the circular route service.

Glasgow Automobile Movement.—A meeting under the auspices of the Scottish Automobile Club, Edinburgh, was held in Glasgow this week, when a resolution was unanimously adopted that a Glasgow and West of Scotland section of the Scottish Automobile Club, affiliated to the Automobile Club of Great Britain and Ireland, be formed forthwith.

Bristol Tramways Co.—We are informed that the directors of this Company, having decided to issue the further 25,000 4 per cent. cumulative preference shares created at the last general meeting of shareholders, have given to registered holders only of the Company's debenture stock, preference, and ordinary shares the privilege of applying for the new shares at par.

Worthing.—The Town Council had the proposition before them at a special meeting last week that application be made for a provisional order authorising the construction of electric tramways or light railways in the borough and adjoining parishes. A numerously-signed memorial against the proposal was present. Ultimately the consideration of the matter was deferred.

Darlington.—The Town Council have decided to apply to the Light Railway Commissioners for an order authorising the Council to construct and work or to contract for the construction and working of light railways in Darlington in substitution of the present tramways. A public meeting has passed a resolution in favour of a plébiscite of the town being taken on the question of the tramways.

Nelson.—At the last meeting of the Town Council, the Deputy Town Clerk reported the payment of the purchase money and interest to date for the Nelson portion of the tramway undertaking. The Borough Surveyor submitted his report on the repaving of Manchester-road with wood or granite in connection with the reconstruction of tramways, and the consideration of the matter was deferred for a month.

Warrington.—The agreement between the Corporation and the Warrington and Northwich light railway has been concluded. By it the Corporation have secured the option of purchasing railway No. 1 at cost price, plus 5 per cent. for supervision, and the cost of incidental works authorised by the order. The agreement also provides that the promoters shall take electric power from the Corporation with a minimum consumption of 200,000 units per annum.

North Metropolitan Scheme.—The application of the North Metropolitan Tramways Company to the Light Railways Commission for an order authorising the construction of a network of tramways, to be known as the Tottenham, Walthamstow, and Epping Light Railways is being strenuously opposed. Both the Wanstead and Woodford District Councils object to the scheme, and a resident committee is busy drawing up petitions of protest and convening public meetings.

Post Office Motorcars.—An experiment was successfully made on Tuesday by the Liverpool postal officials in carrying the mails

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between that city and Southport by a motor vehicle. At last week's trials the representatives of the Post Office were greatly impressed with the utility of the motor carriages for roadwork, and it was decided that further experiments should be conducted to test the value of the vehicles for mail carrying purposes. The Liverpool postmaster will report to London on the subject.

Cardiff.—At the Town Council meeting on Monday objection was taken to the lowering of the roads under the railway bridges in order to be able to run double-decked electric cars, the Board of Trade demanding a distance of 6ft. 6in. between the roof and the bridge, on the ground of the great expense which this course would involve. The Tramways Committee's report on the subject was referred back for further consideration. It is stated that tenders for 2,000 tons of rails will be confined to manufacturers in this country.

Newport (Mon.).—At Tuesday's meeting of the District Council an amendment was brought forward to the reports of the Electricity and Tramways Committee that the tramways be leased to an electrical company. The Mayor would not accept this amendment, as it was in direct conflict with a resolution already adopted by the Corporation to work the tramways themselves. The whole matter of the new power station on Corporation-road was then approved, and the tenders for construction and equipment were agreed to.

Darlaston.—The District Council have approved the plan submitted by the promoters of the Wolverhampton District Electric Tramways, Limited, showing the line to be constructed from Bilston boundary to Darlaston Green, subject to granite setts being laid in lieu of whinstone setts. As regards the section from Darlaston Green to Crescent-road, however, the Council have decided to ask the company to construct this similarly to the portion approved. A special committee has been appointed to consider the question of widening the roads and raising and widening bridges along the route.

Pemberton.—The Urban District Council have approved the draft agreement between them and the tramways company, subject to a clause being inserted to prevent the leasing or subletting of their line, and to restrict the company from first offering their light railway to any other body than the Pemberton District Council. A report of the tramways valuer, Mr. Davidson, fixing his valuation of the tramways at £7,750, so far as the district of the Pemberton Council was concerned, to be paid by the Council to the Wigan Corporation, was adopted.

South Shields.—At the last meeting of the Town Council a letter was read from the British Electric Traction Company, Limited, stating their intention of making application to the Light Railway Commissioners for an order authorising the construction and working of light railways in the district. It was resolved to write the company stating that in the event of their making application for an order authorising them to lay down lines and work the proposed tramways within the borough, the Corporation would take steps to oppose the granting of such order.

Metropolitan District Railway.—A special general meeting of the shareholders has authorised the Company to subscribe and hold shares for any sum not exceeding £200,000 towards the capital of the Brompton and Piccadilly-circus Railway, and the directors to subscribe for debentures in the Whitechapel and Bow Railway Company, and also to join with the London, Tilbury, and Southend Railway in guaranteeing interest not exceeding 4 per cent. upon any part of the debenture stock of the Whitechapel and Bow Railway, and also subscribe for shares of the same railway not exceeding half of the capital of the Company.

Wolverhampton.—At the last meeting of the Tramways Committee a letter was read from Mr. A. H. Walker, of Johnstown, U.S.A., with reference to the Lorain (or Brown) surface-contact system which is about to be put down in Wolverhampton. Personally, he was of opinion that the system is everything that could be desired but he would hesitate putting it in over an extended area until it has had a more prolonged trial than it has in Washington, where it was laid some three years ago. It would be wise to put in, say, a mile or so under proper guarantees and test it under all conditions for a year or so.

Dublin.—The Judicial Committee of the Privy Council have refused an application of the Cavehill and Whitewell Tramway Company for powers to employ electric haulage and to raise the necessary capital for supplying it in the tramway between Whitewell and the Antrim-road junction of the Belfast Street Tramway Company's system. The Lord Chancellor said that having regard to the nature, character, and extent of the changes sought to be made in the existing order, and having regard also to the fact that the local authorities opposed, the committee thought it right to leave those who desired the change to proceed in the ordinary way. The application was accordingly refused.

Hackney.—The General Purposes Committee consider that the routes of the proposed North-East London and the City and North-East Suburban electric railways, as amended so as to provide for the line crossing Hackney Marshes to be constructed in tube, will afford great facilities for traffic; tend to decrease the at present overcrowding of the trains during the early morning and evening on the North London and Great Eastern Railways, and be a great boon to the inhabitants of the district. The committee, however, are of opinion that there are many clauses in the Bills which, as at present drawn, are extremely unsatisfactory, and efforts will be made to secure amendments at committee stage.

Morley.—At a monthly meeting of the Corporation, the Town Clerk reported that he had received the draft of an order in regard to the application which had been made to the Light Railway Commissioners by the British Electric Traction Company, Limited. An order was obtained last year for the construction of certain lines within the borough, and an undertaking was given by the promoters that they would apply for an extension of those lines so as to authorise them to construct a branch from the Bottoms down to the London and North-Western Railway Station. This order appears to be the one which they are applying for to give effect to that undertaking. The matter was referred to the Electric Lighting Committee.

Birkenhead.—The Town Council have authorised the Tramways Committee in respect of the following: To provide double tracks in place of single tracks in the following streets at an estimated cost as appended—in Park-road North, £4,694; in New Chester-road, between Green-lane and St. Paul's road, £205; in Laird-street, from Park road to the car-sheds, £4 066; in Park-road South and in Prenton-road West, £1,200; and passing places in Argyle street and Hamilton-street, at a cost of £936; also to apply to the Board of Trade for sanction to borrow £13,000 for 15 additional cars; for £7,500 for extra generating plant; and for £1 000 for machinery and fittings at the north-end depôt, for effecting repairs to the rolling-stock.

Huddersfield.—According to the official returns the receipts on the Corporation tramways, when the cars were run for the first time on a Sunday, amounted to £123. 6s. 6d. This is more than the average on a Saturday or other day of the week. It is estimated that over 15,000 people availed themselves of Sunday's trams. With the introduction of Sunday labour, however, the tramcar employés are agitating for wages for Sundays at the rate of time and a half. It is said they determined last week-end to refuse to work. At a meeting of the General Purposes Committee on Tuesday the matter was under discussion, and it was moved that the men be granted time and a quarter pay, but the committee eventually left the matter in abeyance for a month.

Halifax.—A meeting of the ratepayers in the Warley road district has been held to protest against the action of the Tramways Committee in reducing the service of cars on the branch route from King Cross to West View Park. A resolution was adopted requesting the committee to renew it immediately "as an act of common fairness and equality." It will be remembered that this was one of the routes which came under, under the decision of the committee to reduce the number of cars running in different parts of the city in order to effect a saving in the weekly expenditure. The Town Council have adopted the following resolution: "That the surplus now standing to the credit of the tramways account and all further surpluses be placed to a renewals account, and that all renewals be paid for out of that account."

Wigan.—At the last meeting of the Town Council it was stated that the Martland Mill line is growing in success. Up to the end of the financial year the takings on the line averaged £75 a week. For the last two months they have averaged £98 a week. The Wigan-lane line has now been opened for public service. Negotiations are proceeding with the Wigan and District Tramways Company with a view to the Corporation taking over their lines. As regards the difficulty of selling the Pemberton line, of which notice has been given of purchase by the Pemberton District Council, a sum has been agreed satisfactory to both parties. The Wigan Corporation are endeavouring to get the consent of Parliament to a Bill to continue the Wigan line to Standish and on to the Royal Oak at Coppall, and also the extension of the present line from Martland Mill to Crooke. Instructions have also been given to the borough engineer to prepare plans for tramways down Poolstock.

New South Wales Tramways.—The Railway Commissioners of New South Wales in their quarterly statement for the three months ended March 31 last state, with regard to the tramways, that the total earnings during the quarter amounted to £151,668, an increase of £38 599. The expenditure amounted to £114,312, an increase of £28 383 the net improvement being £10,216. The number of passengers carried was 25 682 063 an increase of nearly 7,000,000 passenger fares. This advance in the tramway business is no doubt due to the popularity of the electric tram system (which is rapidly being substituted for the steam system for many years in use), and also to the effect of the general introduction of penny fares. During the quarter a new section of tramways, that to Leichhardt (a suburb of Sydney) has been converted to electric traction. During the same period an extension of 77 chains has been made on the line to Tighe's Hill, one of the suburbs of Newcastle.

Lancashire Tramways.—Although the Lancaster Corporation have refused to sell their rights to carry out an electric tramway scheme within the borough, it is reported that the syndicate in question have entered into an agreement with the Lancaster and District Tramways Company to purchase their line from Lancaster to Morecambe for £1 per preference share and 18s. per ordinary share, upon condition that the Lancaster Corporation will extend the powers of the company for an extra term of 25 years—*i.e.*, that they will promise not to exercise their powers to purchase until 1935 instead of 1910. If this power be obtained, the syndicate will convert the present tramways from Lancaster to Morecambe into an electrical overhead system of traction, using double lines. They would enter into an agreement, it is said, with the Corporation for the supply of electrical energy, and make a contribution for the widening of Skerton Bridge, over which the trams to Morecambe pass.

Hebburn.—The Urban District Council have for some time past been considering a series of proposals for the introduction of electric energy and tramways into the town, and we hear negotia-

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tions are now approaching completion. Having obtained a provisional order, the authority sought to make the best terms possible with competing companies in preference to entering upon an undertaking of their own. At the present time there are four companies with whom the Council are in negotiation for the supply of electricity. Three of these have practically agreed to provide lighting and tramway facilities, while the fourth is willing to supply illumination and the necessary energy for the trams. There is a feeling that it would be desirable to have a through service between Gateshead and Shields, and this may not be accomplished if a tram service for Hebburn alone is established. In the meantime the authority have asked the companies to furnish amended conditions on one or two vital points, and when these have been received and considered a final decision will be come to by the Council.

Gateshead.—The running of the electric cars in the town has so far proved a great success. All the routes have not been opened, but the Low Fell, Sunderland-road, and Teams lines, which are running, are extensively patronised. Nevertheless, a petition signed by 1,084 residents of Coatsworth-road and district, protesting against the charges of the tramways company, has been presented. The Parliamentary Committee of the Town Council have received a report from the Board of Trade inspector relative to the danger from falling trolley wires. It stated that both he and the town clerk had grasped the wires and had hardly felt any shock. In wet weather the shock might be greater than on the fine day in question. Under ordinary circumstances, he stated that a shock at 500 volts was more unpleasant than touching a kettle of boiling water, but not so painful as touching a red-hot poker. Unless an extensive and prolonged contact were made, it would not be dangerous. It was possible that a falling trolley wire might cause an accident. It would, no doubt, kill a horse. A simple device might be employed to cut off the current, but he was not prepared to recommend its use.

Motor Traction Co.—The half-yearly meeting of this Company was held on Monday, when the report of the directors was presented, which stated that the two motor-omnibuses which for a considerable time were running between Kennington and Oxford-circus were withdrawn in December last, the directors having come to the conclusion that all the experience that could be got from the working of these vehicles had been gained. The improved omnibuses ordered from the Daimler Company of Cannstatt were expected to be delivered in March, but, owing to certain alterations deemed necessary, some delay has occurred; delivery, however, is promised in a few weeks. In the early part of the present year the factory buildings were so far completed as to admit of work being commenced in a portion of the premises. The additional machinery required is being put down as quickly as possible, and the Company will soon be in a position to undertake the construction of motor vehicles of the most approved type. A large space being available for storage purposes at the depôt, the Company is now prepared to house, repair, and keep in order any description of motorcar, and has special facilities for charging electric cars and for the sale of petrol spirit.

Wakefield.—The report to the Board of Trade by their inspector, Lieut.-Colonel Donop, on the question of running the proposed tramway or light railway over Wakefield Bridge has been communicated to the promoters of the scheme and to the local authorities concerned. Colonel Donop is distinctly favourable to carrying the line over the bridge, to which objection had been raised on the ground of its narrowness and insufficient strength. He sees no reason why the light railway scheme should be hung up pending the decision of the local authorities as to exactly what steps they are going to take with regard to the widening. We understand that the promoters are now seeking further powers at the hands of the Light Railway Commissioners, having applied for an order to connect Ossett with Horbury, which, in turn, is to be connected with Wakefield, and to lay a tramway from Wakefield to Lofthouse, Rothwell, and Hunslet, there to join the Leeds Corporation tramway system. It is expected that the East and West Yorkshire Union Railway Company, who have already obtained powers to construct a passenger line between Rothwell and Leeds, will have something to say on the matter when the local enquiry is held.

Newcastle.—A detailed report as to present expenditure and the prospective cost of the electric trolley system of tramways now being laid down by the Corporation states that when the parliamentary powers were first obtained the total estimated expenditure was £614,250. It is now estimated that it will amount to £803 281. The chief causes of the rise are put down to the increased cost of generating plant and trolley wires owing to the advance in materials, the cost of the tramcars, in the purchase of property of the old company not originally contemplated, and involving payment of £34 000, and £6,450 for arc lamps provided at the request of the Watch Committee for street-lighting. The only portion of the undertaking which is likely to remain within the estimates is the track. The sum of £400,000 was estimated for this, but it is now stated that £325 000 will suffice. Mr. Mordey, of the firm of Messrs. Mordey and Dawbarn, of London, has prepared a report for the Corporation upon the supply of electrical energy within Newcastle, the concluding remarks of which are: "The Corporation can never again have such an opportunity as the present for a satisfactory rearrangement. It seems to us that it would not now be difficult to take the matter up, aiming at a general supply by (1) the development of the existing stations within the municipal area, making full use of the new tramway station; (2) unification of the system over the whole area; (3) interconnecting, so that one station only could supply all needs during periods of light load." The Town Council have appointed a sub-committee to consider the report fully, and to prepare such form of communication as they might consider desirable, to be sent to the Board of Trade. The City Council have sealed the following document: authority to the Public Works Loan Commissioners to deliver certificates for £50,000 (part of the loan of £350,000 for tramway construction) to the city treasurer.

Sheffield.—With reference to the recent trouble with the tramway men, the following report of the Tramways Committee appears in their minutes: "The committee have investigated the cause of the recent threatened strike in connection with the dismissal of Mr. G. E. Francis, the car-sheds superintendent. As a result thereof, they are glad to find that it originated only with a few fitters, car washers, and labourers directly under the control of Francis. The committee summoned before them all the men who had taken part, and requested them to give explanations of their conduct. Nearly all the men concerned in it having expressed their regret at the action they then took and promised not to offend again, the committee recommend that no further action be taken against them, with the exception of four men, with regard to whom it is recommended that one week's wages in lieu of notice be given to them to terminate their engagement." The accounts of the Corporation tramway undertaking for the year ended March 25 last show that the number of passengers carried was 34,370,763, as compared with 19 209,714 the preceding year. The receipts were: horse traction, £27 494; electric traction, £108 300—making a total of £135,794. The gross profits are £48 657, and after deducting interest and sinking fund a net available profit of £21 817 remains. It is proposed to place £15,000 of this to a special fund to provide for renewals, bringing the surplus account to £51 277. The rates have now been relieved from the proceeds of the tramways working to the extent of £22,000. The total street mileage is now 22, and the receipts are constantly growing. In Whit-week they amounted to £4,590, or nearly £1,000 in excess of the Easter takings. The Tramways Committee have under consideration the question of laying tramrails up Glossop-road, thus providing an alternative route to Broomhill. The doubling of the rails in Church street and West-street is to be taken in hand at the earliest possible moment. Rapid progress is being made with the work on the Intake route—from the cemetery to Intake village. There is likely to be some delay in regard to the extension from Heeley to Norton Woodseats, considerable difficulty having arisen as to the widening of the road from Woodbank-crescent.

London Underground Railways.—The Joint Committee of both Houses of Parliament appointed to consider the proposed routes in various Metropolitan Underground Railway Bills, now before Parliament, continued their enquiry on Tuesday. Mr. H. B. Palmer, traffic superintendent, put before the committee his views as representing the Metropolitan Railway. He did not consider the proposed loop at the end of the Central London line was necessary, and the advantages of such a loop were more imaginary than real, and disproportionate to the cost. The Metropolitan Company had not realised the advantages they had hoped to gain from the adoption of the circle in place of the horseshoe service. It would be cheaper and more convenient for the Central London Company to add to their line by about a train's length, and put in a cross-over road from up to down line. By this means a service of 30 trains an hour could be kept up, and by adding another coach to their trains the Central London might increase their carrying capacity by 33 per cent. Such was the experience of the Paris railway. His view was that in the adoption of the Bank as the central point for the termini for tubular railways lay the basis of a very good solution of the problems of London traffic. The extension of the North-East London line from Liverpool-street to the Monument was not necessary in the public interest, and it would be merely parallel to the Metropolitan route. His view was that it was undesirable to run tubes through the central district. For public convenience these tube railways should lead to and from a common centre, with exchange stations at convenient points to communicate with main lines of railway. Delays and irregularities in service would in that way be less likely to occur. If a tube railway had a through route, say from Tottenham and Walthamstow to Charing Cross and Hammersmith, a breakdown at the Charing Cross and Hammersmith end would dislocate the traffic throughout. In answer to the Chairman, the witness said that with the adoption of electric motive power his company would be able to increase the service on both the Inner Circle and suburban connections. Mr. Thomas addressed the committee on behalf of the Metropolitan Railway Company, disclaiming any attitude of general hostility to tubular railways, but claiming for the company that they should be allowed to keep the traffic they had secured by the facilities they offered, and which they were prepared to increase to meet public demands. Mr. G. Dew, alderman of the London County Council and member of the Housing Committee and secretary to the Central Association for the Extension of Workmen's Trains, gave evidence from the point of view of the housing question. The means of transit on many of the suggested railways were so fragmentary, dealing only with such small sections and touching such small districts of inner London, that they would offer little assistance towards the solution of the housing question. A complete scheme must start from a central point where workmen wish to arrive in large numbers and thence run into the outer suburbs, taking in not only the densely-populated parts of inner London, but going to the leaner and undeveloped districts. After consultation, the committee decided to confine evidence for the present to the question of route. The committee adjourned.

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LIGHTING AND GENERAL.

Levenshulme.—A destructor scheme is being discussed in committee.

Leith.—The salary of Mr. J. G. Scott has been increased by £50 per annum.

Bangor.—Application is to be made for sanction to borrow £2,000 for new cables.

Montrose.—The Town Council have decided to erect electric lights in various streets.

Colne.—Arrangements are being made for an electric light installation at the new market.

Aylesbury.—The Electric Lighting Committee are offering £600 for a site for the electric lighting works.

Accrington.—The Corporation have decided upon an expenditure of £9,000 for electric lighting extensions.

Clyde Valley.—The Clyde Valley Electrical Power Bill has been read a second time in the House of Commons.

Tenbridge.—The 113 tenders received for the electric light installation have been referred to Mr. Hammond.

Share Market.—Little was done in electric shares during the week, but there was a good demand for debenture issues.

Stockton-on-Tees.—The Town Council have decided to apply for sanction to borrow £27,500 for electricity works extensions.

Blackburn.—The Electricity Committee have decided to reduce meter rents to 2s. a quarter for all sizes up to 50 amperes.

Southend.—The surveyor is about to prepare a scheme and estimate for the provision of a destructor at the London-road depôt.

Trowbridge.—Mr. David Stevenson has been appointed to undertake the planning and supervision of the proposed electric lighting.

Dudley.—A suggestion that the electric light should replace the gas at the baths will shortly come before the Estates Committee.

Northfleet.—The Bill authorising the provisional electric lighting order has passed through the unopposed committee of the House of Commons.

Guildford.—The Council have decided to advertise in the technical papers for schemes to work their provisional electric lighting order.

Chesham.—The Urban District Council are conferring with the High Wycombe Electric Lighting Company as to the sale of their provisional order.

South Bank.—The Urban District Council intend to petition in favour of the Cleveland and South Bank Electric Power Bill in the House of Lords.

Morecambe.—The last account of the Electric Light Committee shows a net loss on the year's working ending March 31, 1901, of £667. 9s. 9d.

Electric Hoists.—We understand that an order has just been issued for electric hoists to be fitted to all British warships that carry guns in casemates.

Middlesbrough.—The last report shows that there are now 8,681 lamps supplied, and applications for 3,498 are in hand—making a total of 12,179.

Monmouth.—Transformers and cables are to be provided for supplying electric light to the grammar school and the high school, at a cost of £400.

Perth.—It has been remitted to Mr. Hawbayne to make enquiries and report as to the advisability of taking an electric main to the Barnhill district.

Newcastle-on-Tyne.—The inauguration of the electric power supply on Tyneside will take place on June 18 by Lord Kelvin. Sir Andrew Noble will preside.

Winchester.—The Council's application for power to raise the sum of £2,850 by loan for extension of electric light cables in certain streets has been approved.

Stroud.—The report of the engineer respecting the scheme of electric lighting for the town is now before the Lighting Committee of the Urban District Council.

Brierfield.—The Burnley Town Council have offered to supply the Urban District Council with current at 5d. per unit, provided 30,000 units per annum are guaranteed.

Fulham.—During the fortnight ended June 1, 1901, 1 292 loads of refuse have been destroyed, 24 loads of clinker sold, and 365 tons of clinker had been barged away.

Waterford.—The county borough of Waterford, Ireland, have retained Messrs. Lacey, Clirehugh, and Sillar to furnish them with a report on the electric lighting of the town.

Hackney.—At the meeting of the Borough Council last night it was recommended to consider schemes for cheap slipper baths in connection with the electric light undertaking.

Ayr.—The Council have decided to lay a 2in. pipe from the cable trench to every centre pole for lighting purposes. This will be an extra charge by the contractor for the roadway.

Hartlepool.—The Corporation will at their next meeting consider the electric lighting of the borough. The cost of the necessary plant, etc., is expected to be about £18 000.

Kingstown (Dublin).—A special meeting is to be held to consider the tenders for electric lighting plant, and application is to be made for sanction to borrow £50,000 for the scheme.

Eastbourne.—The Council have decided to charge the Devonshire Park Company 5½d. per unit for electric light supplied during the nine months the municipal orchestra play in the park.

Bath.—The Electric Lighting Sub-Committee have recommended the Corporation to confirm, as a permanent engagement, Mr. F. Teague's hitherto temporary appointment as borough electrical engineer.

Broughty Ferry.—At Tuesday's meeting of the Town Council a motion to the effect that the minute, so far as regarded the purchase of a site for electric light purposes, be rescinded, was agreed to.

Provisional Orders.—The Board of Trade have granted an electric lighting order for the Monkseaton and Whitley district. The Hucknall Torkard Urban District Council are about to apply for an order.

Removals.—The registered offices of the Hove Electric Lighting Company, Limited, and the Calcutta Electric Supply Corporation, Limited, have been removed to Salisbury House, London-wall, E.C.

Clayton.—The District Council have accepted the report on the interview between the sub committee representing the Clayton and Harwood Councils and the Board of Trade on the subject of the electric lighting order.

Worthing.—The Electric Lighting Committee have directed the resident engineer to prepare the necessary specification for the wiring of the electric generating station, and tenders are to be invited for carrying out the work.

London Gazette.—June 27 has been fixed as the last day for receiving proofs in the estate of Mr. A. W. Hirst (trading as Hirst and Co.), Croydon. Mr. A. Mackintosh, 24, Railway-approach, London Bridge, S.E., is official receiver.

Camberwell.—Notices have been received by the Borough Council from the County of London and Brush Provincial Electric Lighting Company of intention to construct a transformer box and to lay mains in Elm-grove and Chumleigh-street.

Keighley.—The Town Council have, after considerable discussion, confirmed the action of the Gas and Electricity Committee in opposing the application of the Fleece Mills Company for powers enabling them to generate and supply electricity generally.

Wakefield.—The salary of the electrical engineer (Mr. Blackmore) is to be advanced to £300 a year, and also, in consideration of the supervision of the extension of the plant, a bonus of 1 per cent. will be paid to him on all completed work on capital account.

Woolwich.—We have already noted that the Council have decided to purchase the existing local electric light undertakings at a cost of about £100,000. At Plumstead the Council are inaugurating their own system of electric light at a total cost of £200,000.

Walsall.—The Electric Lighting Committee have approved of part of the corporate land fronting Freer-street, forming part of the pig market, with the building thereon formerly used as a weights and measures office, as a site for the new transformer sub-station.

Pemberton.—The Council have asked the architect to press the contractors of the station buildings. The electrical engineer is to report to the next meeting as to the number of additional arc lamps required. The Council intend to discuss the question of wiring at an early special meeting.

Brighton.—The Guardians have accepted an offer from Mr. P. Coote, electrical engineer, Brighton, to prepare a specification for wiring the workhouse buildings. An advertisement is to be issued inviting tenders to wire the above-named buildings in accordance with such specification.

Concealed Wiring.—We notice that Mr. J. Bathurst, of the Conduit and Insulation Company, Limited, is just about to start for the United States with the intention of visiting the Buffalo Exhibition in order to see the latest American electrical practices, particularly in respect to wiring developments.

Stafford.—On Tuesday plans were approved for the electrical testing and packing shops, boiler-house, smithy, machine shops, ironfoundry, sawmills, carpenters' shops, brassfoundry, and offices, covering an area of something like 18,000 square yards at the Hough, by Messrs. Siemens Bros. and Co., Limited.

Aspull.—The Lancashire Electric Power Company have asked the Council for an early interview with reference to the supply of electric current in bulk. The clerk has been instructed to reply that the Council thought it too early for the interview, but if the company still wished for an interview one might be arranged.

Mines Drainage and Electrical Pumping.—At the last meeting of the Mines Drainage Commission at Dudley, the Chairman (Mr. Cochrane) said about November next they would be in a position to introduce electrical surface pumping. They proposed to erect an electrical station at Leabrook, and to introduce Mond gas at Tipton.

Swinton and Pendlebury.—The Tramways and Electricity Committee have asked the Salford Corporation upon what terms the Corporation would be willing to supply electricity in bulk to consumers in the Swinton and Pendlebury district for a definite period, and also when it was probable the work of relaying the tramrails would be completed.

Swansea.—During the past month 117 applications were received for the supply of electrical energy, being equal to a demand of 13,748 c.p. As to lighting the docks, it has been decided to submit to an independent expert the question at issue between the Corporation and the Harbour Trust as to what the electric lighting actually costs the Trust.

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Hastings.—The electric light mains are to be extended at a cost of £190, and application is to be made for sanction to the borrowing of the total estimated cost, and of £103. 10s., being the estimated cost of the provision, erection, etc., of the three electric arc lamps ordered at the last meeting of the Council to be placed in the western portion of Norman road.

Chesterfield.—The Town Council have decided to buy an additional boiler for the generating station, in view of the large demand for electric lighting in the borough, and to obtain an additional 200 kw. set of machinery for the generating station, at the estimated cost of £5 000. Application is to be made for sanction to a loan of £6,000 to carry out the proposal.

Redditch.—At the last meeting of the Urban District Council it was proposed: "That, owing to the large and increasing expenditure upon the electric lighting scheme, it is desirable that the Council shall obtain further expert advice upon the undertaking." After a long discussion, it was decided to defer the question until the new generating plant is put down and got in working order.

Shrewsbury.—At a special meeting on Tuesday, the Lighting Committee presented a report recommending the extension of the electric light mains at a cost of £420 and it was also decided to apply for sanction to raise a loan of £16,526 for the extension of the works, and, if possible, to obtain further time for the repayment of all the money borrowed and spent upon the undertaking.

Winsford.—The Board of Trade have explained to the Urban District Council that they had no power to grant an extension of time for the lighting order. The Board also intimated that the undertakers did not appear to have any present intention of giving effect to the order, and it would devolve upon them at the expiration of the time to consider the question of revoking the order.

Ormskirk.—At the last meeting of the Urban District Council, a letter was read from Mr. W. J. Herring, general manager of the Lancashire Electric Power Company, requesting an early interview with the Council in reference to the supply of electric current in bulk to the district by the company. A sub-committee, consisting of Messrs. Walker, Ellis, and Knowles was deputed for that purpose.

Elland.—The attempt to secure the public ownership of the Elland-cum-Greetland gasworks not having been successful, the District Council are seeking to make use of the provisional order to generate and supply electricity, granted nearly two years ago. The Electric Lighting Committee have at the present time under consideration a scheme which is estimated to entail an outlay of about £10,000.

Carnarvon.—The Town Council have decided to apply for an electrical lighting order for the borough, leaving the question to be decided later on whether they themselves or a company under their authority should carry out the works and supply electricity. This step is taken in consultation with Sir W. H. Preece, who kindly promised his gratuitous assistance in the matter, as a freeman of the borough.

Luton.—Mr. Snell has informed the Council that everything is ready for the supply of electric light by June 20, 1901. Mr. W. H. Cooke enters upon his duties as resident electrical engineer from June 1, but Mr. Snell is not relieved of his duties and responsibilities as the electrical engineer for completing the installation. The Council have declined an offer as to free wiring by the National Electric Wiring Company, Limited.

Peebles Hotel Hydropathic.—A new wing has been erected at a cost of £5,000. All the latest appliances from Continental health resorts have been introduced, including static electricity with ozone apparatus attached, such as is in use at Baden and Homburg. An apparatus has also been fitted up for the "bullseye" electric treatment by the use of coloured rays of light applied to various parts of the body, and electric light has been installed.

Batavia.—The *Bulletin Commercial* states that Messrs. H. R. der Mosch and H. Jul. Joostenz of Batavia, have obtained a concession to work, etc., for 30 years an electric light and power supply for the towns of Padang and Djokjakarta. Padang is the most important town on the west coast of Sumatra, and has a population of about 35 000. Djokjakarta has 85,000 inhabitants, and is connected by railway with the town of Samarang.

Colwyn Bay.—A further loan of £8,450 is to be applied for to provide for extensions of the main along the Conway and Abergele roads, as well as a new distributor to Colwyn Bay Hotel and Penrhos College. The Council intend to ask the Local Government Board not to set these loans against the Council's borrowing powers, as the electric works were of a permanent character in the same way as the gas undertakings.

Bury.—The last report of the electrical engineer shows that during the month ended May 19, five additional consumers with 95 8-c.p. lamps were connected, and extensions amounting to 652 8-c.p. lamps were made on existing consumers' premises, making a total of 747 8-c.p. lamps, as compared with 471 8 c.p. lamps for the corresponding period of last year. The cables are to be extended down Manchester-road as far as St. Peter's Church.

Linlithgow.—At the last meeting of the Town Council a communication was read from Messrs. Crompton and Co., enquiring what had been done by the Council in regard to their offer to introduce the electric light to their town, and offering to apply for a provisional order in their own name. The letter was remitted to the Lighting Committee, who are to submit a report of the whole question to an early meeting of the Town Council.

Dissolution of Partnership.—Messrs. Nicholson and de Winton have by mutual consent dissolved partnership as and from March 30, 1901. Mr. F. B. Nicholson, M.I.E.E., will continue to carry on the business of the firm under the style of Nicholson and Co., at 53, Victoria-street, as heretofore. All moneys due to and owing by the late firm will be received and paid by the said F. B. Nicholson. Mr. W. H de Winton, A.I.E.E., will carry on business on his own account at 53, Victoria-street, Westminster.

Cupar.—Figures showing the cost of incandescent lighting and of the electric light, the difference in favour of the electric light being about £130 per annum, having been submitted to the Lunacy Board last week, it was proposed to introduce an electric lighting installation into the asylum, in accordance with the report recently before the Board. The motion, however, was withdrawn, and it was agreed that the matter should be left over until the Board had before them the plans for the addition to the building, when the whole matter would be gone into.

Wolverhampton.—On Monday a report was adopted giving an abstract of the accounts of the electric lighting undertaking for the year ended March 31 last. The result of the year's working has been a loss of £130. 16s. 6d., arising principally from a slight reduction in the charges. If the same charges had been maintained the committee would have made a profit of between £3,000 and £4,000. Last year the consumers benefited by the reduction to the extent of nearly £1 200 During the year the quantity of electricity generated was 850,173 units.

Electric Fans.—We have received from Messrs. J. Gibbs and Son, 72, Duke-street, Liverpool, a copy of a letter from Mr. B. H. Bedell, engineer of the Electric Timber-Seasoning and Preservation Company, Limited, speaking in eulogistic terms of three fans which were supplied by Messrs. Gibbs more than six months ago, and which had been running continuously night and day almost ever since, and stating that the fans were keeping cool, were running sparkless, and were taking now even a smaller current than that which they took when tested at the works.

Southwick.—In consequence of the refusal of the Council to entertain the idea of the Brighton Corporation erecting overhead telephone wires in the district, a deputation from Brighton waited upon the Southwick Council. Subsequently the Council resolved to grant the Brighton Corporation leave to construct certain telephone circuits in the district, provided that all lines crossing tramway wires be taken underground, and also provided that the maximum charge in the district be £5. 10s. each instrument, and in any case not more than will be charged in Brighton.

Worcester.—The Council have approved Mr. Rowe's plans of the proposed Tybridge-street generating station, and have instructed him to prepare a detailed specification and obtain tenders for the work. The electrical engineer is to complete the engineering plans of the machinery and plant for the new station as quickly as possible. Application is to be made for sanction to a loan for building and equipping the new station, amounting to £30,450, on the understanding that the amount of the loan be revised in accordance with the amounts of the tenders when received.

Stock Exchange.—The Stock Exchange Committee have appointed June 19 special settling day for the West London and Provincial Electric Supply Company, Limited 9 891 ordinary shares of £1 each fully paid, Nos. 7.501 to 11,425, 12,926 to 15,025 and 16,026 to 19 891, and 34,314 6 per cent. cumulative preference shares of £1 each fully paid, Nos. 7 501 to 36 045 and 36,146 to 41 914 The committee have ordered to be quoted in the official list Edmundsons' Electricity Corporation, Limited, 6,637 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 6 637.

Dumfries.—At last week's meeting of the Town Council the Electric Light Committee reported that they had found it impracticable to proceed with the scheme of utilising water power for the generation of electric light, according to the report of Mr. Ritchie, electrical engineer. It was decided that the clerk should communicate with Dr. Mond on the subject of the suitability of the new Mond gas for electrical power, and to write to the Board of Trade explaining the Council's position in regard to the provisional order, and asking an extension of time in order to carry it out.

Sheffield.—The accounts of the Corporation electric supply department for the last fifteen months show a total income of £41,939, being an increase of £18,597 over the previous year. The expenditure has been £15 985, and after deducting all interest charges, and allowing for sinking fund, there is a profit of £4,048. The opposition to the Yorkshire Electric Power and the Derbyshire and Nottinghamshire Electric Power Bills in the House of Lords is to be confirmed. The salary of Mr. S. E. Fedden, the chief engineer and general manager of the department, is to be increased by £100 per annum. Land is being purchased near Old Park Wood for the erection of a new electric power station.

Personal.—Mr. L. Paton Greig, formerly of Edinburgh, has been appointed chief electrical engineer to the Bury St. Edmunds electric lighting works, in succession to the late Mr. A. H. Roe, who was appointed to the position on the inception of the electric lighting scheme in Bury. Mr. Greig received his technical instruction in electrical engineering at Heriot Watts College, Edinburgh, and completed it at the Edinburgh electrical works, subsequently receiving an appointment as assistant inspector of mains in the city. After three years' service he was appointed electrician in charge of a portion of the works at Bradford, Yorkshire, and subsequently was appointed assistant engineer at Bury St. Edmunds. His present position is worth £150 a year.

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Hereford.—The Urban District Council have borrowed £6,798 from the Prudential Assurance Company at 3¾ per cent., to defray the initial outlay in connection with their electric light installation. The cables are to be laid as soon as possible to prevent the town being in darkness. The gas company have cut off the supply of gas to the street lamps.

Cheltenham.—The borough electrical engineer (Mr. Hamilton Kilgour) is busy with improvements in the plant both for lighting and traction work. The two 100 kw. alternators have been removed and the engines altered to drive two 170 kw. traction dynamos; two small 30-kw. alternators have been replaced by two 48-kw. exciters; two Babcock and Wilcox boilers and another Parsons turbo-alternator will shortly be erected. About 200 new arc lamps and a number of private lighting extensions are being provided for. About 11 miles of new cable has been laid during the last four weeks.

Yarmouth.—The accounts of the past year's working show an income of £7,225, working expenses at £5 406, leaving £1,819 to pay interest and sinking fund, and as these, with other small items, amount to £2,570, there is a deficiency of £751. This sum will not fall upon the rates, as there is a balance from previous year of £371, and a sum of £380 will be carried forward to next year's account. This result has been caused by the high price of coal, which made the production more costly by about £650, and the reduction in price to customers—made before coal was increased in price—amounting to £900.

West Bromwich.—At a recent special meeting of the West Bromwich Tradesmen's Association the following resolution was passed: "That in the opinion of this association the Electric Lighting Committee has not carried out its compact to supply electric light to shopkeepers at a price equivalent to that of gas at 2s. 4d. per 1,000, and the association considers the present charges for electric light will prove to be prohibitive to its general adoption by shopkeepers, and the association respectfully requests the Electric Lighting Committee to receive at its earliest convenience a deputation to represent the views of the association."

Sunderland.—The annual report of the Corporation electric lighting department states that the number of lamps connected on March 31 was 50,092, and the number of units sold during the year was 1,218,768—an increase of 43 per cent. of lamps and 90 per cent. of units on the previous year. The year's profit on the station was £7,254, or 7 per cent. on the average capital outlay for the year. The sinking fund and interest was £5 997, leaving a net balance to the credit of the department of £1,257. The enormous rise in the price of coal represented an increased cost to the station of £2,315. The total cost per unit was 3d., and the average revenue 3·25d. per unit.

Walmer.—The Joint Electric Lighting Committee have reported the suggestion made by Messrs. Edmundson's Electricity Corporation, Limited, that the two authorities should obtain a joint provisional order, and should then raise a loan of £25,000 or £30,000 to carry out the necessary works. The committee are of opinion that before the local authorities in any way pledged themselves to a scheme, the opinion of an expert should be taken as to the prospects of carrying out a successful installation for the two districts whether with or without electric traction. Enquiries are to be made from several consulting electrical engineers, with a view of obtaining a report on the question.

Longton.—Negotiations have taken place recently with the Duke of Sutherland and the Potteries Electric Traction Company with reference to the purchase by the Corporation of electricity in bulk. The committee in charge of the matter have now recommended that the terms offered be not accepted, "inasmuch as in their opinion they were higher than the cost at which the Corporation could produce the electric current themselves, and that no immunity against loss at start would be secured thereby." The committee also recommended for adoption a scale of charges for the supply by the Corporation of electricity by consumers. The Town Council have confirmed these recommendations.

Battersea.—At a meeting of the Council on Wednesday, the Library Committee reported that they had approved the electrical engineer's specification for wiring the central library, and recommended the wiring of the branch libraries as follows: Lurline-gardens, at £65. 17s. 6d.; Lammas Hall, at £65. 12s. 6d. They also reported the receipt of a letter from the Postmaster-General thanking the Council for their consent to the laying of additional telegraph wire pipes through the vaults under the footway in front of the central library, but declining to pay the sum of £50 required by the Council as compensation, and requesting the Council to reconsider the matter and withdraw the condition as to compensation.

Hoylake and Kirby.—Mr. H. P. Boulnois has held an enquiry into an application of the Hoylake and West Kirby District Council for sanction to borrow £13,500 for the purpose of extending the electric lighting of the district. A description of the opening ceremony of the works will be found in another column. The Council have already obtained sanction to borrow £27,000, but owing to the large demand for electric light they have already expended £30,000. The applications at present amount to 6,000 8 c.p., and it is proposed to erect plant and lay down mains which in the aggregate will cost £40,500, or £13,500 beyond the sum already expended. This would place the Council in a position to supply 14,000 lamps.

Hereford.—The accounts for the financial year up to March 25 have now been made up, and the results exceed the anticipations of the Electric Lighting Committee, as the net profit has been sufficient not only to pay the interest, but almost to discharge the first instalment of capital (£300), the amount to be borne by the rates being only £85. It is proposed to increase the salary of Mr. Poulton, the electrical engineer, by £25 per annum with an understanding that so soon as the financial position justifies their so doing the committee will recommend a further increase of £25 per annum. The committee in their last report state that they fully recognise the zeal and energy Mr. Poulton has shown in the management of the works, and are anxious to show their appreciation of his services.

Nelson.—The electrical engineer's monthly report shows the quantity of current sent out during the month to be 6 934 units. The electrical engineer having reported that it would be necessary to put down a new unit on the three-wire system in order to supply current for the next winter's load, the chairman, Alderman Hudson, and the electrical engineer are to visit Glasgow and Edinburgh to inspect the generating set offered by Messrs. Bruce Peebles and Co., of Edinburgh. The borough surveyor's plan for new station has been approved, and tenders are to be advertised for. Negotiations are pending with the Brierfield Council in regard to the supply of electricity to the Brierfield Council. The question of the tenders for the new generating sets has been left in the hands of the mayor, the electrical engineer, and town clerk.

Birkenhead.—The Electricity Committee have resolved to apply for permission to borrow £40,000 for the following purposes: for costs, charges, and expenses incurred in excess of amounts already sanctioned to be borrowed, £2,430; for providing additional generating plant at Bentinck street works, £11,270; for providing generating plant to supply the south end of the borough, £5,800; for feeder and distribution mains for the Rock Ferry district, £8 000; for distributing mains in other parts of the borough, £7 500; for service mains and connections, terminal boxes, etc., £3 000; for arc lamp mains, lamp-pillars, lamps, and switch pillars, £2 000. The new mains will be in Rock-lane, Rock Park, Highfield, Bebington-road, Bedford-road, Holt-hill, Queen-street, Chamberlain-street, and the connecting mains in New and Old Chester roads.

Crewe.—At the last meeting of the Electric Light Committee the borough accountant submitted a statement showing that up to March 31 the sum of £27,056. 6s. 8d. had been expended on the electric light undertaking, and that after adding other liabilities which had been incurred, there was a sum of £4,364. 15s. 8d. to be provided above the £35,970 already sanctioned to be borrowed by the Local Government Board. A thousand pounds, however, had been set aside for private lighting cables, and if this were taken into account the further sum required would be reduced to £3,364. 15s. 9d. The committee recommended that an application be made to the Local Government Board for sanction to the borrowing of a further sum of £5,000 for electric lighting purposes, the repayments to be spread over a period of 25 years. The borough accountant also reported that there was a deficiency in the electric light revenue account of £618. 0s. 9d., the expenditure for the year ending March 31 having been £1,292. 12s. 7d., and the income £674. 11s. 10d. The report was adopted.

Newport.—The questions of working the tramways by electric power, and whether the power required should be generated at the present electricity works on Friar's Field or a new station erected upon the Corporation-road site, are still being discussed. This has been before the Council for over two years, and there has been a sharp division of opinion upon the question, and it is now proposed that a poll of the ratepayers of the town should be taken upon the subject. The balance-sheet issued by the Electricity Committee shows that the gross profit upon the electric light supply last year was £2,557, but the interest and repayment of sinking fund amounts to £5,322, so that there is a deficiency to be met out of the rates of £2,765 against a net profit of £403 in the previous year. The deficit is mainly due to an increase in the coal bill by £1,774, due to high prices at which contracts were let, the increase in the coal consumption only being 160 tons. In addition, there is an increase in the interest and sinking fund account for the year of £1,663, due to the large repayments for new machinery.

Leyton.—At the last meeting of the Urban District Council it was decided to instruct the engineer to submit a scheme and estimate of the cost for the provision of two additional steam-engines, one being of the size of those now at the electricity works and one of a larger size, and four boilers with accessories. The station was opened in September, 1896, the initial outlay being £16,850, and the capacity of the station at that time was 3,000 lights. Ever since that time it has been necessary to make extensions, and on March 31 last the actual capital invested in the station was £98,032. 16s. 6d., while 51,500 lights were connected. The revenue from September, 1896, to March 31, 1897, was £499. 6s. 11d.; for the year ending March, 1898, £1,769. 3s. 2d.; March, 1899, £3,492. 12s. 9d.; March, 1900, £6,071. 16s. 8d.; and March, 1901, £8,751. 12s. 11d. This year upwards of £10,000 is expected. The charge for current up to March, 1897, was 5d. per unit, in 1898 4·61d., in 1899 4·02d., in 1900 3·95d., and in 1901 3·87d., making an average charge to the whole of the consumers for current during the past year of 3·78d.

Chiswick.—At a recent meeting of the Free Public Library Committee a letter was read from Messrs. Rawling and Co. stating that they were willing to carry out the arrangements for electric lighting in such a manner as to secure the best results. The suggested alterations would be made without cost, provided it was decided to proceed with the work forthwith. They estimated that the committee now paid about £40 per annum for gas, to which must be added an extra £4 for mantles, bringing the cost up to £44. Their estimate for electric light worked out at 945 units at 6d. per unit, and 1,170 at 4d., making the cost of

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electric light per year £43. To this must be added £2 for the renewal of lamps, bringing the total cost up to £45 per annum, and the cost of installation was £45. The installation was to consist of 38 16 c.p. lights of 220 voltage, to be guaranteed, the fittings included, for three years. The Chiswick Electric Lighting Company sent an estimate for 60 or 70 8-c.p. lights, to cost, approximately, £50. Their charge for current was 6d. per unit. The matter was referred to a small committee, and the chairman and vice-chairman, to consider further and report on.

Lowestoft.—The matter of the subsidence at the boiler-house having been discussed with Mr. Hawtayne, the consulting engineer, who asked that an independent surveyor should make an examination with him, Mr. W. J. Roberts was requested to inspect the site. Mr. Roberts has now reported that the whole bed of the existing boiler has sunk bodily, about ¾in., and bearing in mind the very treacherous nature of the subsoil, he is of opinion it would be wise to guard against the foundations of the new boilers going likewise. He recommends that the new boiler bed be placed entirely to the eastward of the proposed position, and that it be carried down to the level of the raft in engine-room, this bed to be further supported by iron screw piles, tied together with iron girders embedded thoroughly in the concrete. Mr. Roberts has been instructed to prepare specifications for carrying out the work necessary. The tender of Mr. G. E. Hawes for carrying out the works at the station rendered necessary by the subsidence, and also for lengthening the flue at £307. 17s. 8d., has been accepted. The total cost of the various necessary works and building will be £1,400, and application is to be made for sanction to borrow the necessary sum.

Radstock and Midsomer Norton.—Mr. A. H. Preece, of Messrs. Preece and Cardew, has reported upon the question of the proposed combined scheme for electric lighting and power for Radstock and Midsomer Norton. According to the scheme recommended, the total horse-power installed will be about 120, and will supply electricity for the public lamps and for the average number of private lamps burning at one time. The estimated capital expenditure is as follows: Building and generating plant—building, £500; boiler, engines, dynamos, condensers, etc, £2,069; switchboard instruments, etc., £488; battery, £836; sundries, £107. Mains and overhead work—poles, cross-arms, insulators, stays, etc., £513; lanterns (lamps, fuses, etc.), £274; copper wire, £660; sundries and erection, £153; contingencies and engineering, £550; preliminary expenses, say, £250. Total, £6,400. If the mains are laid everywhere underground it will increase the capital expended to £8,500, but overhead wiring is recommended. The generating station would be situated at Old Welton Colliery. There is a railway siding allowing of coal being delivered by the railway company on site. There is also the river accessible for water for condensing the steam. It has been assumed that no charge would be made for water. The plant first installed would consist of two boilers and engines, each engine driving a continuous-current dynamo.

Dublin.—The following appears in a Dublin journal of Tuesday, with the statement that it is the full text of the letter which has been addressed to the Corporation by the Board of Works relative to the application for a loan of £254,500 for the purpose of carrying out the Hammond scheme for the electric lighting of the city: "Office of Public Works, Dublin, June 4, 1901. Sir,—I am directed by the Commissioners of Public Works to state with reference to application for loans for electric lighting purpose (£254,500), for sewage works (£820), and for private improvements (£800), that they find that the Corporation have not paid within the month allowed the instalments due on the 1st ult. on account of outstanding loans. When an application for a loan is under consideration, the ordinary rule is that such a default as that referred to puts a stay on the proceedings, but in view of the importance of the first loan mentioned, and the desirability of expediting its consideration, the Board are unwilling to apply the rule and stop the proceedings. Later on, however, when submitting the case to the Lords Commissioners of his Majesty's Treasury, it will be their duty to refer to the fact of such default having occurred, and their lordships will no doubt consider the matter in its bearing on the question of the sanction of the loan. I am, sir, your obedient servant, H. Williams, secretary. The Town Clerk, City Hall, Dublin."

Beetle.—The first report of the borough electrical engineer, Mr. W. R. Wright, shows the progress of the municipal electrical undertaking. The works were taken over from Messrs. Thomas Parker, Limited, in October, 1899, when the plant consisted of two 120-h.p. and one 250-h.p. sets, with two 250-h.p. sets on order for traction purposes. Additional mains have been laid in a number of streets. On taking over the works there were 36 public arc lights erected, which were supplied in groups of four. These have been altered to work in four groups of nine, as by that means a saving to the department was effected of the energy taken by one lamp in nine, or that taken by four lamps in the 36, or £50 per annum. Tramways in Knowsley-road, Rimrose-road, Derby-road, and Stanley-road had been fully equipped during the period covered in the report. Fifty-five cars are working on the lines, consuming approximately 2,000 units per day. Mr. Wright states that arrangements have been made with the contractors to subject the whole of the mains as laid by them, to a test, by supplying a pressure of 1,000 volts between all mains and earth, any faults being repaired at their own cost. Much trouble has been caused by the swinging of the lamps on the swan-neck brackets during storms, the swinging of the lamp causing breakage of the insulated supports or cutting of the cable and connections. The committee are experimenting with some rigid supports to be attached to all similar brackets. The apparent deficit, continues the report, of £1,800 (estimated) was due to the fact that the plant put down had been capable of dealing with a large tramway load, but only had a small load up in October last. Liverpool expected to take some 700,000 units per annum. So far this year that City had taken about 395,000, or about half, so that the plant had been practically idle for the half year. The coal bill seemed heavy, but the Corporation were buying coal in a very expensive market. As much of the plant was standing idle during the daytime, special terms had been offered to consumers of motive power. The one drawback was that the hours of serving the two classes of consumers overlapped during December and January, when it was dark at 4 p.m., and motors and light were all on together. In any case, spare plant had to be kept which could cope with this. Several consumers were applying for motor loads. The following is the number of units turned out during the year, allocated to their different headings: public lighting, 130,913; tramways, 337,061; meters, 159,495; works, 21,900; lost in feeders and batteries, 81,035—total generated, 730,404.

Cardiff.—Mr. A. Ellis has presented a report upon the charges made in Cardiff for current, in which he points out that with the change of the supply system from alternating to continuous current, and the extension of the system to the docks, there would be a large increase in the demand, especially for power purposes. The committee have adopted the maximum-demand system, but they have made numerous departures from that principle. Mr. Ellis says the prices should be fixed at an amount which would not only increase the demand on the plant, but would keep the plant employed for a greater length of time. "There is no reason whatever," the report continues, "why all working, interest, and sinking fund charges should not be paid out of the income and a substantial amount left over," either towards reduction of capital or relief of rates. As it is, the station has been working six years, and no clear profit has been made. The plant is now worked on an average of 2½ hours per day, and figures are given by which Mr. Ellis shows that if the plant were worked an average of even three hours per day a profit of £1,688 per annum could be made. To bring this about he recommended that the maximum-demand system be retained, that 7d. per unit for the first hour and 2d. per unit afterwards be charged, by which means those who used the light over two hours a day would get a considerable reduction. For power purposes the price recommended would work out at 4d. per unit for consumers who used the plant one hour per day, and 1½d. per unit for those who utilised it eight hours.

St. Marylebone.—The following report has been submitted by the Electric Lighting Committee: "(*a*) The chairman reported in relation to the Council's Bill for electric lighting order that the St. Marylebone Electric Company had made an offer as regards their opposition to the said Bill, and that he had, on behalf of the committee, entered into an undertaking in consequence of such offer, that in consideration of the withdrawal of that company's application for an electric lighting order, and of their opposition to the Council's order, and subject to clauses being inserted in the Council's Bill embodying the terms of the agreement to purchase the Metropolitan Electric Supply Company's St. Marylebone undertaking, the Council will pay to the St. Marylebone Company the sum of £500 in the event of the passing of the Council's Act and order, or of the purchase above mentioned not being completed. The chairman also reported that in consequence of the above-mentioned undertaking, the Council's Bill, having passed the second reading, had been referred to a committee of the House of Commons as an unopposed measure. Resolved, that the chairman's action be approved, and that the Council be informed accordingly. (*b*) The committee resumed consideration of the Metropolitan Electric Supply Company's application to lay low-tension armoured mains in St. Marylebone, pursuant to substituted plans numbered 6,723, dated April 1, 1901. Resolved that the company be informed that the committee now approve the works set out in the above-mentioned substituted plans, and that the Council be informed accordingly. Resolved that the Board of Trade be informed, in reply to their letter, read at the committee's last meeting, asking for the Council's observations on communications from the Metropolitan Company forwarded therewith, appealing against the Council's disapproval of the company's substituted plans above mentioned, that the committee have informed the Metropolitan Company that, on behalf of the Council, they now approve the works proposed to be executed, in accordance with such substituted plans, and that the Council be informed accordingly. (*c*) The committee considered communication from the Metropolitan Electric Supply Company with regard to the mains laid in excess of approved plans, stating the sole question now at issue is the method of laying the authorised mains. Resolved that the company be informed that in view of the committee's approval of the company's general scheme of mains as per sub-stituted plan No. 6,723, the committee do not propose further discussing the question of the extra mains, or the method of laying the mains affected by the recent police court proceedings; and that they note the company undertake to save the Council harmless against any damages directly arising from the existing works not having been laid in accordance with the approved plan; and that the Council be informed accordingly. (*d*) The committee recommended approval of notices from the Metropolitan Electric Supply Company as to laying a 5in. cast-iron pipe along the east and west sides of Marlborough-hill from Nos. 28 to 51, crossing Marlborough-hill at the boundary; also along the north-west side of Circus-road from No. 56 to west side of Wellington-road, and along the south-west side of Lennard-place from north-west side of Circus-road to 2, Lennard-place; and as to laying a 5in. cast-iron pipe along the east side of Loudoun-road from Nos. 26 to 42."

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PROVISIONAL PATENTS, 1901.

JUNE 3.

11307. Improvements in overhead trolleys or collectors for electric tramway or railway vehicles. Richard Henry Wilkinson, 4, Clayton-square, Liverpool.

11308. Improvements in and relating to joints for conducting cables. Israel Holmes, Sunbridge-chambers, Bradford.

11315. The "Sparkless" regulator for electric motors. David MacKay and Henry Sclater, 5, Waddel place, Leith.

11327. Improvements in and relating to the electrical transmission of signs or sounds. Sigmund Musits, Richard Horóath de Szent György, and Etienne Hagyi-Ristic 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11348. Improvements in syntonic space telegraphy. Oliver Joseph Lodge and Alexander Muirhead, 323, High Holborn, London.

JUNE 4.

11371. An improved guard for the prevention of the fouling of overhead wires by a trolley or trolley arm used in the overhead rolling-contact system of electric traction. Francis Joseph Hewitt and William George Dunning, 54, Gascoyne-street, Vauxhall road, Liverpool.

11408. Improvements in electric railways. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Samuel B. Stewart, jun., United States.) (Complete specification.)

11408. Improvements in insulating supports or "insulators" for electric conductors. Albert Anderson and Johan Marinius Andersen, 11, Southampton buildings, Chancery-lane, London. (Complete specification.)

11450. Improvements in appliances for high-tensional electrical conductors for ensuring safety in case of fracture. William Henry Stewart, 6, Lord street, Liverpool.

11470. Improvements in printing telegraphs Robert Ashworth Fowden, Norfolk House, Victoria-embankment, London. (Complete specification.)

JUNE 5.

11473. An improvement in the mode of suspending or holding globes or shades for chandeliers, brackets, electroliers, or other lighting purposes. Henry Bisseker, 11, New Bartholomew-street, Birmingham.

11500. Improvements in the manufacture of chlorine and chlorides and in the production of electric energy therewith. Antonio Sansone, 70, Market street, Manchester.

11529. Improved manufacture of electric lighting, heating, and resistance bodies. Wilhelm Boehm, 111, Hatton-garden, London. (Complete specification.)

11530. Improvements in or relating to electric glow lamps or devices. Wilhelm Boehm, 111, Hatton-garden, London. (Complete specification.)

11537. Improvements in electric alarm apparatus. Christian Albert Jensen, 77, Chancery-lane London. (Corrado Zanotta, Italy.) (Complete specification.)

JUNE 6.

11545. An improved method of fixing and connecting up guard wires for the protection of overhead trolley wires used for electric traction, and means for automatically disconnecting the current supplied to the trolley wires. William Arthur Heyes and Lancelot Ovid Heyes, 20A, Millgate, Wigan.

11552. An improved automatic self-locking lifeguard for electric-propelled cars or other vehicles. Arthur Hudson, 13, Fortune-street, Manchester-road, Great Lever.

11582. Improvements in the construction of electrical measuring instruments. Edgar Isaac Everett and Kenelm Edgcumbe, 22, Charterhouse-square, London.

11584. Improvements in lightning conductors. Killingworth William Hedges, 8, Quality-court, Chancery-lane, London.

11600. Improvements in or relating to the formation of positive plates for electric accumulators or secondary batteries. Joseph Johann Heinrich Hunte, 322, High Holborn, London. (Joseph Lürgen, Germany.)

11619. A method of producing electrodes for electric accumulators. Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London. (Complete specification.)

11625. Apparatus for applying plastic material to matrices, more especially intended for use in applying the paste to the grids in making secondary battery elements. The Electrical Power Storage Company, Limited, and William Henry Hanson, 47, Lincoln's-inn-fields, London.

JUNE 7.

11629. An improved lifeguard for electric tramcars. Joseph Bulman, 70, Langham-street, Walton-road, Liverpool.

11640. Improvements in trolley heads for overhead electric traction. Arthur Eustace Rooke and James Patterson, 128, Hope street, Glasgow.

11660. Improvements in wireless telegraphic signalling. Edward Cadett and Herbert Dickinson, 2, Camden-gardens, Shepherd's Bush, London.

11676. Improvements in rheostat elements or resistance boxes. Thomas Steel Perkins, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act 1883. Sec. 103 Nov. 9, 1900, being date of application in United States.)

11677. Improvements in protecting devices for the coils of electrical apparatus. Percy Holbrook Thomas, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 9, 1900, being date of application in United States.)

11702. Improvements in and relating to electric accumulators. Bernard Josef Lürgen, and the D.P. Battery Company, Limited, 18, Southampton-buildings, Chancery-lane, London.

11703. Improvements in electrical distribution boards. Charles Grundy, 18, Southampton-buildings, Chancery-lane, London.

11707. Improved construction of contact maker or current conductor for electric meters. Walter Lacy Allcroft, 166, Fleet-street, London.

JUNE 8.

11730. An improved fitting for incandescent lights specially applicable for electric incandescent lights. Clarence Metcalfe Stead, 30, Park-row, Leeds.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 29.

1900.

8439. Intercommunication by means of electromechanical typewriting or printing instruments. Richardson and Elliott.

10638. Devices for starting electric motors. Thompson. (Fraser Electric Elevator Company.)

10763. Manufacture of filaments for electric incandescence lamps. Thomas.

12296 Fan or air propeller, driven electrically or by mechanical power. Russell.

12392. Clamps for holding the ends of electrical fuses, or links acting as electrical conductors. Callender's Cable and Construction Company, Limited, and Ward.

12598. Driving axles for electric and other vehicles. Contal. (Date applied for under International Convention, Jan. 6, 1900.)

12874. Telephonic apparatus. Blanck.

13085. Method of and means for sounding alarums on electric tram and motorcars. Parietti and Durante.

13362. Starting switches and automatic controllers of electromotors. Moy and Bastie.

13360. Controllers for electric motors. Perkins. (Date applied for under International Convention, Jan. 13, 1900.)

14895. Electric ignition plugs for internal-combustion engines. Simms.

19900. Electric punka-motors. Spühl.

20214 Electric lighting cane or walking stick. Bergmann.

21364 Electric meters. Lux.

1901.

3972. Machines or mechanism employed in the manufacture of pipes or tubes or for covering telegraph and telephone cables and wires with lead or other metallic substance for electric purposes. Claremont and Stratton.

7959. Increasing the economical efficiency of electric incandescent lamps. Bushe.

8803. Safety devices for electrical measuring instruments. Arcioni.

8920. Electric switches. Spagnoletti.

8965 Skates or contact makers carried by cars for use in a surface-contact system of electric traction. Parker.

8967. Method of forming armature coils for dynamos and electric motors, and apparatus for use therein. Parker.

9056. Electric insulation of cotton-covered cables or wires. Claremont and Beaver.

9211. Insulation of electrical conductors and the like and to compounds therefor. Lake. (Hungerford.)

9217. Electric fuses or cut-outs. Johnson. (D. and W. Fuse Company.)

9295. Means for preventing the oscillation of alternators connected in parallel. Haddan. (Blathy.)

9388. Electric arc lamps. Helios Upton Company and Spencer.

9512. Solenoid and other electric coils. Heany.

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9527. **Electrical fuses.** Johnson. (D. and W. Fuse Company.)
9610. **Electrical exercising machines.** Lake. (Courtney.)
9616. **Electrical time switches.** Rausch.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 8	746	724	+ 22	—	—
Birmingham Trams.	,, 8	4,624	5,503	- 879	97,939	—
Blackburn Corp'rat'n	,, 7	510	752	- 242	10,542	9,591*b*
Blackpool Corporatn.	—	—	—	—	—	—
Blackpool-Fleetwood	,, 8	878	1 834	- 956	7,871	7 729
Bolton Corporation..	,, 9	1,702	1,756	- 46	32,104	22,637
Bradford City Trams	,, 9	1,012	788	+ 223	14,972	9,345
Bristol Tramways Co.	,, 7	4,406	4,708	- 302	—	—
Carlisle Tr'mw'ys Co	—	—	—	—	—	—
Central London Ry.	—	—	—	—	—	—
City & South London	,, 9	1,922	1,501	+ 421	45,208	29,255
Cork E. T. and L. Co.	,, 6	544	541	+ 3	9,345	8 135
Darwen Corporation	,, 7	193	190	+ 3	3,396	4,063
Dover Tramways ...	,, 8	220	270	- 50	4,170	3,857
Dublin & Lucan E.R	,, 8	113	185	- 72	2,116	1.988
Dublin U.T., elec. cars	,, 7	3,819	4,276	- 457	—	—
Dublin S.D. Electric	,, 7	927	1,254	- 927	—	—
Dundee Tram Co. ...	—	—	—	—	—	—
Glasgow Corporation	,, 8 1	1,598	10,49	6+ 1,102	—	—
Halifax Corporation	,, 9	2,868	1,745	+1,123	—	—
Huddersfield Corp'n.	,, 8	848	953	- 105	7,691	7,122
Hull Corporat'n E.S.	,, 8	1,657	1,568	+ 88	73.015	37,367
Liverpool Corporat'n	,, 1 1	0,159	7,950	+2,209	184,124	156 542
Liverpool Overhead	,, 9	1,651	1,781	- 130	36,106	32,790
Oldh'm-Asht'n-Hyde	,, 7	583	615	- 32	10,951	10,420
Portsmouth Corpn...	,, 8	682	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 9	3,654	—	—	—	—
Southampton Trams	,, 6	817	807	+ 10	—	—
Southport Corporat'n	,, 8	930	—	—	3,395*a*	—
Swansea Tramways..	—	—	—	—	—	—
Wolverhampt'n C'p'n	—	—	—	—	—	—

a From April 1, 1901. *b* Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £372 decrease.

Barcelona Ensanche y Gracia, £67 decrease. Barcelona, £257 increase.

Brisbane, £75 increase.

Buenos Ayres and Belgrano Electric, £509 increase.

Calcutta, £155 increase.

Cape Town (month of May), receipts, £12,700; expenditure, £6,070.

Mexico Electric (month of May), receipts, £18,500; expenditure, £10,600.

Perth Electric, £312 increase.

Port Elizabeth (month of May), receipts, £3,298; expenditure, £1,818.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞
Aron Electricity Meter. 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	11/16-13/16
—— Ordinary, 1-125,000	1 —	13/16-15/16
British Electric Works, Ordinary, 50,001-95,000	1 —	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 —	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 —	85-90
British Insulated Wire, Ord., 1-70,000	5 —	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100 —	100-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref...	5 —	4¾-5¼
Brush Electrical Engineering, Ordinary	2 —	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2 —	2⅛-2¼
—— 4½ per cent. Debenture Stock	100 ..	103-108
—— 4½ per cent. 2nd Debenture Stock	100 —	101-104
Callender's Cable, Debentures	100 —	109-113
—— Ordinary	5 —	14-15
—— 5 per cent. Pref.	5 —	5¼-6
Crompton and Co.	3 —	3¾-4
—— 5 per cent. Debentures	— —	101-104
Edison and Swan United, Ordinary	3 —	1-1⅛
—— 5 per cent. Debentures	5 —	2-3
—— 4 per cent. Deb. Stock, Red.	100 —	87-89
—— 5 per cent. Second Deb. Stk., Prov. Crts.	— —	94-98
Electric Construction, Limited, Nos. 1 to 112,100	2 —	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 —	2¾-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	100-103
General Electric Company (1900), 5 per cent. Cum. Pref...	10 —	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	15½-16½
—— 4½ per cent. Preference	5 —	5¼-6
—— 4½ per cent. Debentures	100 —	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 —	21-22
—— 4 per cent. Debentures	100 —	101-104
Telegraph Construction and Maintenance	12 —	35-39
—— 5 per cent. Bonds	100 —	102-105
Telegraph Manufacturing, Ordinary	5 —	10½-11½
—— 5 per cent. Cum. Pref.	5 —	5¾-6
Willans and Robinson, Ordinary, 1-20,000	5 —	10½-11½
—— 6 per cent. Cum. Pref., 20,001-60,000	5 —	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 —	105-107 xd
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 —	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75 —	70-75
Bournemouth and Poole, Ordinary	10 —	11½-12½
—— 4½ per cent. Cum. Pref.	10 —	10-11
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 —	7⅞-8¼
—— 7 per cent. Preference	5 —	8¾-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-80,000	5 —	7-7½
Charing Cross and Strand	5 —	9-10
—— 4½ per cent. Cum. Pref.	5 —	5¼-5¾
Chelsea Electricity Supply	5 —	5¾-6¼
—— 4½ per cent. Debentures	100 —	109-112
City of London, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10 —	12-13
—— 5 per cent. Debenture Stock	100 —	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.) Red.	— —	101-103
County of London and Brush Provincial, Ordinary	10 —	8¼-9¼
—— 6 per cent. Cum. Pref.	10 —	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 —	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 —	5¼-5¾
—— 6 per cent. Cum. Pref.	5 —	5¼-5¾
—— 4½ per cent. First Mort. Deb.	100 —	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 —	4¾-5¼
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5 —	6¼-6¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 —	7¼-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 —	11½-12½
—— 4 per cent. Debenture Stock, Red.	100 —	102-105
Kensington and Knightsbridge and Notting Hill	100 —	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9¾-10½
London Electric, Ordinary	3 —	1½-1¾
—— 6 per cent. Pref.	5 —	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	98-101
Metropolitan, Ordinary	10 —	13½-14½
—— ,, 85,001-98,760	5 —	12½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 —	110-113
—— 3½ per cent. Mortgage Debenture, Red	100 —	96-99
Notting Hill Electric Lighting	10 —	15½-16½
Oriental, 1879	1 —	1½-1¾
—— £5 Shares	5 —	6¾-7¼
—— £4½ Shares, New	4½ —	5¼-6
Oxford Electric, Ordinary, 1-96 and 407-10,510	5 —	5¼-6¼
River Plate Electric Light and Traction, Deb.	100 —	66-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 —	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 —	2-2½
—— 4 per cent. Debenture Stock	100 —	80-90
South London, Ordinary	5 —	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5 —	15-16
—— 7 per cent. Pref.	5 —	8½-9¼
—— 3½ per cent. Deb.	100 —	98-101
Westminster, Ordinary	5 —	12-13
Electric Railways.—		
Central London, Ordinary	10 —	9½-9¾
—— Pref. Half-Shares	5 —	4¼-5
—— ,, ,, deferred	5 —	4¼-5¼
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 —	113-118
City and South London, Consolidated Ordinary	100 —	51-53
—— Ordinary	10 —	4¾-5¼
—— 4 per cent. Debenture Stock	100 —	111-116
—— 5 per cent. Pref. Stock '91	100 —	122-127
—— ,, ,, ,, '96	100 —	122-127
Liverpool Overhead, 5 per cent. Pref.	— —	12-12½
—— Ordinary, 1-50,000	— —	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	103-104
Waterloo and City, Ordinary	100 —	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 —	124-129
Blackpool and Fleetwood Tramroad	10 —	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 —	2¼-2½
—— 5 per cent. Cum Pref., Nos. 1-75,000	5 —	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 —	99-101
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 —	6¼-7
—— Non-Jum. 5 per cent. Pref., Nos. 25,001-38,600	10 —	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,350 of £40 each	40 ..	99-101 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 —	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 —	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5¼-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	5-5½
—— 5 per cent. Deb. Stock, Red.	100 —	104-107
—— Prov. Cert., all paid	100 —	96-99
Cape Electric Tramways, Shares, Nos. 1-400,000	1 —	1¼-1⅜
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	98-102
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15¼
—— 4½ per cent. Deb. Stock	100 —	113-114
Kidderminster and District Lighting and Traction, Pref.	5 —	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 —	104-105
New General Traction, Ordinary	5 —	3-3¼ xd
—— 6 per cent. Cum. Pref.	10 —	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 —	11½-12¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 —	10-11
—— 4½ per cent. Debenture Stock	100 —	105-107
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £51,132 6 per cent. Preference	6s. ..	5/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c...	80 p.c.
Wolverhampton Tramways Company	— —	—
Telephones.—		
National Telephone, Ordinary	5 —	3½-3¾
—— 6 per cent. Cum. First Pref.	10 —	11½-12½
—— 6 per cent. Cum. Second Pref.	10 —	11½-12¾
—— 5 per cent. Non. Cum. Third Pref.	5 —	4¼-4¾
—— 4 per cent. Deb. Stock, Red.	100 —	95-98
—— 3½ per cent. Deb. Stock, Red.	100 —	87-90
Oriental Telephone and Electric Company	1 —	¾-1

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NOTES.

Book Received.—"The Induction Motor: being a Short Treatise on its Theory and Design," with numerous experimental data and diagrams, by Mr. B. A. Behrend, has just been published by the *Electrical World and Engineer* of New York.

Induction Telegraphy.—It is rumoured that a private company, with a capital of £50,000, has been formed to work the patents which have been granted to Prof. Oliver Lodge relating to induction telegraphy. It may be remembered by our readers that a paper on the subject was read before the Institution some 12 or 15 months ago.

Central Technical College.—The fourth annual dinner of the Association of Old Students of the Central Technical College will be held at the Restaurant Frascati, Oxford-street, on Wednesday, July 3, at 7.30 p.m. Prof. O. Henrici, F.R.S., president of the association, will take the chair. Tickets can be obtained on application to the hon. secretary, Mr. Maurice Solomon, 12, Edith-road, West Kensington, W.

The Franklin Institute.—The *Journal* of the Franklin Institute for June continues Mr. C. J. Reed's paper on "Electrochemical Action," which will be concluded in a later issue. We also notice the continuance of a paper by Mr. George W. Colles on "Rotary Transformers," and a paper on "The Flow of Metal" by Mr. Henry V. Loss. Other interesting papers also appear in this number of the *Journal*.

Wireless Telegraphy on the Irish Coast.—We note that in addition to the Dover station referred to in these columns last week, the Admiralty have commenced the erection of a wireless telegraphy station at Roches Point. When completed this station will probably be the most important on the Irish coast, and it is thought will offer great facilities for communication during the forthcoming naval manœuvres. The next place at which we may expect to hear of the installation of a Government wireless telegraphy station will probably be Queenstown.

The Symons Memorial.—A meeting of the subscribers to the Symons memorial fund was held on the 11th inst. in the rooms of the Royal Meteorological Society, when the executive committee reported that the proposal that the memorial to the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist and founder of the British Rainfall Organisation, should take the form of a gold medal, had been approved, and that the sum of £713. 14s. 7d. had been subscribed for that purpose. It was resolved that the medal should be awarded biennially for distinguished work done in connection with meteorological science irrespective of sex or nationality.

New Book.—We have received a copy of a new work entitled "Les Automobiles Electriques," by Messrs. Gaston Lenciel and A. Delasalle, with a preface by Mr. Chas. Jeantaud. This is an octavo volume of 400 pages, published by Mr. Chas. Dunod, 49, Quai des Grands-Augustins, Paris. The book, which contains about 200 photographs and designs, has since publication obtained the silver medal of the Automobile Club of France, and is a complete and concisely-written treatise on the latest developments of electric and petrolio-electric motorcars. It deals not only with the construction, but also with the scientific details of the various inventions used, giving a number of formulæ which may be useful to makers of accumulators.

American Electric Lighting Convention.—From the various accounts which have appeared in the New York technical Press it would appear that the twenty-fourth convention of the National Electric Light Association of America, which has just drawn to a close at Niagara Falls, has proved most satisfactory in every respect. The attendance, we note, was unusually good, and the papers read were almost without exception of a particularly interesting and valuable character, eliciting in most cases useful discussions. At the close of the convention Mr. James B. Cahoon, the newly-elected president of the association, made some remarks on the importance and value of such an association to the electric lighting profession in general.

Wireless Telegraphy on the "Lucania."—A number of Press representatives and others accepted the invitation of the Cunard Steamship Company on Saturday last to witness the Marconi system of wireless telegraphy in operation on the company's fine steamer "Lucania" as she steamed from Liverpool to Queenstown. Communication was kept up with three different stations in succession—viz., the training ship "Conway" off Birkenhead, Holyhead, and Rosslare, on the Irish coast. During the passage to Queenstown large numbers of Press and private telegrams were dispatched to various parts of the country *vid* Holyhead, and communication was shortly afterwards established with Rosslare and maintained until the "Lucania" was within a short distance of Queenstown.

Niagara Falls Power.—We gather from a note in an American contemporary that the Niagara Falls Hydraulic and Manufacturing Company have been compelled to discontinue the use of six dynamos of their installation, owing to the fact that the great flow of water at the outlet of the tail-race into the river is wearing away the rocks. This had become a serious matter on account of the power-house being situate in the immediate vicinity. The device which has been adopted to overcome future destruction consists of a number of pieces of boiler iron riveted together to form the bottom of the tail-race. There are upright side extensions, also of iron, to preserve the side walls. At the end toward the river there is a slight upward curve in the iron plate to throw the water upward, and thus prevent further undermining.

Society of Arts Conversazione.—The Society of Arts conversazione will be held, by arrangement with the council of the Royal Botanic Society, in the gardens of that society, Inner Circle, Regent's Park, on Friday, June 28, from 9 p.m. to 12 o'clock. The Royal Botanic Society's exhibition of rhododendrons will be on view, and it is possible that arrangements will be made for a supplementary exhibition of flowers. A pastoral play, for the benefit of the Soldiers' and Sailors' Families' Association, will be given in an adjacent portion of the gardens. A selection of music will be performed by the string band of the Royal Artillery in the conservatory, and by the band of the Grenadier Guards in the gardens, which will be illuminated. A vocal and instrumental concert by the Royal Criterion Handbell Ringers and Glee Singers, under the direction of Mr. H. Tipper, will be given at intervals in the clubhouse.

Motorcar Restrictions.—It is refreshing to note that even on the question of further restrictions on motorcars as to speed, etc., the county councils are not all of one mind. As one exception to the general opinion that the speed of all motorcars should be reduced to a maximum of 10 miles an hour, we may mention the Worcestershire County Council. On the recommendation of their Highways Committee, the Council have replied in the following strain to the circular letter sent out by the County Councils Association—viz.: "That the Light Locomotives on Highways Act of 1896 should be amended so as not to prescribe the speed at which motorcars should travel, that the ordinary provisions of the law as to furious driving

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should be applicable, but that some adequate means for identification of motorcars should be prescribed, and that the cars should not be allowed to be driven except by persons certified to be competent drivers."

A Portable Surgical Motor.—A new form of portable surgical motor, which appears to have some good features about it, is described in the current number of the *Lancet*. The 16-volt accumulator is of the sealed type, having a capacity of 18 ampere-hours, and it weighs 34lb. The motor itself is of the type known as the "D" pattern, on account of the shape of the field magnet. The armature is a Gramme ring, and is attached directly to the shaft which carries the cable, thus taking the part of a flywheel. It weighs about 15lb., and is mounted on a gunmetal turn-table, which enables it to rotate and follow the movements of the operator. The entire apparatus with cases included weighs about 70lb. For hospital work the motor is wound to suit the voltage of the main current. The various details of the invention have been perfected by Messrs. Mayer and Meltzer, of Great Portland-street, and the device is said to be giving every satisfaction.

Municipal and County Engineers.—The annual meeting of the Incorporated Association of Municipal and County Engineers, to be held at Leicester on Thursday, Friday, and Saturday next week, promises to have considerable interest for electrical engineers, in that the programme includes the reading and possible discussion of one or two papers relating to electric traction. Among these are: "Permanent-Way Construction for Electric Traction," by Mr. W. Howard Smith; "Methods of Safety for the Overhead Electric Trolley System," by Mr. E. Manville; and "Points as to Wear on Roads caused respectively by Horse Haulage and Motor Traffic," by Mr. W. Worby Beaumont. On Friday also the day's proceedings include a visit to the extensive Falcon Works of the Brush Electrical Engineering Company. The Automobile Club, too, has placed at the disposal of the members a number of motorcars, and on Saturday special trips to the different works of interest in progress in the locality have been arranged for.

Standard Sections.—A committee has recently been appointed by the Institution of Civil Engineers, with the support of the Institutions of Mechanical Engineers and Naval Architects, and of the Iron and Steel Institute, to consider the advisability of standardising the various kinds of iron and steel sections, and, if found advisable, then to consider and report as to the steps which should be taken to carry such standardisation into practice. The committee is composed as follows: Mr. James Mansergh, Pres. Inst. C.E., Sir Benjamin Baker, K.C.M.G., Sir John Wolfe Barry, K.C.B., Sir Frederick Bramwell, Bart., Sir Douglas Fox, Mr. G. Ainsworth, Mr. William Deane, Mr. A. Denny, Mr. J. Allen McDonald, Mr. E. Windsor Richards, Mr. James Riley, Prof. W. C. Unwin, F.R.S., and Dr. J. H. T. Tudsbery (hon. secretary). Mr. Leslie S. Robertson, M.I.C.E., of 28, Victoria-street, S.W., has been appointed secretary to this committee, which has already commenced its work by taking evidence tendered by engineers, manufacturers, and contractors bearing upon the subject of the enquiry.

Telephone Wires in Liverpool.—During the past 12 weeks, since the accident at Liverpool, when a network of telephone and trolley wires fell to the ground in Pembroke-place in a heavy snowstorm, causing the death of two persons, great strides have been made with the work of placing the telephone wires underground. At the time of the accident the National Telephone Company had already begun placing their wires underground, but their engineers have since so pushed forward the work that in the past 12 weeks they have dealt with 6,500 places where telephone wires crossed trolley wires. Where they have not placed the telephone wires underground they have formed them into overhead protected cables, suspended on strong steel wires, and even if through some unforeseen cause a cable should break its indiarubber covering would prevent contact with the trolley wire. The substitution of these cables for the old system made necessary the erection of 71 new poles. The work of placing the lines underground on the metallic return system will be continued until completed, but meanwhile the public are protected. Where the Post Office overhead wires cross the electric main lines the Corporation have put up guard wires, using wooden guards where trolley wires are crossed by telephone lines.

Kew Observatory.—On the occasion of the annual official visitation to the Royal Observatory, Greenwich, by the Board of Visitors, several members of the Royal Society and other scientific bodies were allowed the opportunity of going over the observatory and inspecting the various apparatus which are in use there. The report of the Astronomer Royal has a special interest this year, in that it touches upon the difficulties which arose with regard to the introduction of electric tramways into the locality. Discussing the magnetic observations, the report expresses hope that the example of the London County Council, in proposing to thoroughly insulate the electric tramway system in the neighbourhood of the observatory, will be followed by the South-Eastern Metropolitan Tramways Company. The two systems mentioned would most seriously threaten the magnetic work unless complete precautions are taken, and the report recommends that the Board of Trade should issue regulations on this point, as the magnetic work, which has been carried on at Greenwich for a period of 60 years, "can not be transferred to another site." In the course of the afternoon the visitors were shown the working of the various apparatus, including the elaborate time-recording device, which by means of periodical electric currents regulates the recording time all over the world.

An Electrically-Operated Mine.—There is increasing evidence that electricity as a motive power is being universally employed wherever the circumstances of the work in hand permit. This, perhaps, is more apparent in the States than in any other country, and the rapid development of water power in America is attracting considerable attention just now. One of the most interesting electric power plants which has come to our notice recently is that which is now operating the mines and mills of a large silver company at the Swan Falls, on the banks of the Snake River, in Idaho. The main part of this river runs between such high cliffs that the water cannot be diverted, but at Swan Falls there is a reef of rock lying across the stream and making a fall of 5ft. It was at this point (according to our contemporary the *Electrical Review* of New York) that a dam for the power plant was constructed and four 72in. turbines installed. Each wheel runs under a 17ft. head, generating 750 h.p. Pits for two more wheels have been constructed, and 16 may be added by digging new pits, for which there is room. The cost of the plant, with its entire equipment, and the appliances at the mines and mills, has been about £70,000. Originally power was costing the mining company about £10,000 a year, and this expense was annually increasing, so that when it was found possible to generate electric power the present plan was determined upon, and has only recently been inaugurated.

A Telephone Call-Recording Device. — The British Consul at Philadelphia in a dispatch home describes a new telephone call meter recently patented in

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America, by which a register can be kept of all telephone calls made both by the subscriber and the telephone company. In shape the new meter has the appearance of a box with a push-rod on the top, while on one side is an indicator which shows the number of calls made. When the subscriber wishes to make a connection, he must press the push-rod before the central office will connect him with the desired number, and the call is thus registered. A comparatively simple counting machine with a dial is provided in the central office, and by means of a switch the attendant can put this machine instantly in connection with the meter. When a reading is to be taken, the switch is turned on and the subscriber is asked to press the plunger on his meter. This releases the spring in the meter, which unwinds, and by a mechanical device it closes and breaks the electrical circuit for each call that has been made. Every time the circuit is closed the central office register counts one. It will be readily seen that such a device has many advantages. Each call being registered, subscriber and company always know how they stand, and it is not necessary to use an attendant's time in recording by hand the number of calls made by the subscriber. Another point which will probably recommend itself is that while the company are strictly informed of all the subscriber's calls, the subscriber himself can keep a check on the company.

The Post Office Telephones.—Some interesting information relating to the new postal telephone system was elicited from the Secretary to the Treasury, as representing the Postmaster-General, in the House of Commons on Tuesday. In reply to Sir James Woodhouse, Mr. Austen Chamberlain said the expenditure already authorised by the Treasury under the provision of the Telegraph Act, 1899, for works in progress or about to be undertaken, amounts to £813,040. Of this amount £677,945 is for the London exchange system and £135,095 for the development of the other parts of the Post Office telephone system in various places, but more particularly in the north-east of England and in South Wales. The actual payments for new works brought to account up to March 31 last amount to £269,941. Mr. Chamberlain went on to say that it is not possible at this stage to state definitely what the final cost of the London exchange system will be, but the whole sum of £2,000,000 authorised by Parliament will be expended in such extensions of the Post Office telephone system as seem most urgently necessary, whether in London or elsewhere. The delay in opening the most important exchanges of the London system has been due to the scarcity of skilled labour, the difficulty of getting materials for contractors, the necessary restrictions on the opening of streets to avoid excessive interference with traffic, and the difficulty of constructing exchanges in buildings in use for other Post Office work. Full particulars of the rates and conditions of the service will be brought before the public at an early date, and it is hoped that it will be available in some parts of London in the autumn.

The Institution Conversazione.—Notwithstanding that some 1,200 ladies and gentlemen attended the annual conversazione of the Institution of Electrical Engineers at the Natural History Museum last Friday evening, it could in no sense of the word be truly described as a "crush." The magnificent hall, tastefully decorated as it was with flowers and palms, presented a brilliant spectacle, and, so far as we could gather, the occasion must have proved at least as successful as any of its predecessors. The guests were received by the President (Mr. W. E. Langdon) and Miss Langdon, and among those present we noticed Sir G. Molesworth, Sir Douglas Fox, Sir H. C. Fischer, Sir A. R. Binnie, Sir Wm. Crookes, Sir Henry Mance, General Webber, Mr. J. W. Swan, Prof. Silvanus Thompson, Mr. A. Siemens, Prof. Ayrton, Prof. Armstrong, and others. A special interest attached to the function in that it marked the thirtieth year of the existence of the Institution. A particular centre of attraction during the evening was the illuminated address recently presented to the Institution by the American Institute of Electrical Engineers, conveying their "sincere thanks for the many courtesies extended to them" during their visit to London and Paris in connection with the International Electrical Congress of last year. The evening on the whole was spent very enjoyably, despite the entire absence of anything in the nature of a "side show." Nor were there the interesting exhibits and demonstrations of the uses of scientific apparatus which one usually associates with this class of function. The nearest approach to anything of the sort was a section of a gigantic Californian tree which looked remarkably like a huge armature in position. Plenty of music, however, was provided by the band of the Royal Engineers, which rendered an excellent selection during the evening under the direction of Lieutenant J. Zommer.

Rontgen Rays and Electric Light Treatment.—The correspondence columns of the various daily papers have been used to a considerable extent of late in discussing the respective merits or demerits of the Röntgen rays for the treatment for lupus, rodent ulcer, etc., and of the electric light treatment. We notice in the *Times*, for instance, a letter from the surgeon to the Röntgen-ray department of the London Skin Hospital on the subject, in which he states that the action in both cases is very similar, but that the Röntgen rays possess every advantage of the electric light treatment with none of its advantages. The points which are put forward by the writer in support of this statement are five in number. In the first place, he says, the Röntgen-ray apparatus costs only about £100, compared with many times that cost for the electric light apparatus. Then there is absolutely no pain or discomfort in the application, whereas the electric light treatment is by no means free from some discomfort and pain. The time required for each application, too, varies from five to fifteen minutes, compared with from one to two hours required in the light treatment. Again, the number of applications need to effect a cure in any given case is much fewer than that of the light treatment. And, lastly, there is no need for any special nurse, and the surgeon can carry out the application single-handed; whereas the same is not possible in the case of the light treatment. In answer to this, Mr. Sydney Holland, chairman of the London Hospital, writes to the *Times* in favour of the Finsen light, which, he states, has been found from actual experience to be far superior to the Röntgen rays, and at the London Hospital they have given up using the Röntgen rays in the majority of cases. When the disease affects the interior of the nose and mouth then the Röntgen rays must be used, as the Finsen method cannot be applied. So far, continues the writer, there is no evidence that the Röntgen rays are germicide, whereas the rays used in the Finsen treatment are powerfully so. Lupus being a bacterial disease, theory would therefore suggest that it would more likely be successful than the Röntgen rays, and this has been found so in practice. The only disadvantage, of the Finsen treatment, in addition to the expense, is the length of the sitting—an hour at a time. The treatment of lupus by the Finsen light is to be discussed at the meeting of the British Medical Association at Cheltenham in August next.

Liquid Hydrogen. — Prof. Dewar delivered the Bakerian lecture of the Royal Society at Burlington House

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last week, taking for his subject "Nadir of Temperature and Allied Problems." Dealing first with the physical properties of liquid and solid hydrogen, he showed that hydrogen, like oxygen and nitrogen in the liquid condition, had a refractivity in accordance with theory. Coming next to the separation of free hydrogen and other gases from atmospheric air, he described two methods. The one depended on the use of liquid hydrogen to boil the dissolved gases out of air kept at a temperature near the melting point of nitrogen, the other one a simple arrangement for keeping the more volatile gases from getting into solution after separation by partial exhaustion. By the latter method something like $\frac{1}{34000}$th of the volume of the air liquefied appeared as uncondensed gas. The crude gas thus separated gave on analysis: hydrogen, 32·5 per cent.; nitrogen, 8 per cent.; helium, neon, etc., 60 per cent. After removal of the hydrogen and nitrogen the neon could be solidified by cooling in liquid hydrogen and the more volatile portions separated. There existed in air a gaseous material that might be separated with liquefaction of the air. For this purpose air was sucked through a spiral containing glass wool and immersed in liquid air. After the process had been continued for some time the spiral was exhausted at the low temperature of the liquid-air bath and then allowed to heat up. The condensed gas, after purification by spectroscopic fractionation, showed the chief lines of xenon when examined in a vacuum tube. Prof. Dewar then went on to discuss the results given by 15 electrical resistance thermometers for temperatures near the boiling point of hydrogen, pointing out that the law correlating electrical resistance and temperature is not truly known as yet. The hope of being able to liquefy helium, which appeared to have a boiling point of 5deg. absolute, was dependent on subjecting it to the same process as succeeded with hydrogen—only instead of using liquid air under exhaustion as the primary cooling agent, liquid hydrogen under exhaustion must be employed, and the resulting liquid collected in vacuum vessels surrounded with liquid hydrogen. Prof. Dewar concluded by showing how a crystal of nitrate of uranium when placed in liquid hydrogen became for a time self-luminous, on account of the high electric stimulation brought about by the cooling causing actual electric discharges between the crystal molecules. When the cooled crystal was removed from the liquid, the luminosity and electric discharges took place again during the return to normal temperature.

Gloves for High-Tension Work.—The necessity for a good glove for use by electricians at work on machinery or electric wires of high tension will be readily admitted on all sides. With a view to stimulating manufacturers to devise an efficient protection for the hands and forearms which will resist electrical tension and accidental perforation, etc., the Association des Industrielles, of France, some time ago offered a prize for the best glove having these qualifications. In addition to these conditions, of course, it was provided that the glove must be light to carry, and give the worker freedom to use his fingers. The competition was an international one. The committee appointed for the purpose selected six gloves for practical trial, and these were submitted to the Central Laboratory of Electricity at Paris and subjected to two distinct tests. In the first, each glove was placed in a vessel containing mercury, and the glove itself filled with the same metal. The electrical resistance between the mercury inside and outside the glove was measured, the height of the immersed glove being about 20cm., and the power used about 105 volts. In the second series, the gloves were filled with fine sand and placed in a vessel also containing sand, the sand being made conductive with water containing chlorhydrate ammonia. The gloves were allowed to remain wet for 36 hours before the tests were made. The best result obtained was from the glove submitted by Mr. Franz Clouth, of Cologne. In the first case the electrical resistance of the glove was 52,500 megohms, and under the second test 157 megohms. The prize of £40 was eventually awarded in respect of this glove, which is of rubber with a fairly long cuff lined with tricot. The glove is made very strong, and the seams are well overlapped in a slanting direction, so as to prevent destruction. It is coated with a strong layer of rubber without seam or junction. The second best result was obtained with the glove made by Mr. Charles N. Hill, of London. This glove is also made of rubber, with a double lining of tricot. The fingers are reinforced at their junction, and the seams are strengthened on the outside with indiarubber. Under the first test this glove showed a resistance of 6,200 megohms, while under the second series the resistance measured was 24 megohms. A subsequent breakdown test showed Mr. Franz Clouth's glove again to give the best result, standing 11,000 volts for about three minutes, and 12,200 volts for one minute, before it was penetrated. Mr. C. N. Hill's glove stood 1,000 volts for about three minutes, when the glove was penetrated. The gloves were afterwards tested as regards their resistance to wear and tear, and equally satisfactory results were obtained, particularly in respect of the two makes mentioned.

Electric Lamps in Coal Mines.—In view of the present comparatively limited use of electric lamps in coal mines, a paper by Mr. W. O. Wood, read recently before the North of England Institute of Mining and Mechanical Engineers, is of particular interest in that it is devoted to a description of the electric lamps, dynamos, etc., employed at the Murton Collieries. The first installation was made in September, 1897, when a small number of Sussmann lamps were introduced into the colliery. The result was so satisfactory that 500 of these lamps were put into regular work the next month, 100 were added in April, 1898, and 400 in September and October, making 1,000 lamps now in daily and successful operation. At first objection was taken by the miners to the weight of the lamp—about 4lb.—but the difficulties afterwards encountered were more of a practical character, particularly the extinction of the incandescent lamp or bulb and failure of connections and of batteries, the last being the most troublesome. The number of failures of the ordinary oil safety lamps previously in use at this colliery was 2·11 per cent., and even at the first the failures of the electric lamps were not very excessive, being from all causes only 3 per cent. At the present time, however, as the result of various improvements, the failures are only 0·01 per cent. Before adopting the lamp the author made many experiments to satisfy himself that ignition would not take place if the bulb were broken in an explosive mixture. This was done in mixtures of coal gas and mine gas with incandescent lamps varying from 1 c.p. to 16 c.p. and currents varying from 4 to 110 volts. The result was invariably the same, and out of many experiments there was no ignition, while faulty oil safety lamps, under the same circumstances, at once exploded the inflammable mixture. The lamp is made in two patterns: No. 1 with an ordinary or fixed bulb, and No. 2 with a top (patented by the author) containing a removable bulb, so that in the event of a bulb failing in the mine, the deputy or other official can replace it by a new one in a couple of minutes. The secondary battery is of the Faure or pasted type. The complete battery weighs 3½lb., and has an E.M.F. of two volts per cell, with a capacity of 8½

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ampere-hours, which maintain the incandescent bulb alight for eight to ten hours with one charge. The battery can be charged up to 0·8 ampere, but this point should never be exceeded. Each battery has a capacity of 5½ ampere-hours, so that taking the charging rate to be 0·65 ampere, it is necessary to leave them connected for 13 hours, or for 12 hours at 0·7 ampere, the lower rate being preferable. The total cost of working the lamps over several months, including all charges except interest on capital, and the cost of running the dynamos, was 3·79. With wages at 52 per cent. above the basis rates, this figure was increased to 4·82. The life of the battery up to the present time averages 10 months, but certain improvements have recently been made whereby it is expected to reach 12 months.

Lord Kelvin on James Watt.—At the recent celebrations in connection with the ninth jubilee of Glasgow University, Lord Kelvin gave a most interesting oration on James Watt, whose name, he said, was famous throughout the whole world, in every part of which his great work had conferred benefits on mankind in continually increasing volume up to the present day. Referring to Watt's early career, Lord Kelvin thought it was fitting that the University of Glasgow, in the celebration of its ninth jubilee, should recollect with pride the privilege it happily exercised 145 years ago of lending a helping hand and giving a workshop within its walls to a young man of no university education, struggling to begin earning a livelihood as a mathematical instrument maker, in whom was then discovered something of the genius destined for such great things in the future. It was about the year 1761 or 1762 that Watt tried some experiments on the force of steam in a Papin's digester, and formed a species of steam-engine by fixing upon it a syringe ½in. diameter with a solid piston, and furnished also with a cock to admit the steam from the digester or shut it off at pleasure, as well as to open a communication from the inside of the syringe to the open air, by which the steam contained in the syringe might escape. That single-acting, high-pressure syringe engine, made and experimented on by James Watt 140 years ago in his Glasgow College workshop, now in 1901, with the addition of a surface condenser cooled by air to receive the waste steam and a pump to return the water thence to the boiler, constituted the common road motor, which, in the opinion of many good judges, was the most successful of all the different forms tried within the last few years. Referring now more particularly to Glasgow University itself, Lord Kelvin said it was certainly unique in being the first British university to have an engineering school and professorship of engineering. Again, Glasgow was the first university to have a chemical teaching laboratory for students and also a physical laboratory. Pioneer though it was in these three departments, it had been outstripped within the last 10 or 15 years by other universities and colleges in the elaborate buildings and instruments now needed to work effectively for the increase of knowledge by experimental research and the practical instruction of students. But there was no lagging to-day in the resolution to improve to the utmost in all affairs of practical importance, and they almost saw attainment of the further aspirations to excel over all others in the magnificent James Watt engineering laboratory of the University of Glasgow, to be ready for work before the expected meeting of the Engineering Congress next September. Now, through the magnificently generous kindness of Mr. Andrew Carnegie to the people among whom he has made for himself a summer home in the land of his birth, all the four Scottish universities could look forward to a largely-increased power of benefiting the world by scientific research, and by extending their teaching to young people chosen from every class of society, who were likely to be made better and happier and more useful to our country by university education.

Electricity and Municipal Trading.—In a letter to the *Times* under this heading Mr. Sydney Morse, chairman of the Municipal Trading Committee of the London Chamber of Commerce, condemns the policy taken up by far too many of our local authorities of opposing everything in the nature of private enterprise advanced in this country. It is difficult to understand, he says, why our municipalities and local authorities, to which so much public work of the utmost importance has been entrusted, should place difficulties in the way of the extension of private enterprise and should be allowed to continue to do so. Municipal trading is always put forward as a method of relieving the rates by keeping for the ratepayers the profits made by those whose only object is alleged to be profit-making without regard to the interests of the ratepayer. The cardinal principle underlying all trade is that the trader must give a good article at a reasonable price if he is to find customers and so make a profit. In the some manner with regard to public undertakings, such as the supply of electrical energy, or the service of railways and tramways, unless the business be well managed and the company or trader give what the public requires at a reasonable price, there are no profits. Municipalities and local authorities have entirely neglected these considerations. Indeed, they have denied them. By certain Acts of Parliament the consents of municipalities and local authorities are necessary to the establishment of an enterprise; but municipalities and local authorities in considering whether such consents should be given have taken a line which, he submits, is absolutely opposed to the interests of the ratepayers whom they represent. For example, in connection with electric lighting and tramways, instead of simply requiring that the service shall be good and the price reasonable, they have made conditions increasing capital expenditure—often putting upon the undertaking what are in fact public improvements—and then have insisted upon power to purchase the undertaking after a very short period at a price approaching the price of old iron. Again, when the local authority has been the possessor of an electric lighting station or of a provisional order which they have not put into force, a condition is added that the tramways or railway shall take all electrical energy required from the local authority at a price giving a large profit to the authority. The natural result follows: the service is not so good as it might be, it costs more than it would otherwise cost, and there is nothing to encourage the trader to extend the undertaking, all the result of the action of the local authority, but all put down to the company or trader. If, continues Mr. Morse, science continue to give us new inventions, sooner or later corporations will be driven to scrap plant, the cost of which will still be represented in their books by unpaid loans, and for the repayment of which rates will have to be levied. In matters of ordinary trading the usual economic laws will protect the public sufficiently. And where parliamentary powers are required, and the industry is in the nature of a monopoly, the public interests can be sufficiently safeguarded by providing for an efficient service, fixing maximum rates and maximum profits, and by provisions similar to the auction clauses in Gas Acts for placing additional capital. If, Mr. Morse concludes, the members of our municipal and public bodies really have at heart the interests of the public as distinguished from the public body, they should accept such a solution.

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ELECTRIC POWER SUPPLY ON TYNESIDE.

The successful inauguration by the Right Hon. Lord Kelvin, G.C.V.O., F.R.S., LL.D., of electric power supply on Tyneside (the proceedings in regard to which ceremony are detailed in another column), marks the official completion of the first of a new series of large power transmission schemes which cannot but have a very beneficial influence on the status of the electrical industry as a whole. The undertaking under notice differs from the Trafford Park power scheme recently described in these columns in that the area of supply which it embraces is relatively much larger, thereby involving problems of distribution not common to the Trafford Park scheme, whence our justification for designating the Tyneside supply the first of a new series. As will be seen later on, the predominating idea in designing the scheme has been to secure absolute immunity from serious breakdowns, and to this end more than usual attention has been given to the transmission lines and distributing network, the system being single-pole throughout, with single-core distributors laid in separate channels for the three-wire low-tension network, by which means liability to short-circuits and their attendant disturbance is effectively excluded. It is, of course, absolutely essential to the lasting success of any scheme designed for the distribution of power in bulk to secure immunity from serious breakdown, and the means adopted to attain this end lend additional interest to any scheme for the supply of electricity in bulk. New problems have had to be solved, and to those who have been engaged in the pioneering work must be accorded full credit for the bold manner in which these have been tackled. Practice in regard to such power schemes is likely to become standardised to a much greater extent than is possible in ordinary central-station work, because the general features and conditions of supply in each case will be practically identical in so far as supply of power in bulk to more or less distant consumers is concerned. Experience may suggest modifications, but, apart from the minor details, we venture to think the most essential advancement will be in adopting larger units of plant; and unless manufacturers at home make provision for the construction of standard sets of, say, 3,000 kw. capacity each, large orders are bound to go abroad. However, we are wandering from the main purpose of this article—namely, to describe the electric power supply on Tyneside.

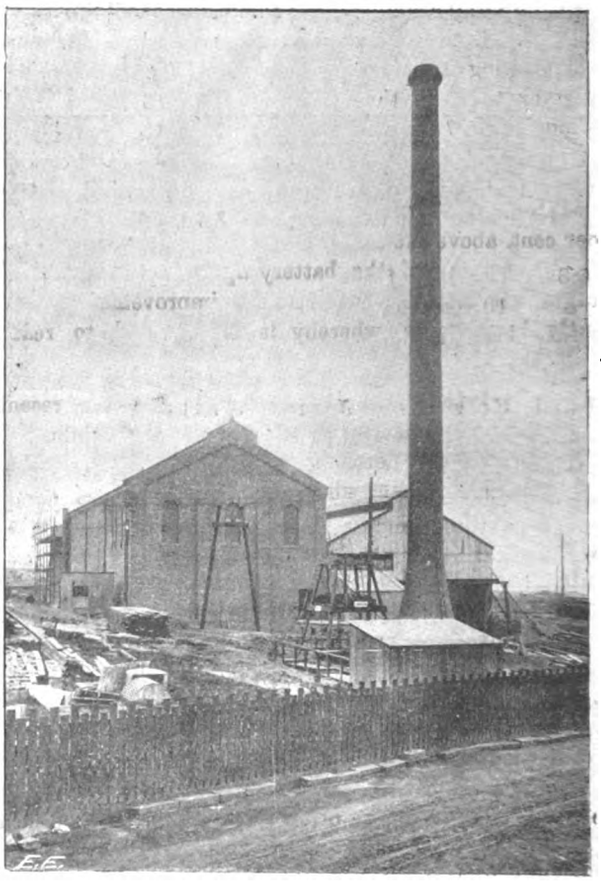

FIG. 1.—Neptune Bank Power Station in course of Erection

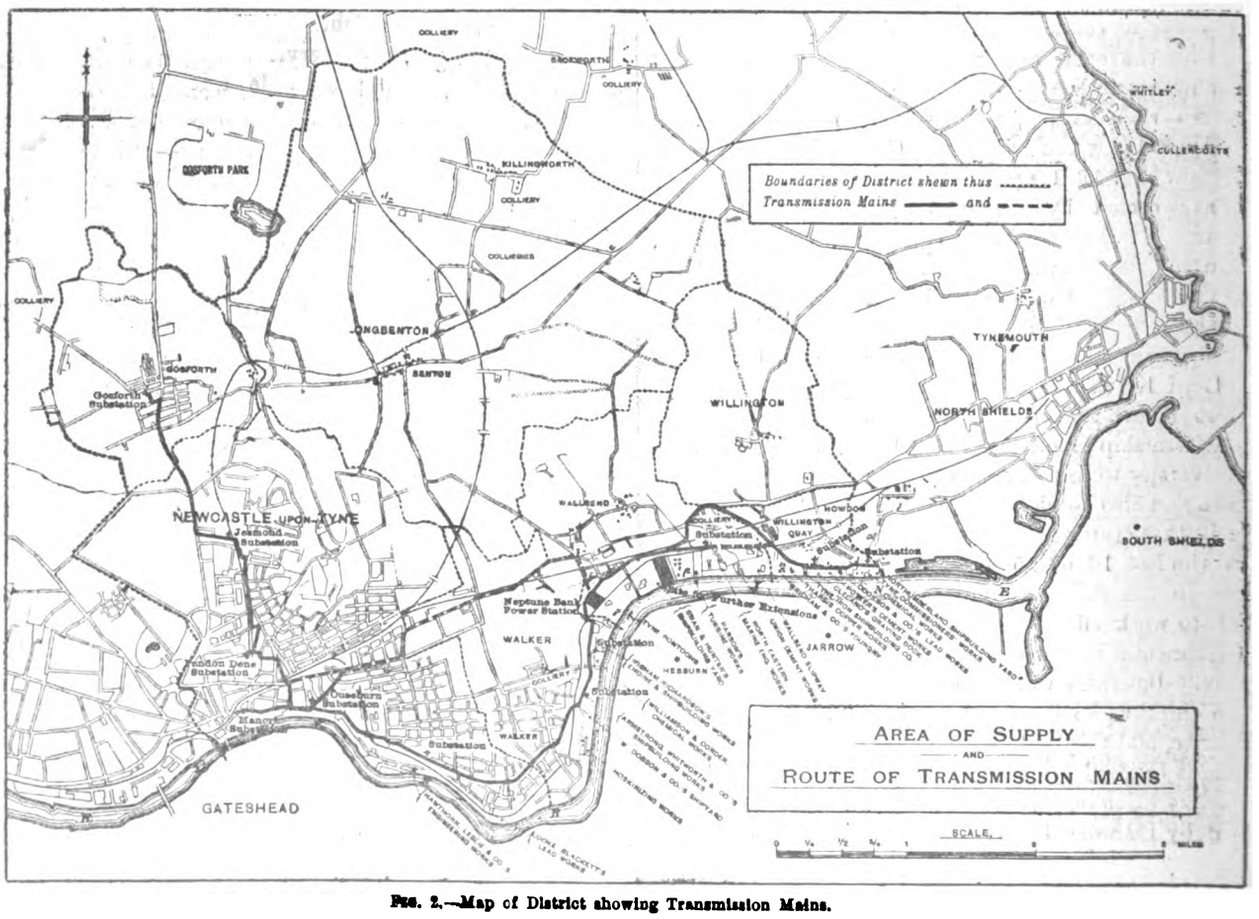

FIG. 2.—Map of District showing Transmission Mains.

The generating station, which is situated at Neptune Bank, is the preliminary power station commenced over a

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year ago by the Walker and Wallsend Union Gas Company on a somewhat smaller scale, and since taken over by the Newcastle-upon-Tyne Electric Supply Company, a new site outside the then existing area of supply, and at the same time to extend this area. The order was granted in August of last year, whereupon an arrangement was

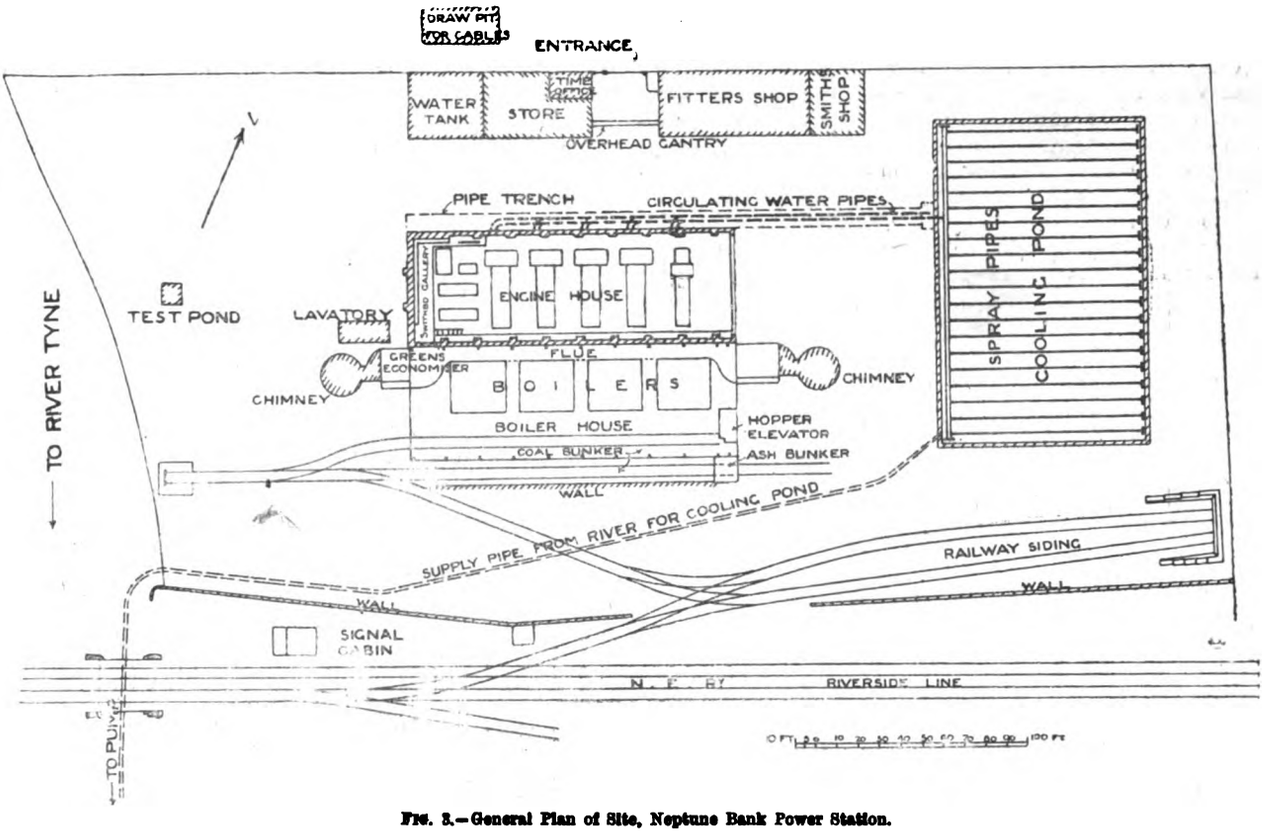

FIG. 3.—General Plan of Site, Neptune Bank Power Station.

Limited. The latter company, it will be remembered, inaugurated an alternating-current supply of electricity from their works situated at Pandon Dene as long since as 1890. This supply was used chiefly for lighting purposes over the company's Newcastle area, but the demand increased to such an extent that last year the Pandon Dene site became obviously too small for the growing requirements, and powers were therefore sought to obtain entered into with the Walker Urban District Council and the Walker and Wallsend Union Gas Company, whereby the Electric Supply Company took over the power station then being erected at Neptune Bank and undertook to supply the requirements of the parties concerned in bulk, in addition to their own needs. Fig. 1 shows the power station in course of erection.

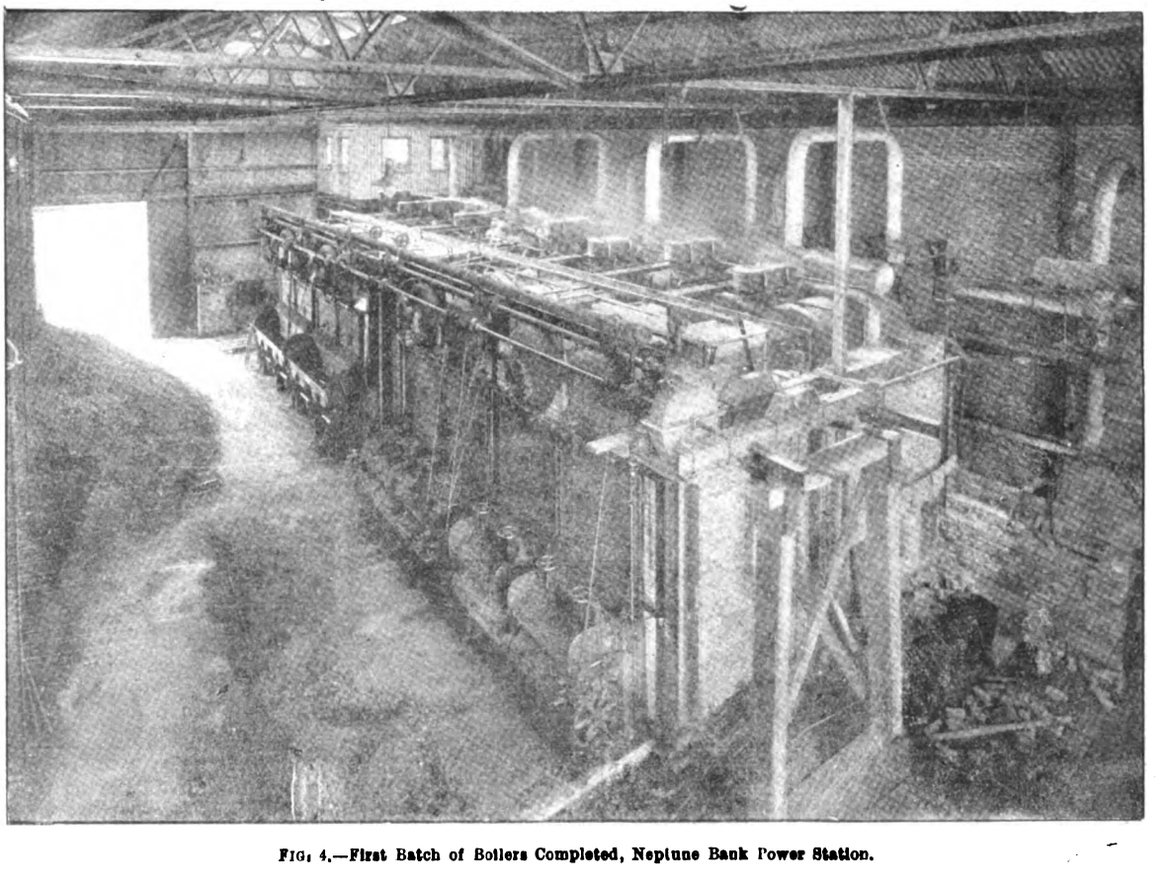

FIG. 4.—First Batch of Boilers Completed, Neptune Bank Power Station.

It should be mentioned that when the gas company

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obtained their order, Parliament refused to allow them to utilise any site but one which they had purchased for gas purposes at Neptune Bank, Wallsend, which, therefore, had to be adopted in the first instance although not actually on the river. Having regard to the position of the site, the station has been designed for a comparatively moderate plant capacity, and when the plant at present installed, together with that on order, has become loaded it is intended to erect another generating station on the riverside site which has been acquired by the company. This new site, which is shown on the map of the district (Fig. 2), is about 15 acres in extent, and centrally situated relative to the pick of the power supply area.

The gas company, in putting down their station, in the first instance adopted the three-phase system, generating at a pressure of 5,500 volts with a periodicity of 40 ⁓ and transmitting at this pressure, then either stepping down by static transformers to 440 volts or feeding a continuous-current three wire network by means of synchronous motor-generators, the motors being wound to work on the full pressure of 5,500 volts. The periodicity of 40 ⁓ and secondary voltage of 440 were adopted because they conformed to both Continental and American standards, thus enabling all class of apparatus to be obtained at an economical price. When the Newcastle Company took over the station the question of transmission pressure was reconsidered with a view to deciding whether it would be advisable to transmit at a higher voltage, but it was found that with the existing Board of Trade regulation as to thickness of insulation the original pressure of 5,500 was within a small percentage of being the most economical possible voltage for the present requirements of Newcastle. The voltage of the Newcastle transmission line is therefore 5,500, which will be transformed to continuous current at 440 volts pressure by means of synchronous motor-generators located in the various city sub-stations, whence the continuous-current feeders radiate to the three-wire distributing networks. Fortunately there has been no incontinuity in the design of the scheme, Mr. Charles H. Merz, consulting engineer to the Newcastle Company, having been responsible for the scheme since its initiation.

The Neptune Bank site, on which the generating station is erected, is about 350 yards from the river, and 60ft. above its level. It is served by a siding from the North-Eastern Railway Company's riverside branch. The position is shown on the accompanying map of the district (Fig. 2), while the general arrangement of the site is seen in Fig. 3.

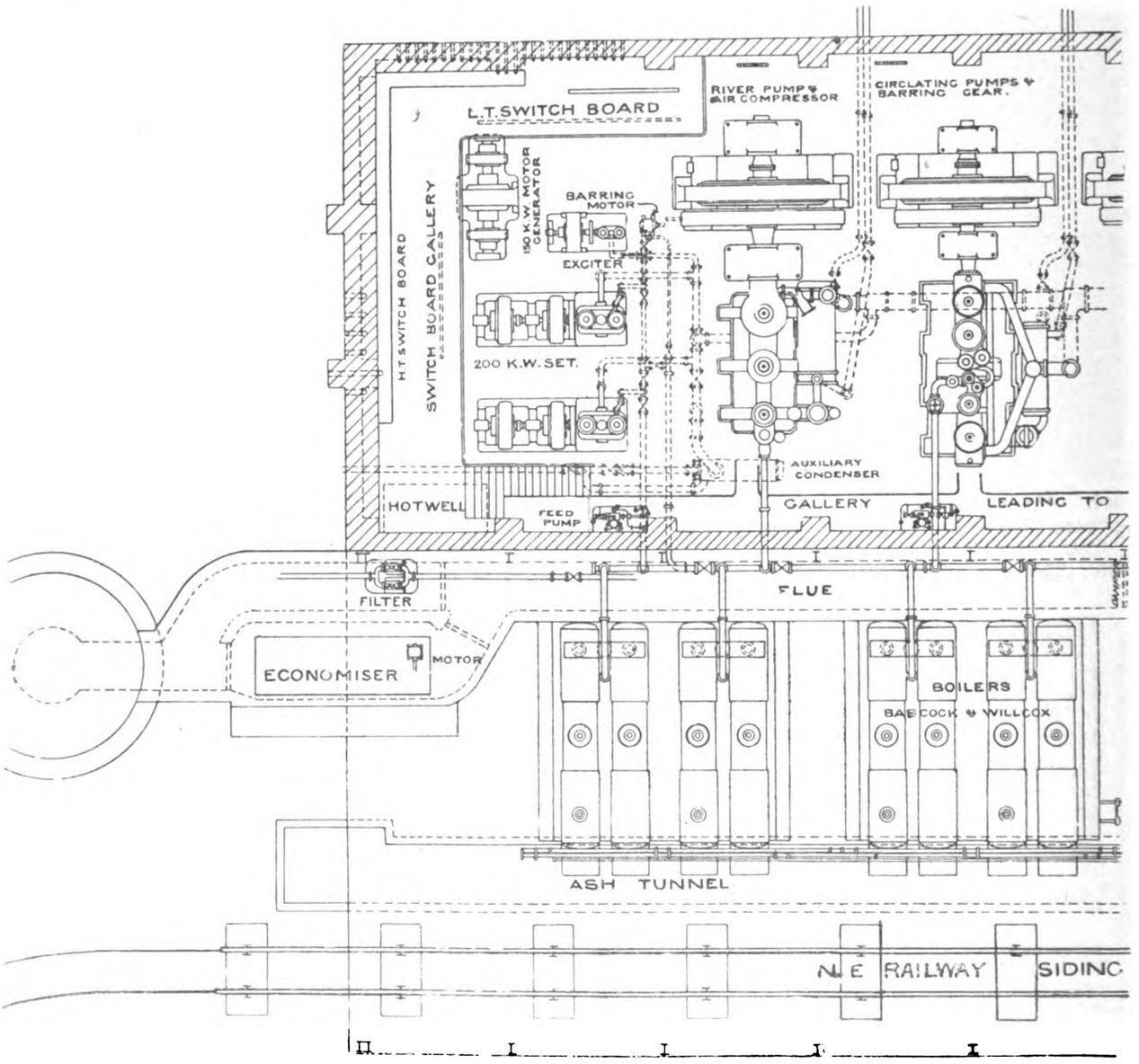

FIG. 5.—Detailed Plan of Neptune Bank Power Station (Left Half).

From the latter figure it is apparent that the station lies to the north and parallel with the railway, and that room has been found on the site for the necessary stores, fitting shops, test pond, etc., as well as for the power station and its cooling pond. One of the first problems in connection with the site which had to be solved was the question as to the best method of providing circulating water for the condensers. In order to settle this point, the capital expenditure, annual cost of running pumps, wayleave rent, etc., were got out for a pumping station at the river bank and a pair of 24in. pipes connecting this with the power station. It was found, however, that it would be cheaper, both in first cost and in running charges, to instal a cooling pond fitted with Korting's spray pipes on the site itself, merely pumping from the river the water necessary to make good the loss through evaporation. A brief description of this cooling pond may not be out

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of place here. The present plant is for dealing with 120,000 gallons of water per hour. This water is delivered through special centrifugal spray nozzles. There are 90 15mm. nozzles carried on 15 rows of 4in. pipes over a pond 146ft. by 58ft. by 3ft. deep. The main distributing pipe is 14in. diameter, and each line of 4in. pipes carrying nozzles has a valve, so that it can be shut off or turned on independently of the other lines. The distributing pipes are supported on piers provided with cast-iron capping plates. The pressure of water required at the nozzles for dividing the water into spray sufficiently fine for efficient cooling is 7½lb. per square inch, or, say, 15ft. head. The water is carried from the engine-room through a main pipe 14in. diameter, and there is a 14in. main suction pipe taken from the pond to the engine-room. From the suction pipe branches are taken to three centrifugal pumps working in connection with the condensers on the several engines. Each of the pumps is driven independently by a 20-b.h.p. Bruce Peebles motor, and is designed for a duty of 1,000 gallons per minute against a total head, including pipe friction, of 25ft. The pumps deliver into surface condensers, and from these the water is carried back through the main pressure pipe to the cooling pond. Additional pipes and nozzles are now on order for increasing the capacity of the cooling plant from 120,000 to 330,000 gallons per hour.

Coming now to the power station itself, it may be mentioned that this comprises two bays, each 52ft. wide by 160ft. long, one bay forming the engine-room, the other the boiler-house. The engine-room is of brick construction, while the boiler-house is of iron. The basement level of the engine-room is on the same plane as the firing floor of the boiler-house, while the engine-room working level and that of the North-Eastern Railway siding is 8ft. above this. This difference of level, while doing away with the necessity of having an underground flue, allows the feed pipes, etc., to be readily brought through the engine-room basement directly into the boiler-house without coming above the working level of the engine-room, and at the same time shortens somewhat the main steam-pipes. The railway siding is, as already mentioned, some 8ft. above the stoking level, thus allowing a considerable quantity of coal to be stored in the bunkers both inside and outside the boiler-house.

The height of the engine-room from basement to the underside of the roof tie-bars is 40ft. 6in., and a 25-ton "Booth's traveller" serves the whole length of the room. At the west end of the engine-room is located the switchboard gallery, which is elevated some 10ft. above the engine floor level, means of access being provided from the gallery to the middle platforms of all the main engines, as well as to the gratings in the boiler-house, from which the stop-valves to the steam-piping system are controlled. Both the high-tension and low-tension switchboards are also operated from this gallery, besides which is provided a reply gong engine-room telegraph for each engine, one dial being fixed to the gallery rail opposite its machine panel, while the corresponding dial is secured to the wall opposite the engine stop-valve. The engine-room basement is divided longitudinally by concrete walls into two chambers, in one of which all the machine rheostats are placed and all the high and low tension cables carried to

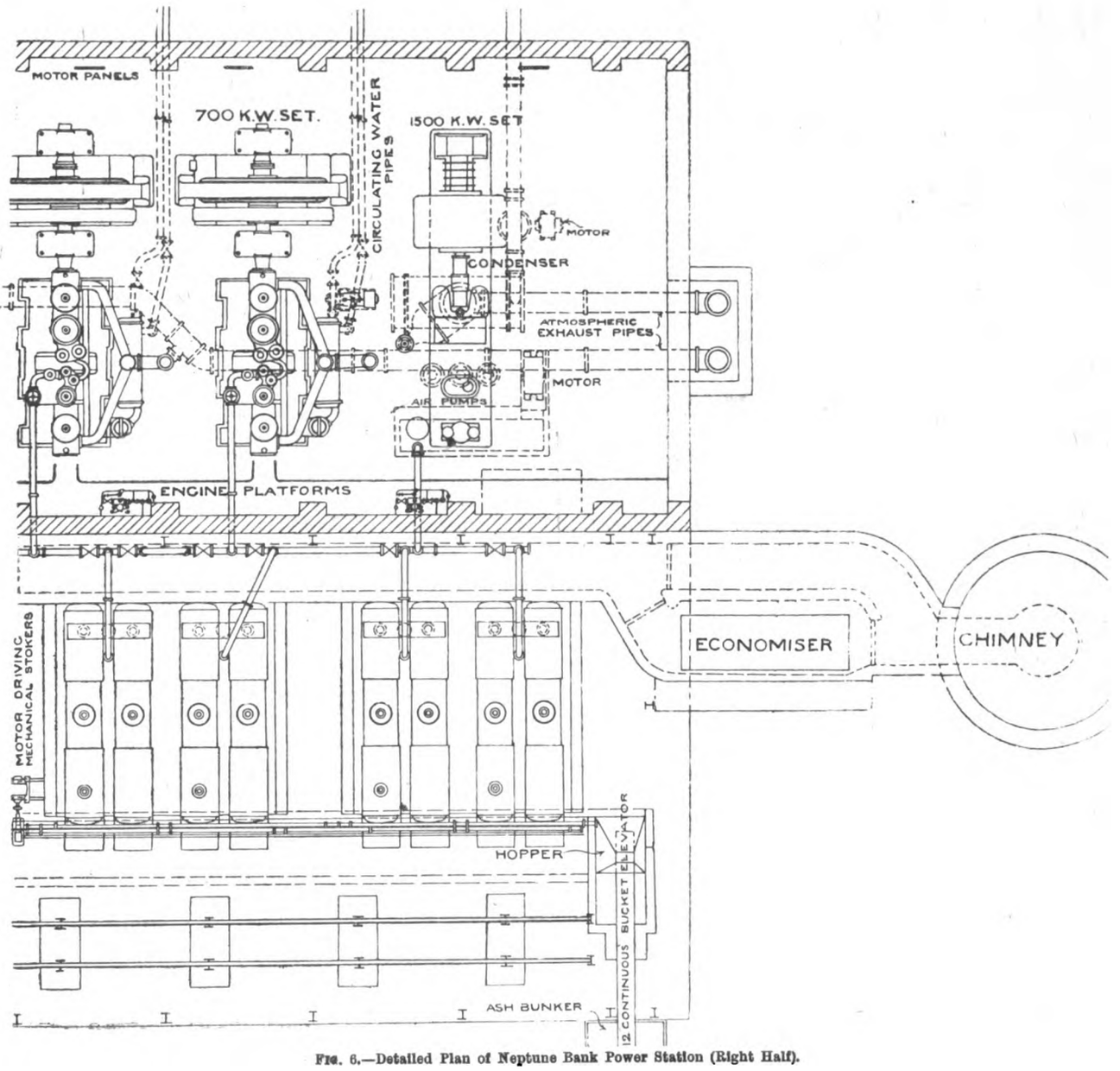

FIG. 6.—Detailed Plan of Neptune Bank Power Station (Right Half).

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the switchboard. The other chamber is occupied by the various exhaust, feed, circulating, and water-service pipes, the hot-wells, the motor-driven centrifugal pumps, the grease separators, and the Wheeler condenser for the Belliss exciter sets. This is an arrangement much more commonly adopted on the Continent than in this country, and one which has been repeatedly advocated in these columns on account of its obvious advantages. All the high-tension machine cables in the basement are made up of three single separately-insulated rubber cables, held together by a braided covering, so that they can be connected on to the three machine terminals without the interposition of a dividing box, it being only necessary to strip back the braid and to connect the individual cables to their respective terminals on the generator. These high-tension cables are carried up to the switchboard each in a separate wrought-iron pipe. The low-tension machine, exciting, and power cables are all of the plain rubber-covered single-core type run in porcelain rack insulators, the low-tension feeder cables being surrounded by porcelain sleeves, and clamped to the wall up to the point where each cable drops into its own pipe duct, whence it is carried outside to join the solid system. The total absence of woodwork from all parts of the basement is another noticeable feature, and the ironwork is, moreover, earthed to a bare copper solid wire of ·1 square inch sectional area, which runs the whole length of the basement, and is connected both to the engine piping system, the generator bed-plates, and to two special earth-plates outside. The centre of the star winding of each three-phase generator is also earthed, but by means of a separate lighting insulated cable, which is, however, connected eventually to the same earth-plates

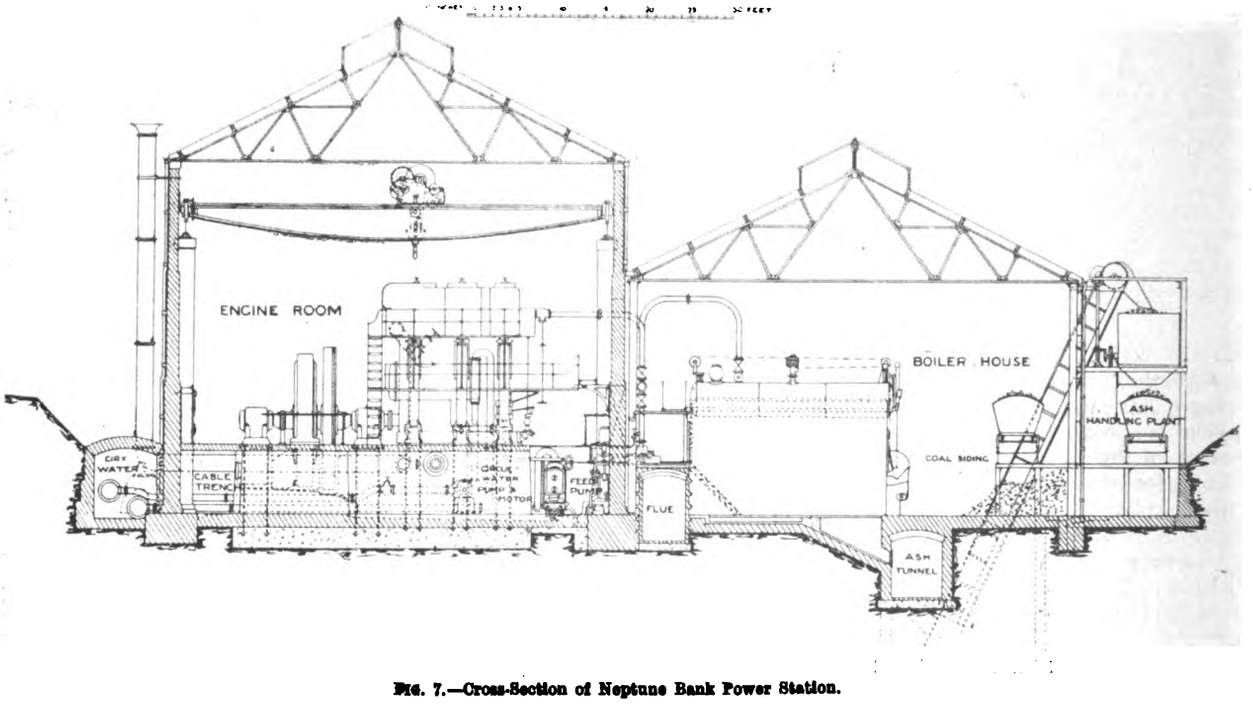

Fig. 7.—Cross-Section of Neptune Bank Power Station.

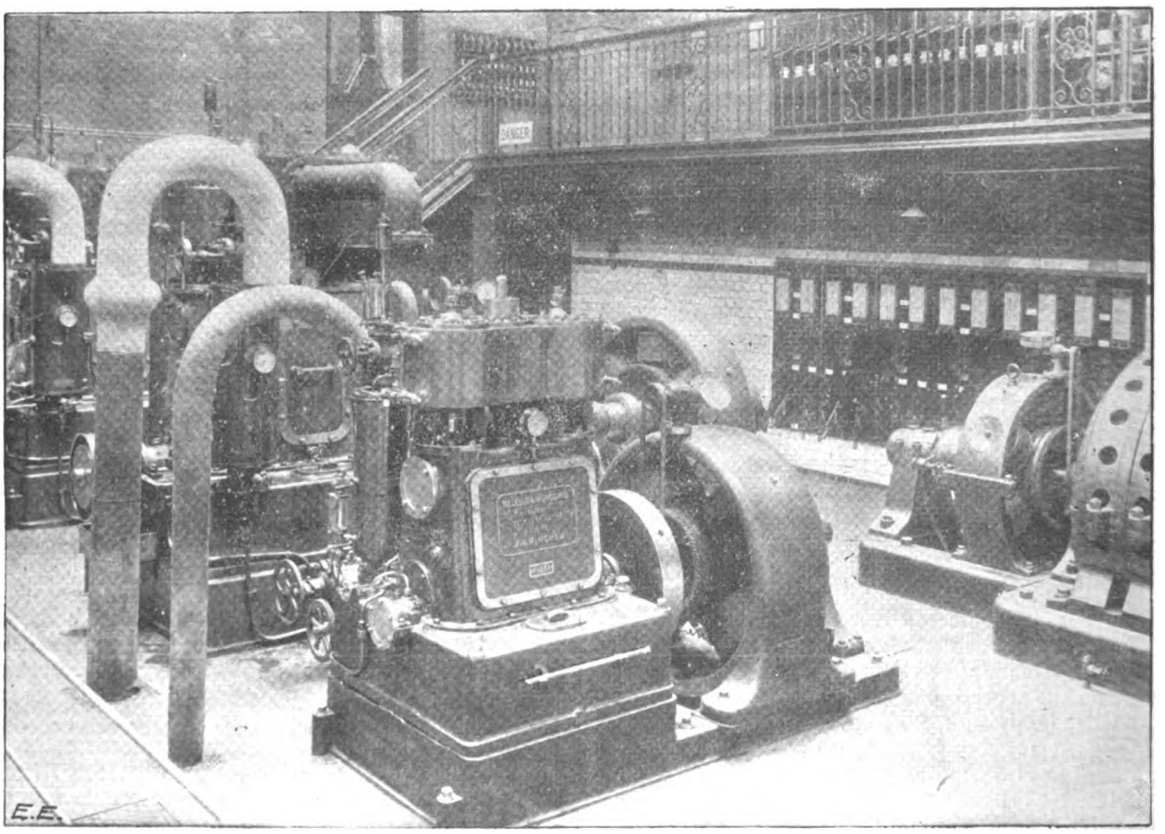

Fig. 8.—View of Belliss-B.T.H. Sets and Direct-Current Machine Panels.

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which serve the rest of the system. In the cable basement there is also provided a small direct-coupled motor-driven air-compressor, and a complete system of pipes leading to the switchboards and to all the machines, by means of which air at a pressure of 60lb. per square inch is utilised for freeing the armatures and high-tension switch gear from dirt and dust.

When fully installed, the equipment of this power station will be briefly as follows: eight Babcock and Wilcox boilers; two 300-b.h.p. Belliss engines, each driving two 100-kw. 240-volt direct-current generators; one 75-b.h.p. Belliss engine driving 50-kw. 240-volt direct-current generator; four 1,400-i.h.p. triple-expansion engines, each driving one 70-kw. 3,500-volt three-phase alternator; one 1,500-kw. Parsons turbo-alternator, 5,500 volts three-phase; one 1,500-kw. 5,500 to 240 volts, three-phase, continuous-current, synchronous motor-generator.

Boiler-House Equipment.

In the boiler-house (Fig. 4) are installed, or in course of installation, eight Babcock and Wilcox boilers, each having 4,020 square feet of heating surface, and being capable of producing 14,000lb. of steam per hour at a pressure of 200lb. per square inch. These are arranged in batteries of two boilers each. Superheaters are fitted to each boiler of sufficient capacity to impart 100deg. to 120deg. F. of superheat to the whole of the steam. These can, however, be flooded so that saturated steam is also available. Two types of mechanical stokers are employed, one by Messrs. T. and T. Vicars, the other being the chain-grate class by Babcock and Wilcox. These are driven by a shaft running the full length of all the boilers, power being supplied by a Bruce Peebles motor fixed in a central position relative to the shaft. An economiser, by Messrs. Green, is placed in the flue close to the base of the chimney, a by-pass flue being provided so that the gases can pass direct to the chimney if required. The economiser tube scrapers are electrically driven, and work continuously while the economiser is in use. An ash elevator (see Fig. 7), by Messrs. Graham, Morton, and Co., conveys the ashes from the ash tunnel to a bunker, which in turn discharges into a truck on the railway siding. This is also electrically driven. The siding is provided with an electric locomotive for handling coal-trucks, etc.

Piping.—The steam-piping (see Figs. 5 and 6) consists of one main running the full length of the boiler-room at the back of the boilers above the flue. Steam is supplied to this by branches from each boiler, one branch also being taken through the centre wall for the supply of each of the large engines. The Belliss sets are supplied from an auxiliary steam-pipe, which also supplies the feed pumps. Under normal conditions the exhaust steam is passed through surface condensers and returned to the hot-well, the circulating water being forced by means of electrically-driven centrifugal pumps through the condensers, and thence to the cooling pond already described. Atmospheric exhaust pipes are also provided, and a separate automatic atmospheric valve is supplied for each engine. Four feed pumps by Weir and Co. are arranged to feed the boilers, either direct or through the economiser, with water either from the hot-wells or town water-mains. Oil separators are placed in the exhausts from the Belliss engines, and filters are fitted to the air-pump discharge mains. Rankine filters are also installed on the delivery pipe before it reaches the economiser.

Engine-Room Equipment.

Two Belliss engines (Fig. 8), each of 300 b.h.p., drive the direct-current generators, and one of 75 h.p. drives the small exciter. They exhaust through oil separators into a Wheeler surface condenser. The engines driving the 700-kw. sets are all of the triple-expansion, vertical, inverted type, fitted with both expansion and emergency governors. One of these is by the Wallsend Slipway and Engineering Company, and is fitted with Corliss valve gear. This engine is remarkable for the economy which it effects in steam consumption, the variation from quarter-load to full load being between 9·94lb. to 10·42lb. per horse-power hour, or between 16·89lb. to 21·81lb. per kilowatt-hour. The lowest consumption was observed at three-quarter load, the consumption at quarter-load being at the rate of 10lb. per horse-power hour. The results of the water-consumption tests for this engine are tabulated herewith.

Summary of Results.

Description of trial.	Duration of trial.	Average steam pressure.	Average vacuum.	Revolutions per minute.	Average total indicated horse-power.	Total kilowatts per hour.	Water per indicated horse-power per hour.	Consumption per kilowatt per hour.
	Hours	Lbs.	In.				Lbs.	Lbs.
¼ load	1½	200	25	99·3	364	167	10·0	21·8
½ load	1½	200	25	98·7	594	332	10 03	18
¾ load	2	200	25½	99·2	850	503	9·94	16·89
Full load..	2	200	26	100·3	1,177	719	10·42	17·09

The three Wigham-Richardson's engines (Fig. 9) are of the four-crank triple-expansion type, balanced on the Yarrow, Schlich, and Tweedy system, and naturally run without appreciable vibration. Governing is done by a Stumpf flywheel governor mounted direct on the crank-shaft, and on all engines an Aspinall emergency governor cuts the steam off entirely at 15 per cent. above the normal speed, which is 100 revolutions per minute. These engines will drive their generators at full load (700 kw.) when exhausting to atmosphere. The disposition of the several items of plant described is shown in the detailed plan (Figs. 5 and 6) and the cross-section (Fig. 7).

Large Alternators.—The large alternators are of the three-phase type with revolving fields and stationary armatures, and were supplied by the British Thomson-Houston Company, Limited. Each machine is placed tandem to its engine, the field being mounted on an extension of the engine shaft, 24in. in diameter. The armatures are arranged to slide parallel to the shaft on base-plates secured to the foundations by bolts. The normal output of each generator is 700 kw. at 5,500 volts, the speed being 100 revolutions per minute. The fields have 48 poles, thus giving a frequency of 40 cycles per second. The armature core is built up of punchings of the best grade sheet iron specially selected for high permeability and low hysteresis loss. They have been japanned before assembling, and are further insulated from each other by sheets of paper inserted to reduce the eddy-current loss. Slots are punched on the inner side to receive the winding, which is held firmly in place by means of wooden wedges. The punchings are assembled with ventilating spaces at intervals to allow of a free circulation of air in direct contact with the core and winding. The armature winding consists of separately insulated former-wound coils laid in the slots and secured therein by the above-mentioned wooden wedges, the coils being completely insulated before being placed in the armature. The winding is so arranged that in case of a burn-out the defective coil can be readily taken out and another put in its place. There is one slot per pole per phase, and the shape of the pole-pieces is such that the wave shape approximate closely to that of a sine curve. The field poles are built of punchings bolted together, these punchings being of high permeability, thus reducing the energy required for excitation. Also hysteresis and eddy-current loss due to fluctuations in the magnetic flux through the poles caused by the reaction of the armature current are almost entirely eliminated. The poles are firmly secured to a cast-steel ring supported by a cast-iron spider mounted on the shaft. The field winding consists of copper strip wound on edge, the successive turns being carefully insulated from each other and from the core. The normal exciting voltage is 250. Carbon brushes are used for the collector rings. The commercial efficiency of the generators is not less than 95 per cent. at full load and 91½ per cent. at half load, excluding the excitation, and the generators will carry an overload of 25 per cent. for half an hour without injury. The rise in voltage upon throwing off full non-inductive load does not exceed 7½ per cent., and the temperature rise after a 10 hours' run at full load does not exceed 40deg. C. as measured by the thermometer. The appearance of these sets is seen in Fig. 8.

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Continuous-Current Generators.—Each continuous-current set consists of two 100-kw. generators, supplied by the British Thomson-Houston Company, Limited, connected up tandem-wise to a Bellis engine, the arrangement being such that the armatures are interchangeable. Each generator has an output as a shunt machine of 100 kw. at all voltages from 260 to 270 when running at a speed of 380 revolutions per minute, and as a compound machine gives 250 volts at no load and 262 volts at full load. The armature cores are of the slotted type, with special ventilating ducts to ensure low temperature rise. The armatures are drum wound, the windings consisting of interchangeable copper coils set into slots in the periphery of the core and insulated therefrom with layers of specially prepared paper and linen. The commutators consist of segments of hard-drawn copper insulated from each other by mica strips, and mounted on a cast-iron shell. The brushes are of carbon provided with a flexible copper conductor connecting them to the brush-holders, thus entirely avoiding all sliding contacts between brush and holder. The field magnets are circular in form, with six inwardly projecting poles of mild steel, and are divided into two parts horizontally. The magnet coils are wound on separate formers, so that they can be readily slipped on or off. The bearings are of the self-aligning, self-oiling type, provided with oil rings. After a 24 hours' run at full load the surface temperatures of any part of the armature or field windings does not exceed 45deg. C. above that of the surrounding air.

Motor-Generator in Generating Station.—This motor-generator was supplied by Messrs. Richardsons, Westgarth, and Co., and is designed for a twofold purpose—that is to say, either for receiving alternating three-phase currents and delivering direct current, or *vice versâ*. The set consists of one three-phase synchronous motor wound for the full pressure of 5,000 volts direct coupled to two continuous-current machines, each machine having an output as a shunt machine of 75 kw. when running as a generator at 400 revolutions per minute. Each machine is shunt and compound wound, and gives at full load 260 to 270 volts. The combined commercial efficiency of this set at full load and normal voltage, and running either way, is not less than 85 per cent. The temperature rise after 10 hours' run at full load does not exceed 72deg. F. above that of the surrounding air as measured by thermometer. The generator either serves the requirements of the power station motor plant, etc., or supplies high-tension three-phase current to the transmission lines on light load as may be required.

High-Tension Switchboard.

The main high-tension switchboard is of the Ferranti type, and is an example of the serviceable adaptation of this firm's well-known gear for multiphase work. The framework consists of heavy slate panels, grouted directly into the wall, with vertical slates dividing the whole into a number of recesses into which the various parts are fitted. When extended for the full capacity of the station, the board will consist of 17 panels in all—namely, six generator panels, one motor-generator panel, two wattmeter panels, and eight feeder panels. Each generator panel contains three fuses, three switches, and three ammeters, and provision is made for disconnecting any panel from the bus bar when alive by means of insulating tools. 'Bus-bar, voltmeter, and synchronising gear in duplicate is provided at the top of the board. The two wattmeters are required for receiving the respective outputs of the two companies. The three-phase switches on the generator panels are of the oil-break type, as are also the fuses, which latter are provided with duplicate contacts and cable receivers. A regulating table under the high-tension panels contains for each three-phase generator a handwheel connected to an "open type" regulating resistance placed in the basement below, an ammeter indicating the current through the field of the alternator, and a double-pole carbon-break switch constructed for a working pressure of 250 volts. Very ample provisions, as previously reported, have been made under the switchboard platform for the regulating resistances and cables leading up to the cable receivers. The circuit panels are of a design similar to the generator panels, with the exception that the switches, being for a smaller capacity, are of the spring-break type without oil. Each phase is in a separate compartment, and the switches for each machine and circuit are distinguished, to prevent the accidental operation of the wrong switch, by extending the division plates between each set of three panels, and by colouring the front edge of these plates white. The board is a good example of Messrs. Ferranti's high-tension

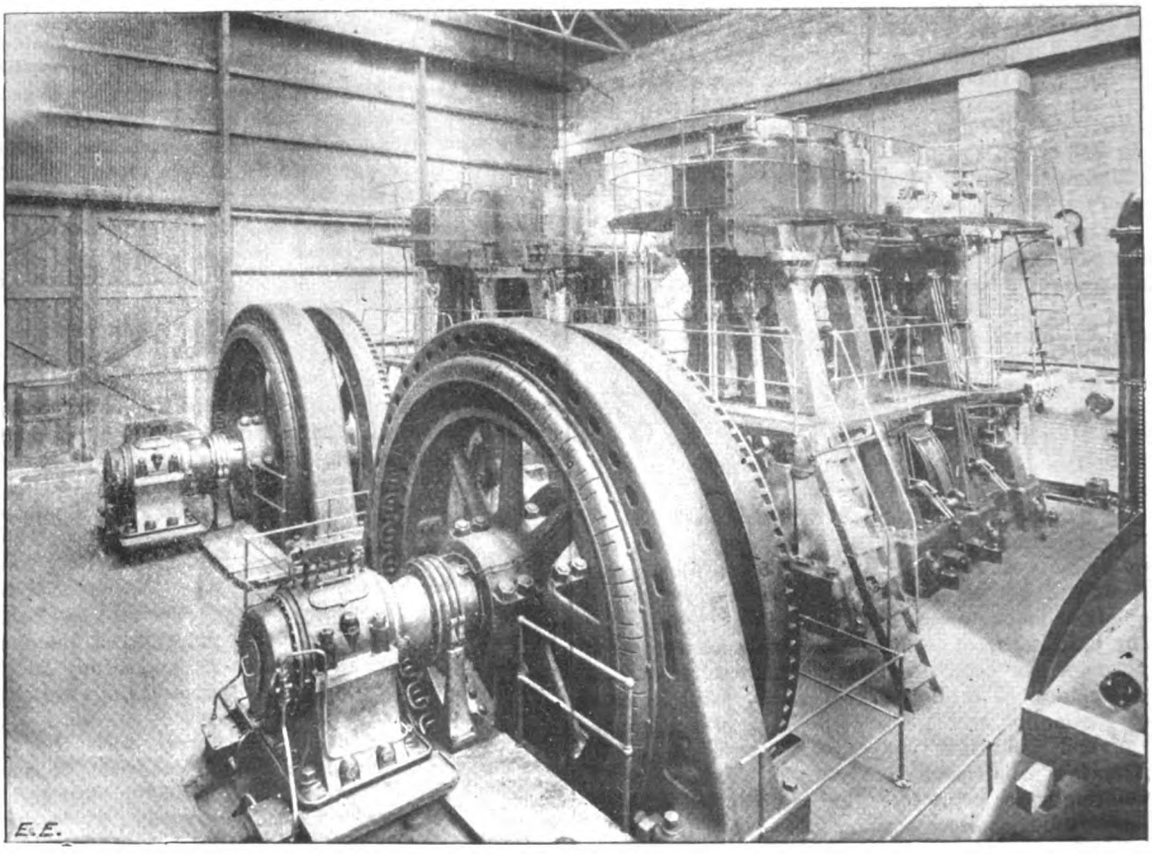

FIG. 9.—Two of the Wigham-Richardson 1,400-i.h.p. Sets and B.T.H. Alternators.

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switchboard work. Fig. 10 shows the connections to both the high-tension and low-tension boards in diagrammatic form.

Low-Tension Switchboards.

The low-tension switch gear comprises three boards, two being on the floor-level of the engine-room and one on the switchboard gallery. These boards control the two 200-kw. Belliss sets, a small exciter set, and the 150-kw. motor-generator. One of the boards on the floor level holds the main dynamo fuses, the compounding switches, and the field switches. The main low-tension board is on the gallery, and contains three sets of 'bus bars—namely, station power and lighting 'bus bars, exciting 'bus bars, and feeder 'bus bars. The station 'bus bars and exciting 'bus bars are arranged one on each side of the system, so that the station power and lighting circuits and the alternator exciting circuits are each operated quite independently at 250 volts. In this way the exciting circuits are kept entirely distinct from anything else, thus greatly reducing the liability of any mishap to the excitation. Double-throw switches are provided by which any generating set can be thrown on to these 'bus bars or on to the feeder 'bus bars. The feeder 'bus bars are connected through a wattmeter panel to the feeder board, which is arranged for four sets of three-wire feeders, and also includes a traction panel for the supply of power to the shunting locomotives in the yard outside.

Test Pond.

A test pond has been constructed outside the station for periodically testing the various generators. The arrangement consists of three plates of lead immersed in a brick pit filled with water. Each plate is separately suspended from a rope passing over a pole carried on a wooden staging above the pit. Three windlasses are provided at a safe distance from the pit, by means of which each plate can be raised and lowered independently, and thus the load can be readily balanced and adjusted. Overhead wires connect these plates with terminals fixed on the wall of the switchboard gallery, from which temporary connections are made for testing any of the three-phase or continuous-current generators, the pond being of sufficient capacity to absorb 1,500 kw. at 5,500 volts. During the construction of the Neptune Bank power station Mr. H. L. Rieeley has held the post of resident engineer.

Mains.

The whole of the main work, with the exception of that portion of the high-tension transmission line between Manors sub-station and Gosforth (see Fig. 2), was executed by the Callender Cable and Construction Company, Limited. There are two essentially different types of mains employed, the first consisting of three-core cables intended to be used on the three-phase circuits and the second of single-conductor cables separately insulated, each one laid by itself on the solid system. The three-phase mains consist of a series of three-core cables, each branch having a sectional area of ·15 square inch, insulated by bitumenised paper. The three cores are stranded together and wormed circular, and on the cable thus formed there is an additional thickness of bitumenised paper so as to bring up the wall of dielectric to the same radial thickness between any conductor and earth as it is between the conductors themselves. The cables thus made are designed to comply with the Board of Trade regulations for working at 6,000 volts effective, even if with no point earthed. The cables which also have a lead sheathing are laid on the solid system in cast-iron troughs supported on wooden bridges, and run in with Trinidad bitumen. The trough is finished by a wrought-iron lid, consisting of ¼in. plate, so as to give the greatest possible mechanical protection in case of accident from the outside.

In order to reduce the possibility of interruption to a minimum, two separate and distinct lines of high-tension mains are run from the power-house, occupying throughout separate trenches. Where they both make use of the Hadrian-road one set of mains is laid on the north side and the other on the south side, but in all other streets in the district the duplicate mains are carried in separate trenches. One three-phase main goes direct to the sub-station at the North-Eastern Marine Company's yard. Another similar main is carried to the sub-station at the Tynemouth end of the district, whilst a third main is laid with connections to both these sub-stations, so that it can supply current from the generating station to either or both, or be used as an interconnecting main between the two sub-stations. Spare ways are laid wherever high-tension mains are put down, and in addition there is a series of telephone and test cables, so that any sub-station

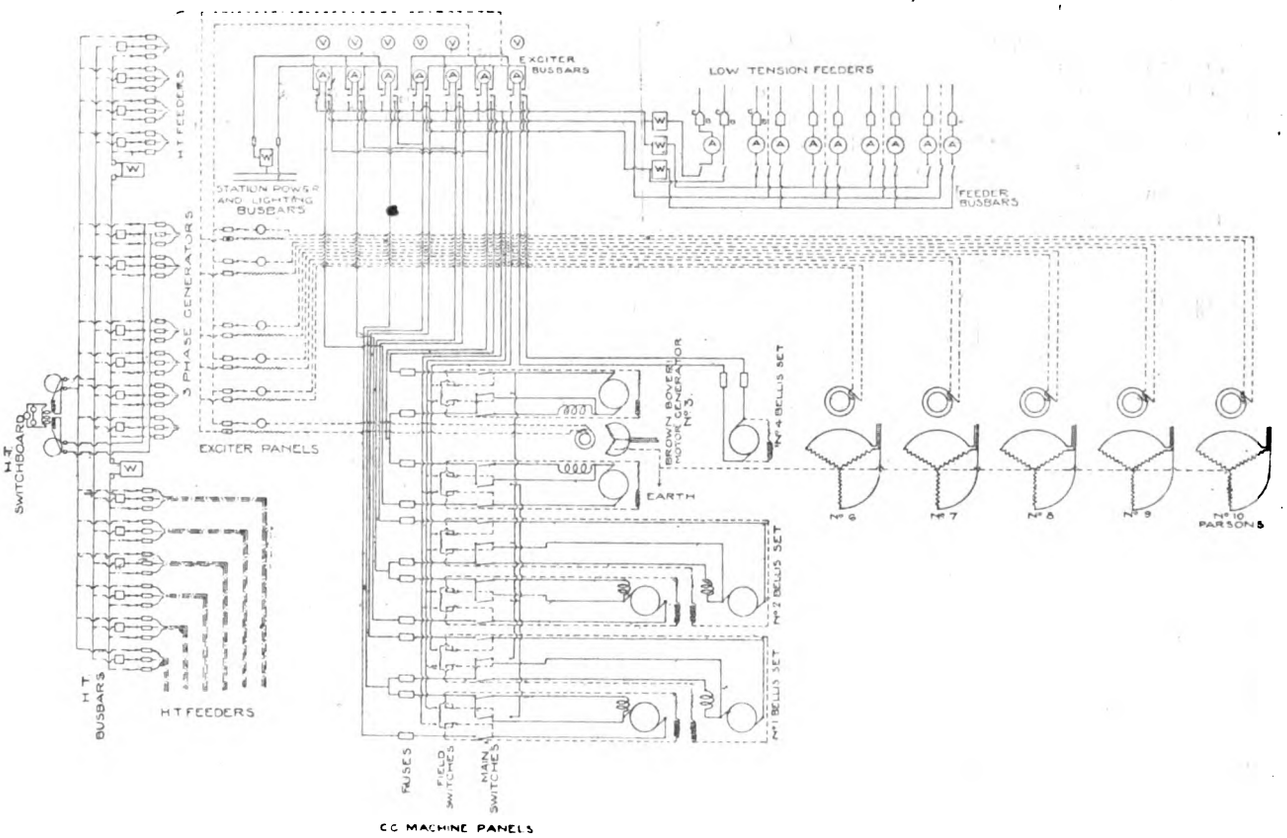

FIG. 10.—Diagram of Switchboard Connections, Neptune Bank Power Station.

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is in immediate communication with headquarters and with its neighbour.

The low-tension network consists of the Callender Company's standard make of vulcanised-bitumen cable. The mains are three-wire, consisting for the greater part of ·5, ·25, ·5 square inch conductors, but in some cases ·5, ·5, ·5 square inch is used. Each cable is laid in an earthenware trough by itself, supported on bitumenised wood bridges, and run in solid with refined Trinidad bitumen, being completed by a covering of hard bricks which are set in the molten bitumen. These low-tension mains run from the generating station along the Hadrian-road to the North-Eastern Marine sub-station. They are also laid in Station-road, Wallsend, and along the High-road, looping back into the main distributing line between the power-house and the sub-station. In addition to this line, there is a network of similar low-tension mains in the Willington Quay district, and low-tension connection is made between networks by means of vulcanised-bitumen feeders running from the North-Eastern Marine sub-station, along the North-Eastern Railway line, crossing the Willington cut viaduct, and there joining the Willington Quay district.

There are several branch distributors of smaller section, and, practically speaking, it may be said that the system is laid out so as to supply any of the factories with either high or low tension current as they may wish. A series of iron pipes has also been laid along the North-Eastern Railway between the power-house and Messrs. Armstrong's for the purpose of supplying them and others with high-tension three-phase current. Briefly put, this is a description of the feeder and distributing network in the Walker and Wallsend district, from which it will be gathered that the main sub-stations are interconnected both on their high and low tension sides, but while the interconnector is, in the latter case, only intended to be used on very light loads, the high-tension connecting cables are, on the other hand, of the same section as are the main high-tension cables from the generating station.

In addition to the above described work, the Callender Cable Company are now busy with the construction of a heavy trunk line to connect the generating station at Neptune Bank with Newcastle City. Their contract provides for the construction of a conduit having nine ways each 4in. in diameter, consisting of specially-made stoneware pipes set in a solid block of concrete, into which three-phase cables will eventually be drawn. These cables will be manufactured by the Callender Cable and Construction Company, and will be in many respects the same as the three-phase mains laid in the Walker district but the sectional area of conductor in each branch will be considerably larger, being ·25 square inch, whilst over the lead cover there will be a sheathing of steel wires so as comply with the new requirements of the Board of Trade as to the conductivity of earth sheathing wherever three-phase high-pressure current is dealt with. The trunk main conduit in question starts at the generating station at Neptune Bank, and runs *vid* Walker-road, through Walker, to the sub-station at the end of Byker Bank. It proceeds thence to the sub-station at Manors, where it terminates. This is to act as a trunk for the supply of current required in Newcastle City, and, except at the various sub-stations, it is not intended to be tapped or interfered with.

FIG. 11.—Laying Callender Mains in Newcastle.

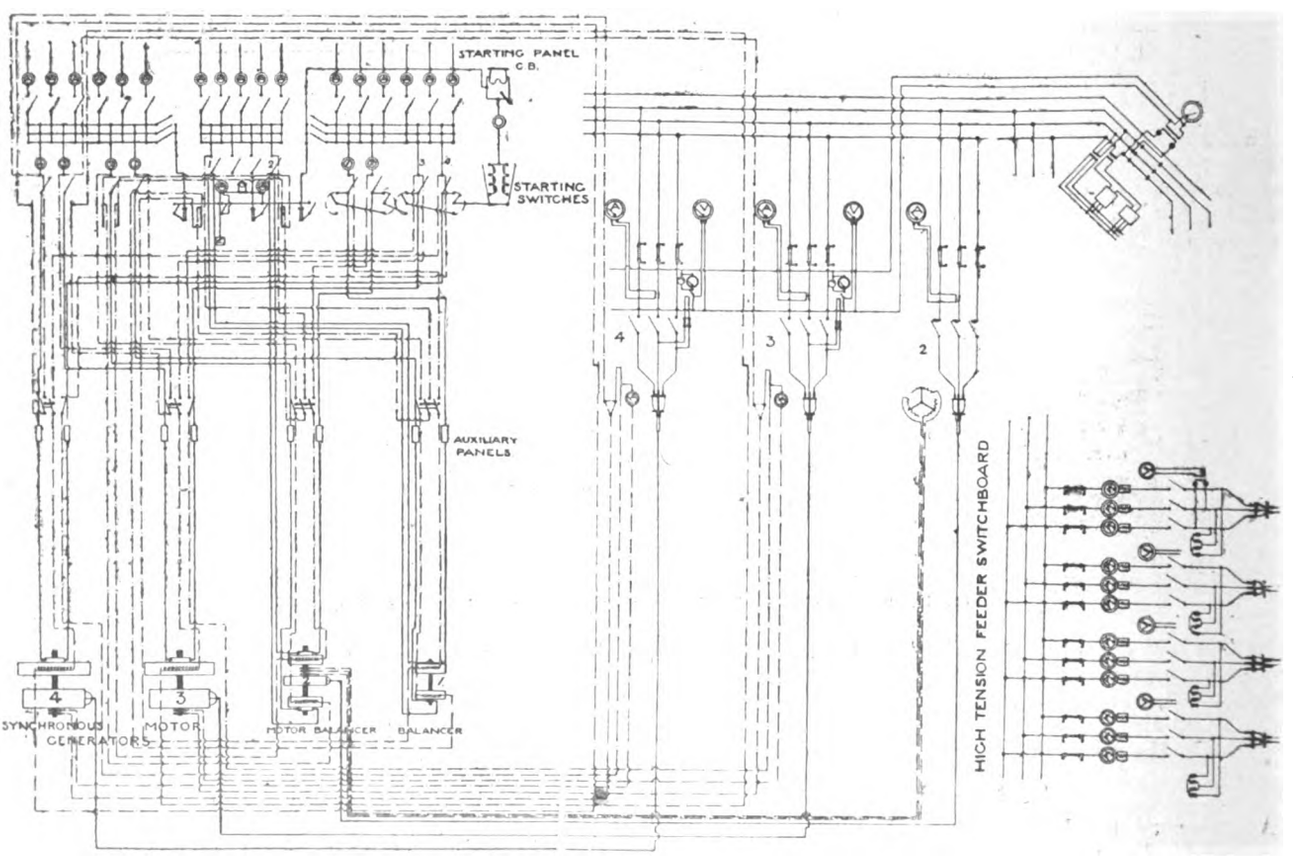

FIG. 12.—Diagram of Switchboard Connections in Manors Sub-Station, showing L.-T. Connections on left and H.-T. Generator Connections in centre.

Along a great part of the road a system of three low-tension mains has also been laid, and it is eventually intended to connect up any portions of this network which at present are not placed in position. This low-pressure network consists of single-conductor cables of the Callender Cable and Construction Company's standard make, insu-

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lated by vulcanised bitumen and laid solid in Trinidad bitumen precisely as used in the Wallsend district, with the exception that instead of adopting three single troughs, one for each cable, a special form of three-chase troughing has been used with the view of economising space.

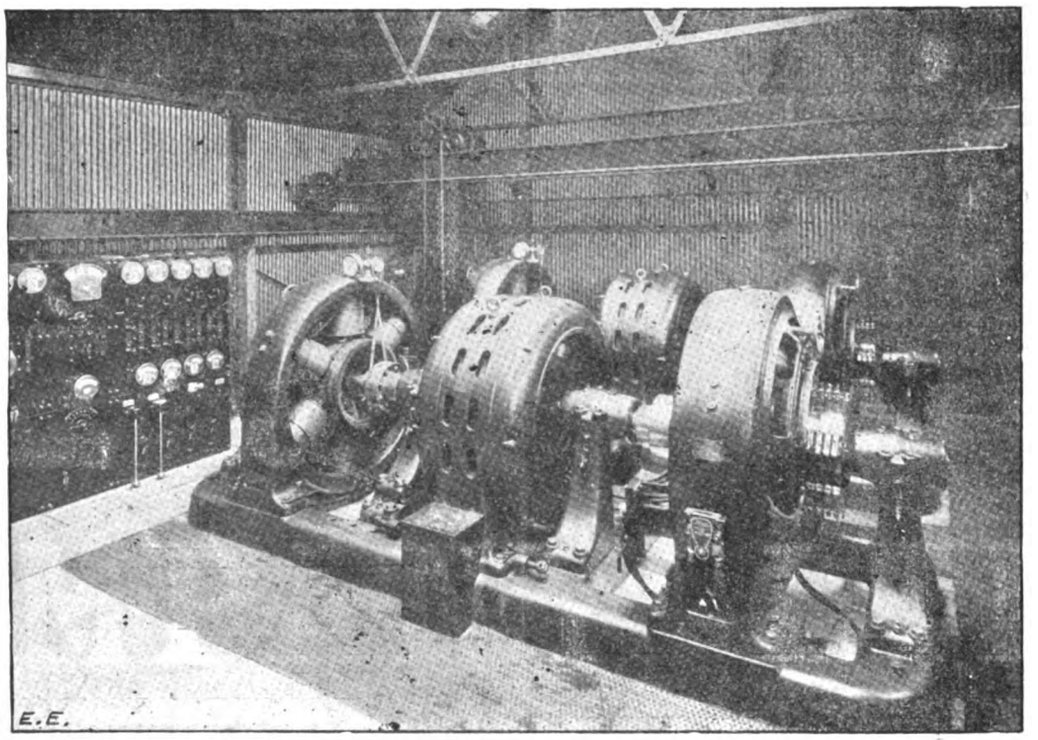

FIG. 13.—Sub-Station near North-Eastern Marine Engineering Company's Works, showing 300-KW. B.T.-H. Motor-Generators.

Throughout the whole of the work on both contracts great care has been taken in regard to the manholes and drawpits. On the Wallsend and Willington line, owing to the difficulties met with and the nature of the subsoil, and the fact that the mains are in the roadways, these are practically small underground chambers. The mains forming the Newcastle trunk line are all laid under the footpath, and consequently the manholes, although larger in superficial area, are not quite so deep. They have been constructed with the view of making it possible to handle the heavy trunk main cables and connect them up as readily as is possible; and although they form an item of considerable expense in the total work, they are probably the best examples of manholes on a heavy drawing-in system which have ever been constructed in this country. The boxes joining the factory lengths of high-tension mains are designed so that there shall be complete continuity of the wire sheathing. They are of a type which has been proved satisfactory in practical working at Wallsend among other places. The disconnecting boxes used on the low-pressure mains are single-pole, and are so arranged as to be readily accessible, but at the same time are kept perfectly watertight through the special design of the lid. The feature in the whole of the boxes in Newcastle and its district is the interchangeability of all parts, everything being made to template, and as few types as possible being adopted.

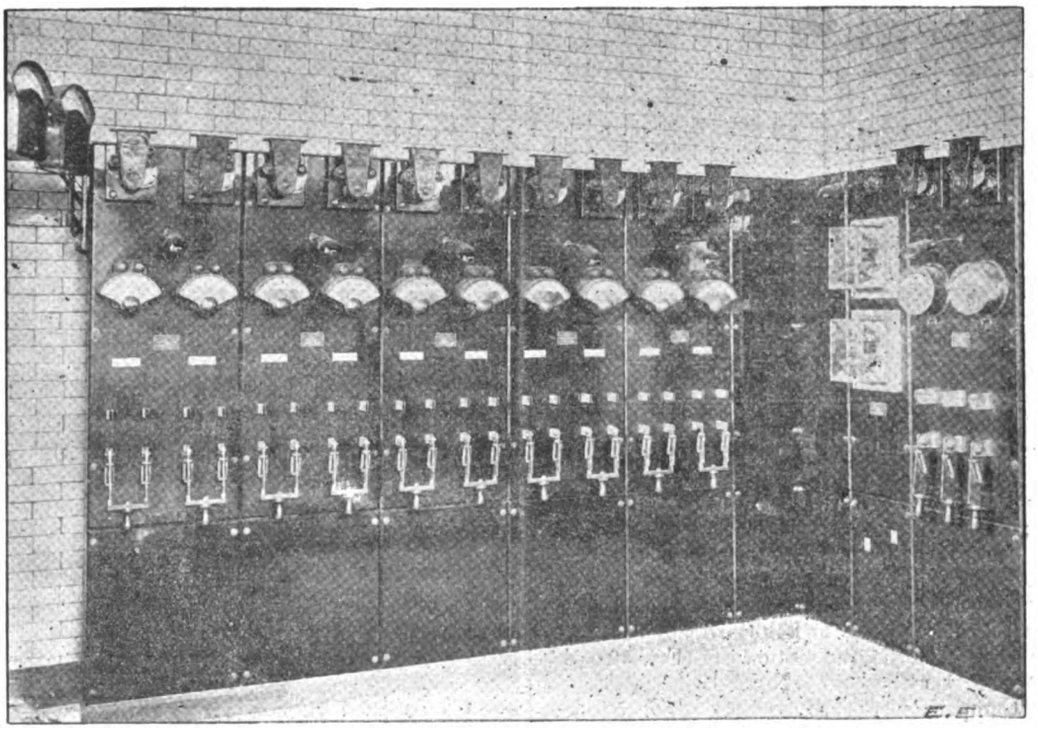

FIG. 14.—View of North-Eastern Marine Company's Sub-Station Switchboards.

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The Callender Cable Company have had a large staff in Newcastle for more than a year past. The Walker and Wallsend work has been carried out under the supervision of Mr. George Marsh; the Newcastle trunk main is in the hands of Mr. F. B. Collard; whilst other work which they are doing in Newcastle City, in Jesmond, and in Walker is in the hands of one or the other of these gentlemen, or of Mr. Fase. Fig. 11 shows the work of laying Callender mains in progress.

The high-tension transmission cables between the Manors sub-station and Gosforth are being supplied and laid by the British Insulated Wire Company. These cables are of the above company's well-known three-core, clover leaf type, each core having a sectional area of ·25 square inch. The requirements of the Board of Trade as to the conductivity of earth sheathing are met in the case of these cables by providing just under the lead cover a continuous layer of copper tape.

Main Sub-Stations.

With regard to the main sub-stations, these are practically identical in design, the only difference being in their over-all length, which was effected by the available site area, but even this difference is only slight, and it may be said that each has a length of about 80ft. and a width of 35ft., being designed for an eventual capacity of 2,000 kw. in synchronous motor-generators. The present equipment of each may be enumerated as follows: two 500-kw. synchronous motor-generators; one 75-kw. asynchronous balancing set; one 25-kw. continuous-current balancer.

Having regard to this uniformity in the design of the main sub-stations, it will suffice for our purpose to take one example only—namely, the Manors sub-station, which is equipped as described. The switchboard connections in this station are shown in diagrammatic form (Fig. 12).

The sub-station serving the North-Eastern Marine Engineering Company's works contains two 300-kw. motor-generators by the British Thomson-Houston Company, Limited. One of these sets is shown in Fig. 13. Each set consists of a synchronous motor wound for 5,500 volts direct coupled to two compound-wound continuous-current machines, one at either end. The output of each of these continuous-current machines is 150 kw. when running shunt at 400 revolutions per minute, the voltage in this case being 265 at full load. Running as compound-wound machines they give 257 volts each. The combined commercial efficiency of each set when running at normal full load is not less than 87 per cent., while the temperature rise after 10 hours' run at full load does not exceed 4deg. C. above the surrounding air. The function of these motor-generators is to receive three-phase alternate currents and deliver direct current to the 500-volt three-wire distributing network. The high-tension switchboard in this sub-station was supplied by Messrs. Ferranti, Limited. It consists of five panels—three feeder and two motor-generator. Each panel contains one ammeter, three switches, and three fuses. Any one panel can be disconnected from the 'bus bars while alive by using insulating tools. Duplicate synchronising gear is mounted on the board.

Messrs. Reyrolle and Co. supplied the low-tension switchboard, which contains seven panels, as follows: one positive, one negative, one neutral, two test, and two starting. There is also a "feeder" board, containing the machine switches and ammeters at the bottom and the feeder and distributing mains at the top. A view of these several boards is shown in Fig. 14.

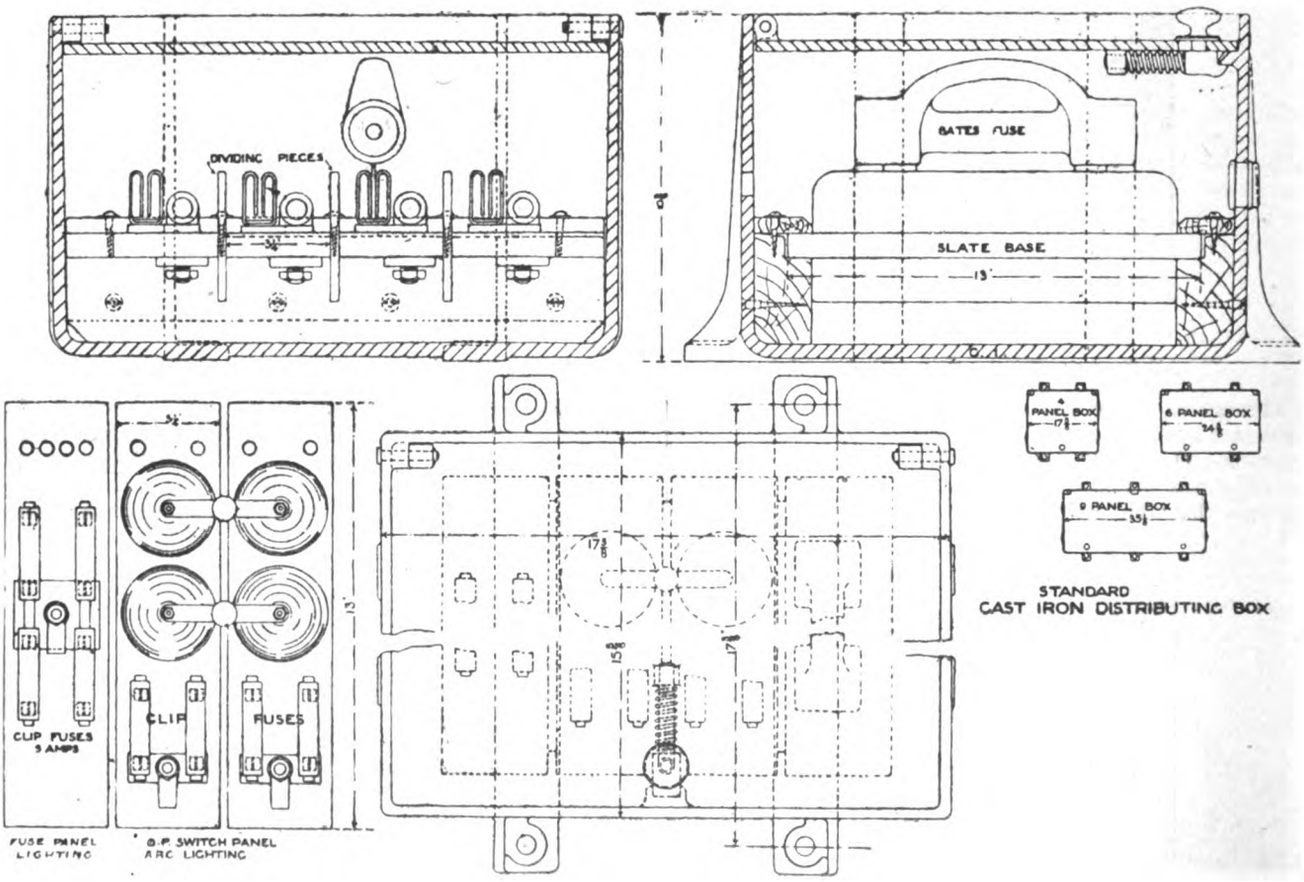

FIG. 15.—Plans and Sections of Works Distributing Box.

A 7½-ton overhead travelling crane, manufactured by Messrs. Morris and Bastert, is also provided. From this sub-station the North-Eastern Marine Engineering Company, Limited, will be supplied with from 1,600 h.p. to 2,000 h.p., exclusive of the demand for lighting purposes.

In some instances a three-phase supply is given. This is notably the case in respect to the Walker Shipyard, owned by Messrs. Sir W. G. Armstrong, Whitworth, and Co., Limited, whose installation may be briefly described. Here also Messrs. Ferranti, Limited, supplied the high-tension switchboard, consisting of four panels—two feeder and two transformer—each panel equipped with one ammeter, three switches, and three fuses; while Messrs. Reyrolle and Co. supplied the low-tension switchboard, consisting of seven panels—two transformer, one meter, and four three-phase circuit—the transformer and three-phase circuit panels being each provided with three fuses, one ammeter, and a triple-pole switch. In the sub-station are also installed seven British Thomson-Houston 50-kw. single-phase transformers, having a ratio of 5,500 to 440 volts. Of these transformers, one is held in reserve, the six in use being connected up in delta, so that

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the failure of one unit does not entail a stoppage of the supply. The efficiency of the transformers at full load is 97 per cent. In this shipyard British Thomson-Houston three-phase induction motors are employed. These are of three types, one having a short-circuited rotor, the others former-wound rotors. The former are started by combined oil-break switches and compensators. Of the other types one has a resistance mounted inside the rotor itself, which is cut out by means of a sliding handle passing through the hollow rotor spindle. The other is provided with slip rings, and used in conjunction with a controller for variable-speed purposes. All the works distributing boxes are of the standard design shown in Fig. 15. They are made of cast iron in different sizes, suitable for taking from three to nine panels each, and are equipped with either power or lighting circuit panels according to requirement, the over-all dimensions of the various classes of panel being identical. To guard against risk of a short-circuit in a power distributing box—*i.e.*, boxes equipped with fuses of over five amperes capacity—single-pole boxes are used. About 400 h.p. of plant is installed in the Walker Shipyard.

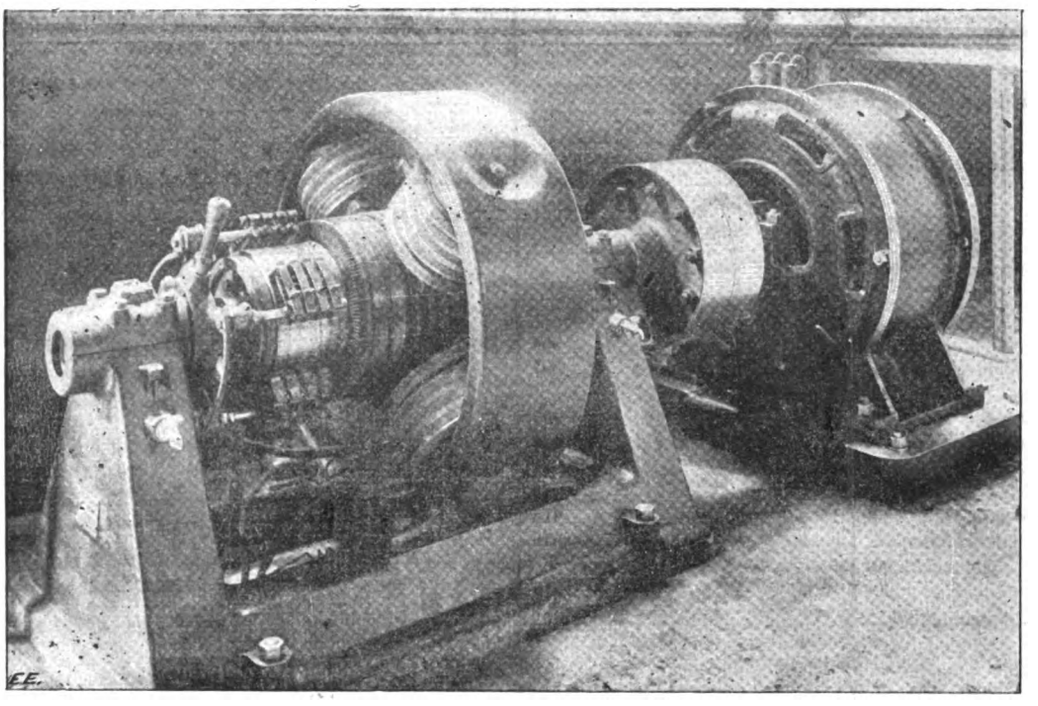

FIG. 16.—75-kw. Brown-Boveri Motor-Generator, Northumberland Shipbuilding Company

In the Northumberland Shipbuilding Company's works sub-station there is installed a 75-kw. motor-generator, manufactured by Brown-Boveri and supplied through Messrs. Richardson, Westgarth, and Co. It consists of an asynchronous motor coupled direct to a 240-volt and direct-current generator, and is illustrated in Fig. 16. There are also four 75-kw. single-phase transformers by the British Electric Transformer Manufacturing Company, having a ratio of 5,500 to 440 volts. Three are in use and one spare.

(Continued on page 899.)

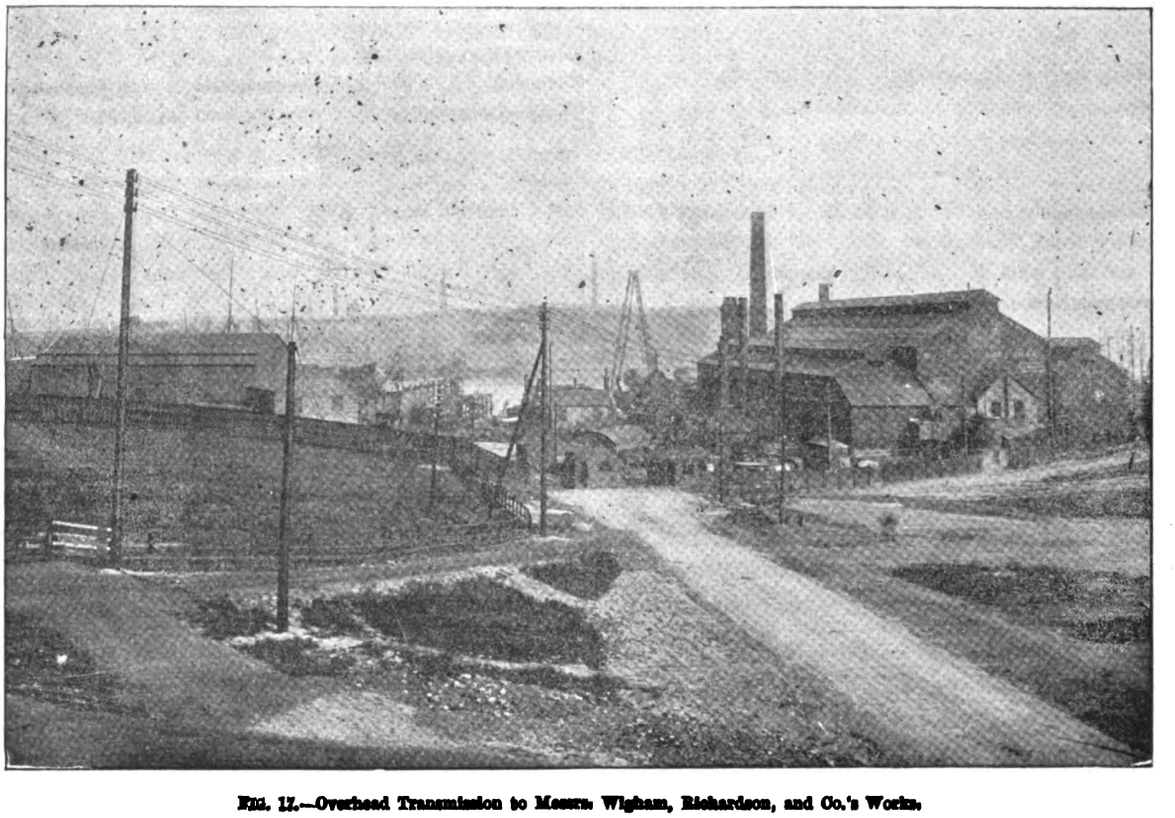

FIG. 17.—Overhead Transmission to Messrs. Wigham, Richardson, and Co.'s Works.

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THE VISIT TO GERMANY.

After a considerable amount of discussion as to how we can best assist in making the visit of the Institution to Germany conduce to the aid of British theory and practice, we have determined to offer

Two Prizes—
One of Twenty Guineas,
One of Ten Guineas,

for the best essays descriptive of the visits paid, comparing the points of detail which may prove of advantage to British manufacturers and organisations, duly considering the conditions under which our home work is carried on. If more than two essays are thought suitable for reproduction, those used will be paid for at our usual rates for contributions. The editors of the *Electrical Engineer* will decide the order of the essays, and their decision will be final. The length of the essays should not exceed fifteen or twenty of our columns. The moving idea for the above is to be found in Bacon's essay on "Studies," wherein he says, "Reading maketh a full man; conference, a ready man; and *writing, a correct man.*" We are anxious to assist in getting "correct men"—hence our offer.

MUNICIPAL ELECTRICAL ENGINEERS.

Glasgow in this year of grace is the city of congresses. At the present time, like the early swallows, they are numbered by units; by-and-by they will be counted in swarms. The Association of Municipal Electrical Engineers is at present sitting in convention in the city of St. Mungo under the presidency of Mr. Chamen, the respected electrical engineer of Glasgow. We assume in our eulogy of the presidential address that the association has nothing to do with the theoretical question of municipal trading, but exists upon purely business lines. The purpose for which its members live is to do the best they can, from a business point of view, for the municipalities under which they serve. Thus the main object of each of these annual conventions is to discuss the question, How best can we improve our business? The address of Mr. Chamen, looked at from this point of view, is most excellent. He analyses the systems of charging for current, the conditions under which current is supplied, giving his conclusions dispassionately but most emphatically; and, really, it is difficult to see that they can be effectively challenged. As the whole address is given elsewhere, it will not be necessary to discuss it at any length. After a preliminary mention of the hardships of having to pay into a sinking fund practically before works are in existence—a hardship which few or none will be found to deny—he deals with the main subject of his address—the best method by which to charge for current. There may be nothing very new in the subject matter, but certainly it is presented in a somewhat novel fashion, and the author is confident enough to say that the conditions under which current for lighting purposes is supplied are somewhat peculiar, and to conclude that the charges must

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be characteristic also. If we understand the argument aright, the moral is that the true charge for current supplied is decided by the state of the load curve at the time that current is supplied. It is the old, old song sung in a new setting. A few sentences point to a remedy, but as yet the necessary apparatus to remedy this great defect is not forthcoming. The curve of generation as regards gas is fairly constant; the curve of supply is as fluctuating as that of electric current. The difference, from a business point of view, is that one can be stored while the other cannot. Invention as regards electrical storage is no doubt in a parlous state, but he would be a bold man who should say it was dead, and that the world is not destined to see some inventions sooner or later that will render it effective. Mr. Chamen is to be heartily congratulated in putting before the members so clearly and succinctly a subject which is of the first importance to them all. He certainly realises the existing conditions, but while his solution may be the best it may not always be expedient in practice.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

GILBERT'S SELF-DRIVING WEIGHT OSCILLATING MOTOR.

SIR,—*Re* Mr. G. Evans's letter in your issue of 14th inst., neither he nor our greatest expert in science (Lord Kelvin) would say, after seeing my latest design of motor, it was "folly persisting further," but as I have arranged to ventilate it in another paper, owing to your lack of enterprise, Mr. Evans may feel disappointed in not having another opportunity to criticise in your journal. As to his notion that the motor should work on a vertical axis, it will do nothing of the kind, but will do so perfectly on a horizontal axis, and without ball bearings. I may mention I have to-day received my first model, weighing about 1cwt., from Messrs. Braun and Co., mechanical engineers, King's Cross, London, but unfortunately with several of the parts badly twisted in transit. This accident will put me back a bit, I'm sorry to say. Mr. Evans may as well say it is folly trying to fly, but my candid opinion is that it will be done, and that it is a much more intricate problem than to cause a wheel to revolve without any external aid. Please use the correct title of my machine as given above, as I have nothing to do with perpetual motion. My machine will work as long as a steam-engine. Nothing more could be desired.—Yours, etc.,

ARTHUR E. GILBERT.

Heaton, June 15, 1901.

[N.B.—We much regret that Mr. Gilbert's motor had parts twisted in transit.—ED. *E. E.*]

PREECE'S WIRELESS TELEGRAPHY.

SIR,—With reference to your interesting article on the above in your last issue, possibly you could allow me to put forward one or two suggestions for its possible improvement. If your map showing the position of the circuit on the Rathin Island and the mainland is correct, then it would appear that the paralleling of the two wires is *not* by any means the best. I should take it that the perfect paralleling of the wires would be one of the first essentials to the successful working of the system, so that the electric waves passing off at right angles from one wire would meet the other wire at right angles, and be picked up by them. The better the two wires run parallel with each other, the better would be the action at the receiving wire.

Another suggestion is that the two copper wires should be nickel plated or galvanised, say, every alternative yard or two yards—that is, one or two yards plated, then one or two yards bare, then, again, one or two yards plated, and so on. Or, better still, have two wires on the island and two on the mainland, one wire to be of pure copper and the other nickel-plated, or a galvanised copper wire, the copper wire to act as a transmitter, as unquestionably copper is the best for such purposes, and the plated wire to act as a receiver. The electric waves from copper would more powerfully and promptly affect any white metals than copper upon copper only. In fact, all electrical work is more or less confirmation of this idea—instance the electric cell, the dynamo, Marconi's wireless telegraph, etc., wherein one metal affects an electrically opposite metal.

Possibly, if the above suggestions were put into practice, the receiving current would be sufficiently improved to affect a galvanometer, or very sensitive electric bell, on the Rathin Island installation.—Yours, etc.,

GEO. H. SMITH.

37, Daniel-street, Cardiff, June 17, 1901.

N.B.—Could you or any of your readers inform me where I can obtain particulars by post of the "*Nobel*" *prizes* that were bequested by the late Dr. Nobel, the inventor of dynamite, etc, and which prizes are offered for four or five of the greatest inventions in the sciences and arts. I am anxious to become a competitor, hence my enquiry. A reply will oblige.—G. H S.

FORTHCOMING EVENTS.

FRIDAY, JUNE 21.

Municipal Electrical Association.—Third day of the annua convention at Glasgow. The meeting closes to-morrow (Saturday).

SATURDAY, JUNE 22.

Institution of Electrical Engineers.—Visit to Germany.

Sports.—Annual sports in connection with Messrs. Crompton and Co.'s Arc Works at Chelmsford.

FRIDAY, JUNE 28.

Physical Society.—At 5 p.m., ordinary meeting in the Wheatstone Laboratory, King's College. Papers: "The Effect of a High-Frequency Oscillatory Field on Electrical Resistance," by Mr. S. A. F. White; "The Spectrum of Cyanogen," by Mr. E. C. C. Baly and Dr. H. W. Syers.

Society of Arts.—At 9 p.m., annual conversazione at the Royal Botanical Gardens.

TYNESIDE ELECTRICITY WORKS.

(Concluded from page 897.)

The British Thomson-Houston Company, Limited, did all the switchboard work in connection with this installation, besides supplying the motor equipment of the works. There are eight spur-driven winches, the electrical equipment of each consisting of a three-phase induction motor with necessary controlling gear and resistance, the whole gear being entirely enclosed by sheet-iron covers. Each winch is capable of lifting three tons at 50ft. per minute, and capable of running in either direction at varying speeds, all motions being controlled by one handle. The cables to the various winches are laid underground in wood troughing, and run in with bitumen to guard against injury. The lighting of the works is on the 240-volt two-wire system, and consists of 50 arcs and about 250 incandescent lamps. This installation represents an aggregate of about 400 h.p.

Another considerable installation is that in Messrs. Wigham, Richardson, and Co.'s Shipyard and Engineering Works, the overhead transmission lines to which are shown in Fig. 17. This comprises a motor-generator of 75 kw. capacity, and transformers of 110 kw. capacity, supplied by Brown-Boveri through Messrs. Richardson, Westgarth, and Co. The works plant includes four three-motor overhead travelling cranes, dealing with 14, 10, and 6 tons respectively. There are also 50 five-ampere Angold enclosed arc lamps—two in series on 240 volts—and over 500 incandescent lamps distributed about the works. The plant connected, exclusive of this lighting load, aggregates

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500 h.p. It may be mentioned that the erection of the plant in each of the motor installations described was carried out by the British Thomson-Houston Company, Limited.

In addition to the motor load already connected, which, it will be gathered from the foregoing, aggregates some 3,000 h.p., and prospects of a further demand in the same direction, there will be also the area at present supplied from the company's alternate-current station at Pandon Dene to provide for. The high-tension transmission line to Newcastle for this purpose is already in hand, as mentioned elsewhere, and a low-tension three-wire network of mains will be gradually laid over the area, while at the same time the generating station at Pandon Dene will be converted into a main sub-station similar to the one already described, whereby the existing supply will be ultimately displaced by a low-tension continuous-current supply. The cost of conversion is estimated at the rate of 2s. 9d. per lamp connected. Thus it will be seen that, besides a very promising day load represented by the power installations on Tyneside, a large night load is also ready to hand, there being the equivalent of between 70,000 and 80,000 8-c.p. lamps connected in the company's Newcastle area.

The future policy of the company further embraces a proposal to construct a system of electric tramways, as shown on the accompanying map (Fig. 18). It will be seen that the intention is to join up to the Newcastle Corporation tramways at three points on the Newcastle side and to the system worked by the British Electric Traction Company on the Tynemouth side, thus connecting these two systems by means of a link running through a sparsely-populated portion of the company's area of supply. No doubt such a scheme would incidentally lead to the opening up of this sparsely-populated district for building purposes, etc. It should be mentioned, however, that the sanction of Parliament to this scheme has yet to be obtained. When complete, the undertaking, should, therefore, contain that element most conducive to the success of such a scheme—namely, a satisfactory load factor. With cheap coal into the bargain—5s. per ton being about the average price, we believe—and other natural advantages of position, etc., there should be little doubt as to the ultimate success of the supply from a financial point of view.

With regard to the large power plants supplied with energy from the company's mains, it may be mentioned that the company undertake to bear the initial cost of installation and to maintain the plant in consideration of a charge at the rate of 15 per cent. per annum on the initial outlay. Of this 15 per cent. one-third represents interest on capital outlay; another third, rental of the installation; and the remaining third, depreciation. After a period of 20 years the installation becomes the holders' own property. In other ways the company are encouraging the use of electricity as a motive power, and, amongst other things, will endeavour to displace the steam-hammer so extensively used in the district by one using compressed air supplied from a motor-driven compressor. When in Newcastle recently we saw one of these air-hammers at work, and so far as we could judge, its action and control left nothing to be desired. There is undoubtedly a wide field for the use of electrical power in this direction, especially around Newcastle, and no doubt there will also be less steam wasted at some of the surrounding collieries as the supply of cheap electrical power becomes available.

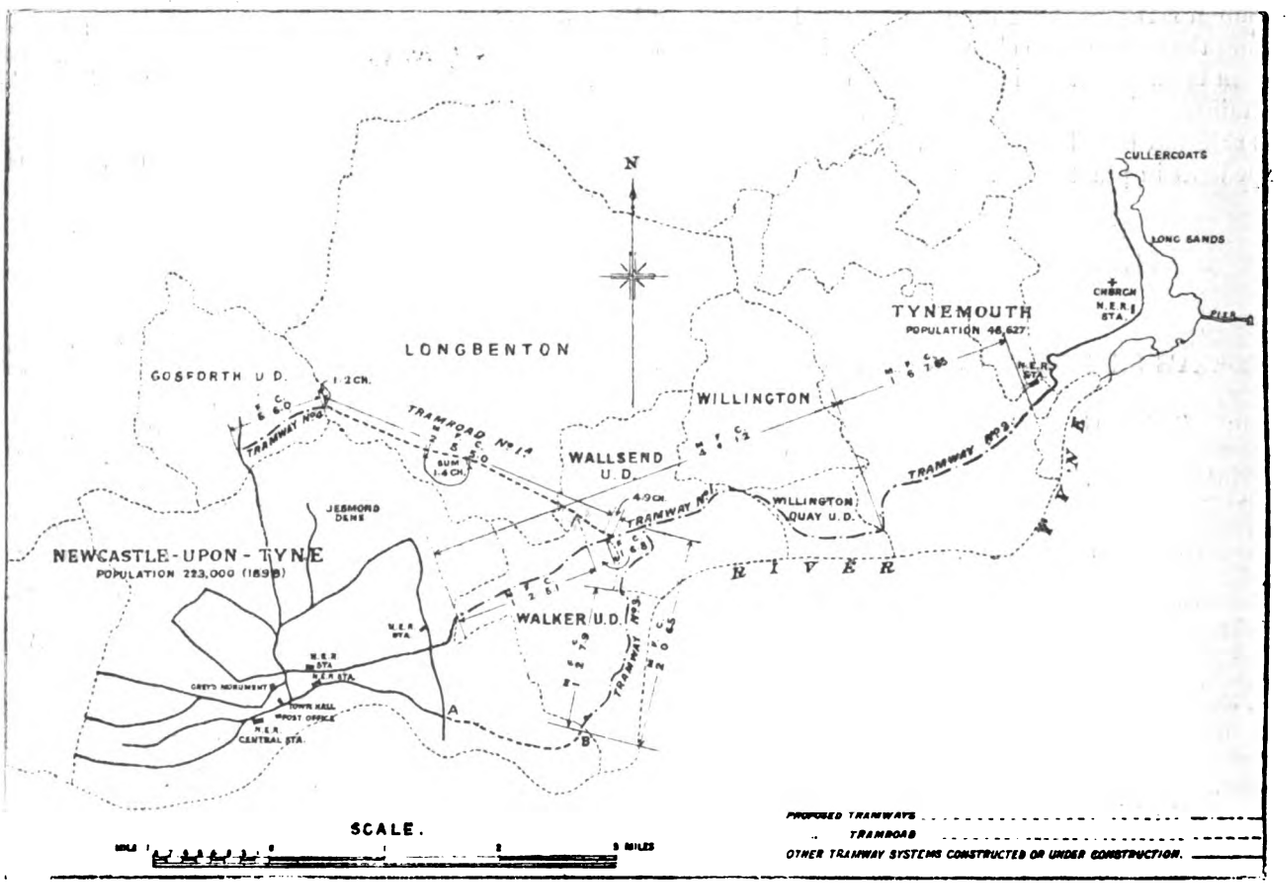

FIG. 18.—Map of Proposed Tramways.

In conclusion, we have to thank the consulting electrical engineer, Mr. Charles H. Merz, and some of the principal contractors concerned for their courtesy in placing at our disposal the particulars given above.

Opening Ceremony.

The formal opening of the above-described works by Lord Kelvin duly took place on Tuesday last, when a special train conveyed a large number of guests to Carville Station, where carriages were ready to take them to Neptune Bank power station. An inspection of the power station and various installations supplied with power, including that belonging to the North-Eastern Marine Engineering Company, was then made. Sir Andrew Noble presided at the luncheon subsequently given at the Drill Hall, Walker. In declaring the electric supply, Tyneside, open, Lord Kelvin said the beginning witnessed that day was on a scale which a few years ago would have been considered very large, but which the Newcastle Electric Supply Company now regarded as only a small part of what they were going to do. They

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had seen the North-Eastern Marine Engineering Works using low-pressure continuous current. They would understand that there might be a reason for choosing continuous-current motors. A great deal of work had to be done at various speeds, and the machines must go fast or slow. That, he believed, was the governing reason. In the present state of electric practice it was not quite so easy to run a three-phase motor exceedingly slow, and at all different speeds, up to the maximum speed with good economy. The Northumberland Shipbuilding Company's yard was interesting, because all the power work done in it was by three-phase motors. Although they had known for years that the three-phase motor was an exceedingly good thing, not many of them had seen much of it at work. It was interesting to note that the three-phase system of distribution gave absolutely fair play to either direct current for the lighting of towns, and for the use of small motors, or for the largest motors. A great boon had been conferred on Great Britain by the work that was now inaugurated.

MUNICIPAL ELECTRICAL ASSOCIATION.

Glasgow Congress.

The sixth annual congress of the Incorporated Municipal Electrical Association was opened in Glasgow on Wednesday last. The president, Mr. W. A. Chamen, took the chair at 10 a.m. at the Institution of Engineers and Shipbuilders in Scotland, and introduced the Lord Provost of Glasgow to the members present.

The LORD PROVOST extended a hearty welcome to the members of the association to Glasgow on behalf of himself and the City Council. They recognised the valuable work done by the association, and the importance of keeping electrical undertakings in the hands of municipalities. He believed that the supply of electrical energy from central stations was still in its infancy, and that they had hardly yet crossed the threshold of the large and valuable field over which electricity would have to be supplied in the future. He wished the association an even richer and wider success than they had yet achieved. As regards Glasgow, they hoped that the good weather for which that city was noted would continue, but in any case the hospitality of the city would be extended to the members of the association.

Mr. W. A. CHAMEN then proposed a vote of thanks to the Lord Provost for his kindly greetings and for finding time to come to the first meeting of the congress.

In reply to acclamations, the LORD PROVOST said that they were pleased to find Mr. Chamen elected president of the Municipal Electrical Association. They had in Glasgow a high opinion of their electrical engineer. When the post was vacant the Corporation determined to get the best man, and they believed that they had succeeded in so doing.

Mr. W. A. CHAMEN blushed, and then read the following address:

Gentlemen,—I have to congratulate you upon the incorporation of this association. We are starting into a new century and into a new reign as a newly-incorporated body. Drawing up the memorandum and articles of the association has been a work of great labour, and has extended over some considerable time. Our hon. solicitor, Mr. Alderman Pearson, has carried the whole matter through for us in a most admirable manner, and we owe him for his toil and patience a great debt of gratitude, which we shall find it hard to repay by anything that we are able to do in return.

On looking over the addresses of the last two presidents, I find that the affairs of the Municipal Electrical Association and its work have been so fully and so ably dealt with, and that so many of the points indicated as requiring attention and providing work for the association still occupy those same prominent positions, that I would ask those of you who were not present at the last two conventions to obtain copies of the *Proceedings* for the last two years from the secretary, if you have not already done so, and to read over those two addresses. I do not propose in this short address to draw your attention to the brief but important history of the Municipal Electrical Association and to its rapid progress, as was so very clearly done by your much respected past-president, Mr. Mountain, to whom so great a measure of the success of this association is due, owing to the unflagging energy he displayed from the start as your first honorary secretary. I have, however, to congratulate you on the further large increase of membership from 77 committee members at last convention to 99, and from 142 engineer members of all classes to 165 at the present time, our present total membership being thus 264, or an addition of 55 since last convention. This increase must be considered most satisfactory, and I think there are indications of a still further considerable increase during the coming year. I regret that we have to record the loss by death of one member—Mr. A. H. Roe, of Bury St. Edmunds.

We have suffered some losses through members resigning their positions as corporation engineers to take up posts with companies or to practice as consulting engineers on their own account. More especially have we to lament in this way the loss of Mr. C. H. Wordingham, who was president, I believe, during the second year of our existence, and who was one of the founders of this association. This is indeed a great loss to us, for the energy and ability which he brought into our meetings was of a kind not easily replaced. Mr. Wordingham was also treasurer of the Benevolent Fund, which owes its existence, I think, almost entirely to his efforts. Though not now one of us, I am glad to tell you that he continues to take great interest in our doings, and he has promised that he will, whenever possible, attend our conventions and join in our discussions. I am sure we will wish him that success in his new departure which he so well deserves.

I have to draw the attention of our associates to the fact that there has not been that enthusiasm displayed by them in sending in papers competing for the prize offered by the association, in consequence of which for the present year the council have been obliged to suspend the award of the prize. This is a matter which I trust will receive your attention, and be discussed at the business meeting on Friday evening.

You will have observed from the programme that there are fewer papers to be read and discussed at this meeting than there were at last year's convention. I believe you will all agree with the council in thinking that it is better to have fewer subjects before us and longer time for discussing them, and that it is more satisfactory for the papers to be read to the meeting by their respective authors than to be held as read and discussed forthwith. The council feel that we are likely to get far more useful discussions in this way, as all present will at least understand what it is that is being discussed.

As already indicated, I do not propose in this short address to touch upon all the subjects which appear to require during the present year the attention of this association, as they have been already so clearly pointed out by your two past-presidents, Mr. Faraday Proctor and Mr. Mountain; but I ought, perhaps, to emphasise one of them—viz., the suspension of payments to sinking fund during course of construction and for two or three years afterwards. Many municipal electrical undertakings are feeling the burden, and, I may say, the unfairness of being taxed during the first few years of their existence, while they are in a state either wholly or partially unproductive of revenue, by being compelled to pay from the start their annual contribution to the sinking fund. While it is, of course, necessary that Parliament should take steps to ensure the paying off of the debt in a proper time, it does seem that it is rather unreasonable to enforce this annual payment from the very start of the undertaking, when it must be so obvious that the concern has had no time or opportunity to bring in a revenue at all proportional to the capital which has been expended upon it. This question is now actively engaging the attention of the council, and I do not know that I need to say more about it here except to point out that it also arises in extensions of existing undertakings into new areas not previously supplied, and which require not only new mains, but new generating stations, and, in fact, a new start and new loans for that specific purpose.

There is, however, one point which has not been touched upon by your two past-presidents, but which I should like specially to bring before your notice. I refer to the question of systems of charging for electricity. Doubtless this is a dry and uninteresting subject, and many of you will think that I might have chosen some engineering point arising out of the experience gained in carrying out the large new electricity works which have been now nearly completed in this city, or in carrying on the supply from these works. Well, gentlemen, that, after all, is what I have done. We engineers naturally love our machinery, our mains, and our whole plant, but we soon find that our attention gets drawn also to other things, and chiefly to that all-important question of money. It is of no use to leave this question to the purely commercial people. If we do so they soon come to us and say, "How is it that you are always asking for more machinery, and thus wanting to increase the capital expenditure? Why won't you get more units out of the plant you have already installed? The undertaking grows it is true, but if you go on at this rate we shall never get the price down. What is the meaning of it?" You all know the answer. The poor engineer has to say, "Well, every winter the maximum load goes on increasing, and we must have the

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TABLE A.

Class.	Hours.	Number of units used by each class.	Standing charge.	Total coal bills.	Total charge.	Average per unit stated in pence.	Level rate of 1·84d. Total bills.
Street lighting	10½	3,832	£8 3 0	£8 1 10	£16 4 10	1·02	£29 6 10
Public-house	5	1,825	8 3 0	3 17 6	12 0 6	1·57	14 0 0
Restaurant	4	1 460	8 3 0	3 12 11	11 15 11	1·94	11 4 0
Domestic consumer	3	1 095	8 3 0	3 2 11	11 5 11	2·45	8 8 0
Theatre	2	730	8 3 0	2 6 10	10 9 10	3 42	5 12 0
Office	1	365	8 3 0	1 5 6	9 8 6	6 14	2 16 0
		9,307	£48 18 0	£22 7 6	£71 5 6	—	£71 6 10

plant if we are to meet the maximum demand that will be made upon us next December." If the engineer leaves the matter at that, the commercial man goes off grumbling, and saying that "he supposes it can't be helped, and that the electric lighting is a poor business," and so the matter ends for the time being.

Many of my colleagues in this association have, however, not been content to leave this question undealt with, and have set to work to explain that it is only for about three or four months in the year that the machinery is all at work, and then only for a few hours each day at anything like full load, so that the only way in which more units can be got out of the plant is by finding some demand which shall make longer use of it. The commercial people see this, and try systems of discount in order to encourage large consumers, but still the trouble remains, and the engineer gets disliked for pointing out a difficulty and suggesting no remedy. The whole business, therefore, settles comfortably down on his shoulders, and he has in the end to suggest some remedy.

The question of price at first sight seems a very simple matter. Total up the cost of coal, wages, repairs, and petty store bills for the year, and add all the capital charges—*i.e.*, interest and sinking fund—and the management expenses; divide this sum by the number of units sold, and the result is the *cost* per unit. Add to this whatever margin is deemed necessary, and the result is the price per unit. Such a method of arriving at the selling price of electricity possesses one advantage—viz., that it is simple. That, however, seems to be all that can be said for it. It is known to everyone that, as a rule, the greater the quantity of any commodity that can be sold the lower will be the cost of producing it, but the real reason why this is so is understood by comparatively few. There is, for instance, the well-known tale of the old woman who said that she made a loss on every article she sold, and that it was only the quantity of business she did which enabled her to get a living. As she is not commonly reported to have become bankrupt, it is presumed that she had grasped the principle correctly, but was not able to understand the exact way in which it worked, or, at any rate, to properly express it in words. Doubtless she would have lost heavily if she had not been able to sell the quantity she spoke of, and for a sale of half that quantity she might have required to increase the price in order to make any profit, or, indeed, to avoid making any loss, so that up to that point she was correct in saying she made a loss on every article she sold. I do not think this old woman ever sold electricity, but I have no doubt that if that problem had been thrust upon her she would have displayed the same sagacity, and would have adapted herself to the altered circumstances. She might have been a most useful member of an electricity committee.

We may here note a few facts before proceeding. I quote figures from the electricity department of Glasgow as being the readiest at hand. The number of units of electricity sold during the year just concluded (May 31) was, roughly, 6½ millions. The maximum load occurred during November, December, and January at 5 o'clock on each night except Saturdays and Sundays. The plant used (allowing ample spares and stand-byes) if continuously in use at full load would have produced some 81 million units in the year, and this extra 74½ million units could have been sold probably at a profit to the existing consumers if they could have taken it for the low price of about ½d. per unit without any additional capital expenditure or increased management expenses of any kind. Of course I do not suggest that we could ever hope to sell such a quantity as this, but there is a long stretch between 6½ millions and 81 millions, and we might sell more than we do. Let us look a little more closely, though briefly, into some of the figures. The cost of buildings, plant (including spares), and mains, run out at present at about £114 per kilowatt. This figure, of course, varies from time to time, and will go down again when fair proportions become established between the cost of sites, buildings, machinery, and mains, perhaps to £80 or less. It is already down to about £104. This, however, does not affect us just now. The standing charges—being interest, sinking fund, wages, rents, rates and taxes, management expenses, and repairs—amount together to, say, £8. 3s. per kilowatt per annum. This figure is arrived at by taking out the individual maximum demands of the consumers and dividing the total standing charges by the sum of them. You will note that the sum of the consumers' maximum demands is greater than the actual maximum demand upon the generating plant by about 25 per cent., which we may take to mean, roughly speaking, that some 25 per cent. of the consumers either do not come on at all or, at least, not to their full extent until after the time of maximum demand upon the generating stations is past. You will note, therefore, that in apportioning the standing charges per kilowatt due allowance is made for this fact, and the standing charges are less than they would be by about 25 per cent. on account of this diversity factor. This shows the advantage which consumers get by taking the supply from a common source. Let us now consider a few different classes of consumers and see how they use their light, taking in each case their maximum demand, for the sake of argument, as 1 kw., and finding out what number of hours used per day the quantity of units they each consume is equivent to, spreading our investigations, of course, over the whole year. We find the following:

	Hours per day.	Units per annum.
Street-lighting (all night)	10½	3,832
Public house	5	1,825
Restaurant	4	1,460
Domestic consumer (say)	3	1,095
Theatre	2	730
Office	1	365
Total		9,307

These figures are simply examples being easy to follow, but they are not quite accurate. For instance, many of the offices average less than half an hour, while domestic consumers average only about 2½ hours, but we need not worry about fractions for our present purpose. Suppose we had a small concern with these six different consumers as partners. The maximum demand of each is the same—viz., 1 kw.—and the standing charge of £8. 3s. incurred by each, quite irrespective of the amount of electricity consumed, and we have already seen that by combining together this standing charge is reduced below what it would be if each had his own plant, owing to the fact that the theatre does not want light when the office does, and that the domestic consumer also does not fully light up when the others are at their maximum. It seems to me, therefore that these partners as ordinary business men would each agree to pay £8. 3s. per annum in a lump sum plus the working costs according to the number of units consumed in each case.

Let us look, however, at the question of coal. I am obliged to put before you some figures obtained some time ago, which while they certainly would be somewhat less at the present time, will serve for our present purpose. The cost of coal per unit for the various different classes of consumers is greater for the short-hour ones than for the long-hour ones, owing to the waste which occurs in getting up steam for such short runs and in running plant at light loads. From careful tests which have been made, I believe that the following would be about the proportions of the cost of coal for the different consumers:

	Per unit (d).
Street-lighting	·51
Public-house	·51
Restaurant	·62
Domestic consumer	·69
Theatre	·77
Office	·84

These costs include carting and handling of the coal and removal of the ashes, etc.; the street-lighting should really be a lower figure, but no information was at hand at the time the figures were obtained, so that it was put in the same as for a five-hour consumer. (In passing, I may say that during the past six months one-third of the coal we have consumed had been wasted practically through intermittent and varying loads.) If we now make up the accounts for these six consumers, we find they come out as given in Table A. It may be objected that I have not taken into account water, oil, etc., but these are small, and will make no material difference to the result. You will observe that the street-lighting consumer pays an average price of 1·02d. per unit, and the office an average price of 6·14d. per unit, and that the other consumers vary between these two extremes. It seems to me that for lighting purposes this method of looking at the matter is a fair and just

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one. An electrical engineer of long standing made the following remark in discussing this troublesome question with me some few months ago: "There are," he said, "two principles upon which consumers can be charged. One is that of dividing the total costs for the year by the number of units sold—that is to say, to charge an average price (which works out at about 4d. per unit). The other is that of approximating the charge to each consumer to the cost of supplying him." I think that expresses our position exactly; but which of these principles are we to work upon? I have shown you in a rough-and-ready manner, without any pretence, of course, to a close degree of accuracy, how the costs per unit must vary between very wide limits, and this mostly on account of the very short use which is made of the plant by many of the consumers. If you take out the average cost per unit from the table I have given you, it will come to only 1·84d. per unit. If you charge this uniform price, however, you will be charging the street-lighting with over £29 instead of £16, and the office will be let off with £2. 16s. instead of paying £9. 8s. 6d., and you must remember that in actual fact the proportions of these different classes of consumers are by no means what are given you in this table. Which of us can show one-sixth of our maximum demand occupied in street-lighting and another two-sixths in five-hour and four-hour consumers? If you take my table and adapt it to your own circumstances, I do not think any of you will be able to work out an average of 1·84d. per unit. By using a sliding scale of charge in Glasgow, the cost of producing our 6½ million units in the year just concluded works out at about 3·18d. per unit, or perhaps less, and we have estimated on selling 9,000,000 units for next year at an average cost of production of 2·61d. per unit. The charges are 6d. for the first 365 hours' use per annum of the maximum demand, and 1d. thereafter, with, however, uniform rates of 3½d. for domestic consumers, theatres, and halls, 3d. for churches, and 1½d. for power. Many of our consumers, however, will be paying only about 2d. per unit for lighting under the sliding scale. Do you think we should be able to keep them at 3½d. or, perhaps, 4d., or do you think we should go on increasing our output at the rate of 50 per cent. per annum, as we have done for the last two years, if we reverted to a uniform rate? I am afraid we should not.

Power supply seems to me to be a different question, not simply because it is a day load and in use, perhaps, more in summer than in winter, but because there is no natural law which forces it to come on at a maximum far in excess of its normal at any particular time of the day, a feature which is so very strongly marked in the case of lighting. The diagram shows in dotted lines the total load curve, which includes both electric lighting and power, on a day in last December, and you will observe how sharp a peak occurs about five o'clock. What is the reason of this? It is probably that the very short office load and the early-closing shop load are both just on in addition to everything else. Business men are in signing their letters, and clerks are all hard at work finishing off with the greatest possible haste lest they should be guilty of any unpunctuality in getting away at the usual time. At this time probably every light in these offices is in use, though only for a very short time, for shortly after six o'clock the load is down again to a much lower point. In the summer and during the greater part of the year this does not happen. As soon as daylight draws out to five o'clock this nightmare of a load is gone until next winter. In Glasgow we have a load of this kind to the value of about 1,540 kw.—*i.e.*, we have consumers of the very short-hour class, who require this amount of plant to supply them, and whose average use per day is just half an hour. They consume 248,343 units per annum, which brings in at 6d. per unit the sum of £6,208, or about 3·7 per cent. upon the capital expended to supply them. It is certain that if there were no consumers using current for longer hours than these the concern would become bankrupt in a very short time, even with a charge of 8d. per unit. I need not point out that this five o'clock peak contains practically all our consumers, except churches, theatres, halls, and places of amusement, and domestic consumers to some extent, as they do not light up fully as a rule until later. In fact, all but 25 per cent. are drawing a supply at this time. The conditions under which light is required cause this awkward peak, and they cannot be altered. The proportions of the peak to the whole diagram can, however, be reduced by getting on a greater number of consumers who use current longer. Power supply is a most excellent way of producing this result if we can get enough of it. In Glasgow up to date we have about 1,894 h.p. connected to our mains. It does not cease at five o'clock in the winter, and does not therefore simply fill in our load diagram in the shallow places. If it did this, it might enable us to charge a uniform rate for everybody. It has no peak of its own, however. It goes on from morning till evening with some variations, of course, due to those motors which are used intermittently, but these variations average out in a reasonable way, as there is no circumstance which compels nearly the whole of the motors, whether in continuous or in intermittent use, to come on together either at five o'clock or at any other time. If we had a power load only to deal with there would not be this peak trouble, and it would seem possible, saving only that a maximum charge of, say, £2 per annum should be made to cover interest on cost of meter, etc., to do all that can be wanted for all ordinary purposes by means of a scale much more nearly approaching a uniform price than the lighting one. For any purpose requiring a supply for 24 hours per day, it would seem to be unfair to make the same charge as for such intermittent use as is experienced in the case of hoists, so that an absolutely uniform rate might not be found satisfactory.

There has been an attempt to arrange a sliding scale of charging by means of meters which work on a different dial at certain hours, so that all units recorded on the second dial can be charged for at a higher price, these being the units consumed on the peak load; but up to the present no one has succeeded in producing a sufficiently cheap and satisfactory two-rate meter, so far as I am aware. Besides, if the system comes to be closely enquired into, I think it will be found that it does not fulfil the necessary requirements, and also that it is very difficult to decide as to how the arrangement should be worked during other months of the year than November, December, and January—that is to say, if the maximum price is to be charged between the hours of 4 and 6 p.m. during these months, during what hours is it to be charged in the other months of the year? It does not seem to me to take a grip of the correct principle, for it would result in charging a long-hour consumer the additional price during part of the 24 hours for the simple reason that somebody else wants to make use of the plant which is supplying him, and makes him pay extra for the other consumers' shortcomings. I must admit that I have not had occasion to think out this system of two-rate meters fully, but I simply mention it as one that should receive consideration in dealing with this subject. It may be that there are ways of getting over these difficulties.

You are aware that the Power Bills which have been recently passed by Parliament contain clauses to the effect that for the first 400 hours' use per quarter of the maximum demand quantity, the price shall not exceed 3d. per unit, and that for all further quantity the price shall not exceed 2d. per unit. This is very taking to the public eye, but where is the magic wand which enables the power companies to produce energy so wonderfully cheaply while we are unable to do so? The trick is very simple. There is no deception. The Bills contain other clauses which allow the companies to pick and choose their consumers and to make contracts with them in a way we cannot do. Of course, the companies say they do not want to supply light, and would not on any account wish to interfere with the corporations who already do so. They obviously wish to get the supply of power, and would willingly come into any municipality and supply it at low rates, leaving the corporations to supply light at much higher prices, which however, might still not pay. They are willing to supply light, too, under certain conditions if asked, and no doubt the price would be a favourable one; but what would the conditions be? They would be found to work out so that only long-hour demands, such as street-lighting or other all-night lighting, could be supplied under them. Is it not, therefore, a question whether it is right to allow these Bills to go through in this way? Surely the fact that they are tied down in price is against the general public interest. It would have been better, it seems to me, to have allowed them a higher maximum price, and to have bound them down closer to supply, on a sliding scale, the general wants of the community no matter whether for lighting or power. I would, in fact, put it to you that while, for power purposes only, the 3d. and 2d. tariff may be good enough, there should be in all these Bills a special scale for lighting, not perhaps with a maximum price per unit at all—for that may work unfairly to the company—but with a fixed charge per kilowatt per annum of, say, £8 or £9, or such other figure as may be found necessary, and 1d., or perhaps 2d., per unit for all current supplied. This is the principle first enunciated, I believe, by the late Dr. John Hopkinson. The principle of fixing a maximum price per unit, at any rate for lighting purposes, does not seem to me to be a desirable one at all, and it introduces complications in accounts which are entirely avoided by the other method, and at the same time there is a simplicity and justice about the £8 per kilowatt of maximum demand per annum which I have always found consumers of the longer-hour class to understand very readily. The fixed charge may be called a "plant rental," being, in fact, nothing but a rent for the plant which they use, and which must be kept for their use whether they want it all the year round or not. If you explain to a house factor that not paying the "plant rental" when you do not want to use the plant is like declining to pay a proportion of your house rent for such time as you may be absent at the coast or elsewhere in the summer, he takes in the situation at once.

The question of storage might under different circumstances affect the matter to some extent, but so far as I have been able to see, there is not much assistance to be got in that direction at present. I am indebted to Mr. Wilson for the gas load diagram now before you. It is taken from the Dawsholm Gas-

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works, Glasgow, on a December day. The straight line across the sheet shows the "make" of gas. Storage in this case is an immense advantage, but we must not jump to the conclusion that storage would get us out of our difficulty as regards system of charge. Look at the whole diagram. It is so different from ours presumably because of the almost universal use of gas, owing to which a much better average load or load factor is obtained. It is probable, too, that our existence is of some assistance to the gas undertaking, as we have relieved it of so many of the short-hour and unprofitable consumers. It is not to be expected that our gas friends will take any great amount of pleasure in perusing our sliding-scale arrangements, because by means of them we shall probably obtain more long-hour consumers, and help to relieve them of some of the profitable as well as the unprofitable ones.

I ought, before concluding, to mention the name of Mr. Arthur Wright, our first president and the inventor of the maximum demand indicator, an instrument which has been of great assistance in the arrangement of sliding scales in the most equitable manner, by enabling us to charge only upon the actual maximum demand the consumer makes and not upon the size of his installation. I do not know whether I have succeeded in making the reasons for a sliding scale and against a uniform rate any clearer than they were, but the matter does seem to be of such importance that I hope some of you will take it up, and perhaps read a paper at our next convention, so that we may get a good discussion upon it.

Alderman BROWN, of Sunderland, rose to propose a vote of thanks to the president, and to request that the address might be printed in the *Proceedings* of the association. The need for a varied system of charging and the importance of the subject was shown by the fact that the Glasgow plant could generate 81 million units with its plant in one year, whereas only 6½ million units were required. He felt that the association were greatly indebted to Mr. Chamen for the clear and able way in which he had presented a most pressing subject.

Councillor J. GREEN HIRST, of Leeds, seconded the motion, which was carried by acclamation.

Mr. W. A. CHAMEN, in reply, said he hoped that the subject of his address would be taken up by someone in a paper at their next annual congress, so that a full discussion on the best system of charges might take place. He had only been able to briefly refer to the general principles involved, and hoped to give more details at such a discussion.

(To be continued.)

LEGAL INTELLIGENCE.

ST JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY.

In the High Court on Saturday, Mr. Justice Cozens-Hardy heard an application under the Memorandum of Association Act of 1890 to authorise the St. James's and Pall Mall Electric Light Company, Limited, to alter its memorandum by giving the company power to guarantee the repayment of the principal moneys and interest to secure the debentures of a company to be formed for similar objects to the applicants' company. It was explained that the St. James's Company required power to guarantee the payment of the capital of the Central Electric Supply Company. The banks had refused to advance any money on a guarantee for the interest alone. The amount required for the purchase of the land and the erection and equipment of the generating station was £350,000.

Eventually his Lordship granted the application, and confirmed the desired alteration.

BERRENBERG ELECTRIC LAMPS.

In the Chancery Division of the High Court, Mr. Justice Cozens-Hardy had the case of Glasier *v.* Berrenberg Electric Lamp Syndicate before him last Friday.

From the statement of counsel, it appeared that the plaintiffs are holders of 12 debentures of £100, which were issued by the defendant company in July last year. It was provided that the interest should become due on Dec. 31 last, but no interest was paid. Plaintiffs asked for the appointment of a receiver and manager, and defendant company not opposing, the application was granted.

SMOKE NUISANCE.

An action brought by Messrs. Hobson and Sugden, property owners, against the Buxton Urban District Council for allowing the chimney at the electricity works in Ashwood Dale to send forth black smoke in such quantities as to constitute a nuisance, came before the magistrates at Buxton on Saturday. It was stated for the prosecution that Buxton based its claims to patronage to a large extent on the purity of its air. The Council's solicitor contended that everything that was possible was being done to reduce the volume of smoke, and that the electrical engineer to the Council was of opinion that he had found a remedy for the nuisance. A fine of 10s. and costs was imposed

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers.

QUESTIONS.

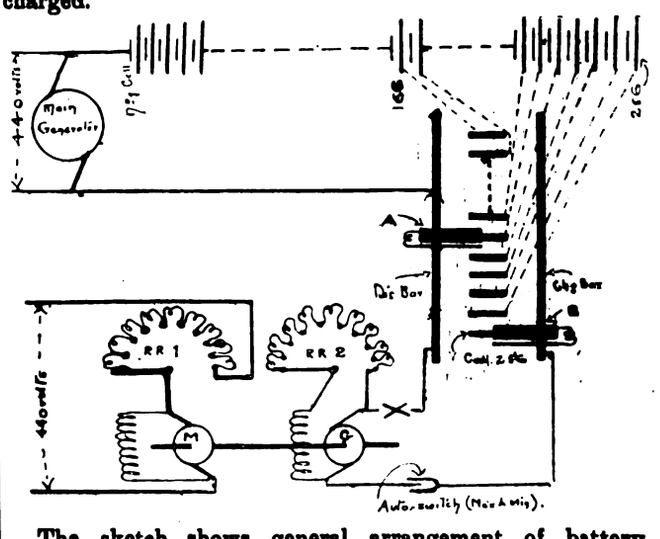
387. It is contemplated to transmit power to a direct-current lighting station a distance of five miles, by means of three-phase alternating current at 10,000 volts pressure. Which of the following systems of conversion would be best: (*a*) synchronous motor-generators; (*b*) asynchronous motor-generators; (*c*) transformers and rotary converters. Consider capital cost, over all efficiency, and practical ease and safety in working.—E. D. W.

388. In a large continuous-current central station it is believed there is a consumer using his current to earth. Which is the best way to detect and locate consumer?—A. F.

ANSWERS.

Question No. 381.—On a three-wire system, when the balancing set is shut down for repairs, and the remainder of the set is connected across the outers at 440 volts, and the motor-transformer is connected up for charging the regulation cells only, what would be the best method of charging up the main battery?

Best Answer to No. 381 (*awarded* 10*s.*).—The questioner does not state whether the battery is connected direct across the outers or as two distinct batteries each across outer and middle; also what type of regulating switch is employed, and should not motor-transformer read motor-generator? We will, however, assume that the battery is across the outers, and at 440 volts there are probably about 256 cells. Of these, say 166 comprise the main battery and 90 are connected up in threes as regulating cells on a 30-point regulating switch. We will also suppose that the motor-generator will give a voltage equal to about two-thirds of the regulators when fully charged.



The sketch shows general arrangement of battery regulating switch, connections of motor-generator, etc. In commencing charging operations, place right-hand switch, B, on contact on which discharge was stopped (say discharge was stopped on 256 cells); then work left-hand switch, A, up until the correct charging current is reached (the main generator voltage, of course, being kept constant). The motor-generator should now be started, and generator run up to voltage corresponding to the

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number of cells between the two switch points, A and B, switched in circuit, and current brought up to working point by means of the regulating resistances, 1 and 2. The charging current would now be kept constant by working left-hand switch, A, and regulating resistances, 1 and 2. As end cells commence to gas, cut out by right-hand switch, B.—S. LEES.

Answer to No. 381 (*awarded* 5*s.*).—It is not quite clear from the question whether the balancer is a motor-balancer, or if it is used to drive the boosters for charging the top cells or steam balancer, and separate motor-generator for charging the top cells, with the remaining machines wound for 440 volts. Whichever it may be, if the balancer is shut down the balancing must be done with the cells. If the machine for charging the top cells is separate from the balancer no great difficulty should be experienced, especially if the balancer is not far out; and it may be mentioned that some stations depend entirely on the cells for balancing, charging the top cells from a motor-generator. All that is necessary to do, then, is to cut out cells till the correct charging current is reached on either side. If you are 10 amperes out of balance on the − side, to keep the balance the + side will have to have 10 more amperes than the − side, and so on. If the balancer consists of two separate steam dynamos, one of which is stopped for repairs, the other could be run on the heaviest loaded side so as not to give the battery too much balancing to do. Suppose that you were out of balance 80 amperes on the + side, and that the normal charging current of the battery was 60 amperes, if you gave the − 60 amperes the + would have to discharge 20 amperes to keep the balance, but if the balancing dynamo was run up on that side the cells could be charged as easily as if both machines of the balancer were running.—C. L. E. S.

Answer to No. 381 (*awarded* 5*s.*).—Owing to the minute particulars given with this question, it will perhaps be somewhat a difficult matter to describe fully what might be done to overcome the difficulty mentioned. It is therefore assumed in this answer that the large sets are coupled direct across the outers at 440 volts, and the balancing arranged to take place at the station end, there being no booster sets, but simply a motor-generator coupled to the regulating cells at the third wire—*i.e.*, the neutral. If the balancer is broken down it is evident that the work of balancing must be done by the battery, and should the load be a variable one, it will require the switchboard attendant's constant attention in order to keep as far as possible an even balance. Owing to the battery having to do the work of balancing, charging cannot be carried out regularly on either side, particularly if the mains are badly out of balance during the running hours, for it must follow that the side of the system having the heavier load cannot give much to the battery, but may require a little help from the battery, while the lightly-loaded side will be receiving a fairly large charging current.

From the above it may be seen that to attempt proper charging during the evening load would be a difficult matter, owing to the irregular charging and probable discharging of the battery. Of course, the charging may be done during the evening load by moving the battery regulators on the positive and negative sides low enough down to charge at the normal rate, but any appreciable amount of out of balance on the mains will upset the even charging of the cells, and too much of this is not caculated to benefit the battery. It appears, therefore, that the best plan to adopt in the case named would be to charge the battery in the daytime, or during the hours of light load. This can be done by starting up one of the sets coupled to the outers or outer 'bus bars, to which it is assumed the battery is connected, having its middle connected to the middle wire by means of the regulating cells. The machine having been put on the bars, the battery regulators should now be moved down so as to allow the normal charging current to enter the battery on each side; and since the load on the mains is small, little balancing will be required, and therefore an equal current may be got into each side. If the cells are gradually cut out on both sides, there will, of course, be a certain number left uncharged. These must be coupled in circuit with the motor-generator and charged independently, either during the time the main battery is being charged or after the charge, preferably the former, since the regulators must be brought higher again to maintain 'bus bar pressure after the charging ceases, so that a number of the cells previously left out of the main charging would be brought into circuit again without having received a full charge. The writer thinks that little difficulty should be experienced if the cells are charged as above suggested, and care is exercised to see that all parts of the battery—*i.e.*, regulators and main cells—are fully charged.—A. H.

Question No. 382.—What is a paralleling voltmeter? How is it connected when used on a three-wire system, and is it a necessary instrument?

Answer to No. 382 (*awarded* 7*s.* 6*d.*).—A paralleling voltmeter is an instrument used in central stations to facilitate the operation of throwing generators in parallel with machines already feeding the 'bus bars. These instruments have their zero in the middle of the scale, and when the voltage of the incoming machine is equal to that of the 'bus bars, the pointer of the instrument is a zero. Fig. 1 shows the connection for a three-wire system. If there are auto cut-outs, or single-pole switches in the dynamo's mains connected to the neutral wire, these must be closed first. Following up the dotted connections, it will be observed that one socket is connected to the 'bus + or −, and the other socket to the + or − of the dynamo's terminals. Let dynamos A and B be connected to the 'bus bars, and are maintaining a voltage of, say, 250 volts between the neutral and the outers, and it is necessary to switch dynamo C into parallel. If a voltmeter having its zero in the middle of the scale be connected to points 1 and 2 (which may represent the contacts of a multiple switch), it is obvious that if contact 1 be connected to the 'bus and No. 2 to the similar

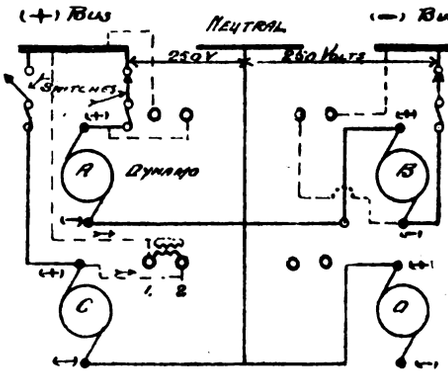

FIG. 1.

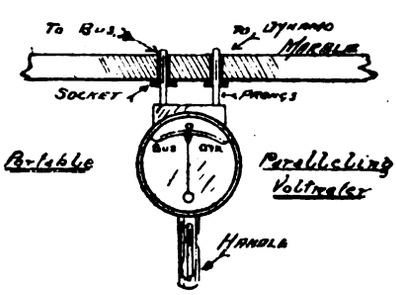

FIG. 2.

pole of the dynamo, no flow of current can take place through the instrument when the voltage of the incoming machine is equal to that across the 'bus and the neutral, the pointer is at zero. If the voltage of the incoming machine is higher than that of the 'bus bars, the pointer of the instrument will be deflected to one side of zero, or if the voltage of the 'bus is higher than the machine volts, the pointer will be deflected on to the other side of zero. It is usual, however, to switch in the incoming machine at two or three volts above the 'bus bars, so as to allow for the drop of potential which takes place in the machine when it is thrown in. Messrs. Kelvin and James White, Limited, have introduced a most convenient portable type of paralleling

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voltmeter, which are arranged as follows: on each of the dynamo panels are fixed two gunmetal sockets at about 3in. apart, and when a machine is required to be run up for switching in parallel, the instrument, which has two metal prongs, is pushed into these sockets, as in Fig. 2. These instruments are extremely handy, and can be used for paralleling any number of machines.

In answer to the latter part of the question, a paralleling voltmeter is not a necessary accessory for the above purpose; ordinary voltmeters can serve the same purpose. On the other hand, zero paralleling voltmeters save a lot of trouble, especially if the ordinary type of voltmeters installed on the switchboard are not reading accurately together.—R. H. FULTON.

Answer to No. 382 (*awarded* 7*s.* 6*d.*).—A paralleling voltmeter is a most useful and handy little instrument. It is used for ascertaining when the voltage of any machine corresponds with that of the 'bus bars on to which it is to be paralleled, therefore giving the correct time to close the main switch without causing the slightest flicker on the

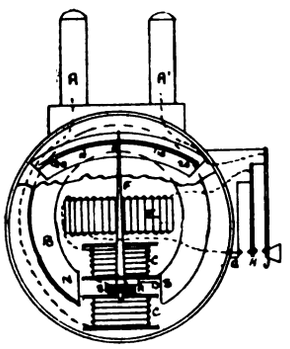

FIG. 1.

lamps. Fig. 1 shows diagram of paralleling voltmeter and connections. A A' are the plugs which fit suitable plug holes in the main dynamo board. B is the permanent magnet which retains the pivoted permanent magnet, D, in zero or mid position when no current is flowing in the coils. The coils, C C, are both wound to act together, and

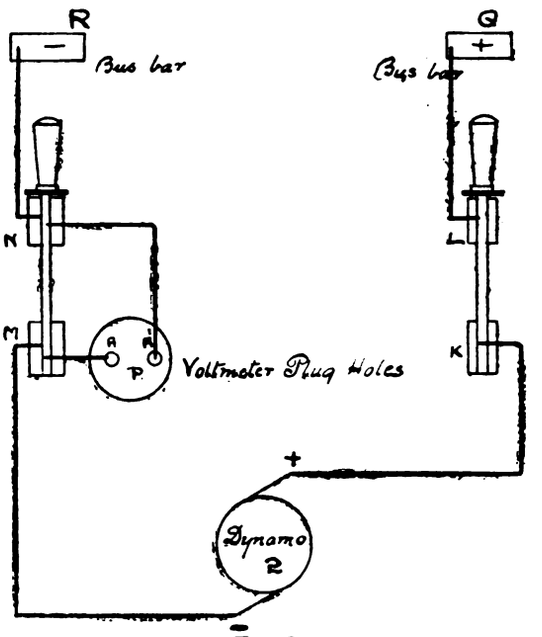

FIG. 2.

tend to move the magnet, D, and, therefore, pointer, F, from zero to either right or left, depending on the direction of the current. E is a resistance, and G H J the switch key and contacts. Fig. 2 shows the connections necessary for the paralleling voltmeter fitting on the main board, each machine being supplied with its own fitting. The contacts, A A', are connected, one to the machine side, and the other to the 'bus-bar side of the main switch. It is immaterial whether the fitting is connected to the + or the − switch, but the usual practice is as shown on sketch. Suppose dynamo 2 is to be paralleled on to the main 'bus bars, Q and R. The engine is started up and the + switch is then closed. The paralleling voltmeter is then plugged into holes, A A', on the board. As the engine is being run up to speed, the key, J, on the voltmeter is pressed on to contact H, and on the first trial there is usually a violent oscillation to either right or left due to the widely different potentials at the contacts N M. As the engine more nearly approaches the proper speed, the difference of potential will grow less and less so that the pointer hardly moves. The key, J, is then pressed further down to the contact G, thereby cutting out the largest portion of the resistance, E. The final adjustment of speed is then made, and when the voltmeter registers zero the main switch is closed. If the key, J, had been pressed down to G, on starting up there would be great risk of burning up the coils, C C, due to the wide difference of potential, but as the voltage of the machine approaches that of the 'bus bar, the greater portion of the resistance, E, may be cut out. The voltmeter is connected up exactly the same for a three-wire as a two-wire system. The great advantage of the paralleling voltmeter is that the man who closes the switch can see the voltmeter, and does not depend on another man to tell him or signal to him when to close it; the usual result in the latter case is a flicker on the lamps. The cost for connections is very slight indeed, and in most cases it would be necessary to have another voltmeter on the board if the paralleling voltmeter was dispensed with. It is not an absolutely necessary instrument, but its advantages are so great and apparent that it is folly to be without one. The ammeter shunt, fuses, etc., are not shown in the dynamo circuit (Fig. 2), as they are not necessary for the question.—H. B.

Answer to No. 382 (*awarded* 5*s.*).—A paralleling voltmeter is essentially a polarised voltmeter having its zero position in the middle of the scale—*i.e.*, there are practically two scales, one on each side of the zero position and reading in opposite directions, so that the person manipulating can ascertain at a glance by how much and in what manner the potential difference of the dynamo differs from that of the 'bus bars to which it is to be coupled. The voltmeter is usually connected between the terminals of one of the dynamo switches, and a light fuse in the other switch to complete the circuit through the switchboard 'bus bar.

A convenient form of voltmeter is that depicted in Fig. 1, and is made by Messrs. Kelvin and White, of

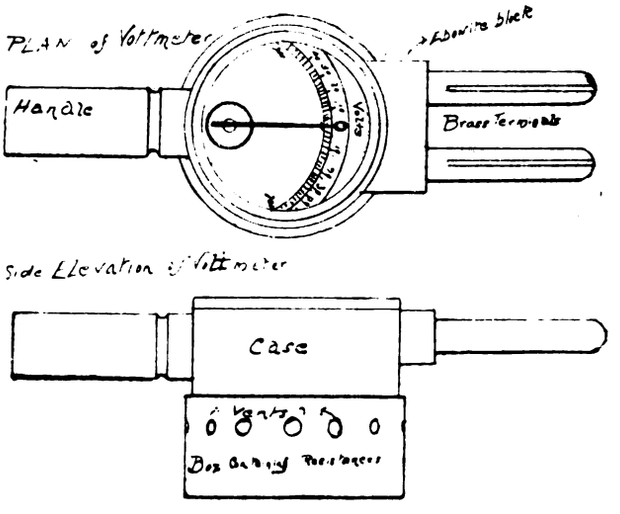

FIG. 1.

Glasgow. This voltmeter is only placed in circuit when the dynamo is to be paralleled, and is removed when the dynamo has been switched on to the bars. The sockets to receive the terminals of the voltmeter are fixed in some convenient position on the switchboard, preferably near to the dynamo switch, and the necessary connections are shown in Fig. 2. In cases where the dynamo has only a single-pole switch it is necessary to have a fuse in one of the socket connections in order to protect the voltmeter from possible harm.

On some switchboards two voltmeters are used, one

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across the 'bus bars, the other across the dynamo terminals; and these voltmeters are often electrostatic voltmeters that indicate in the same manner in whatever direction

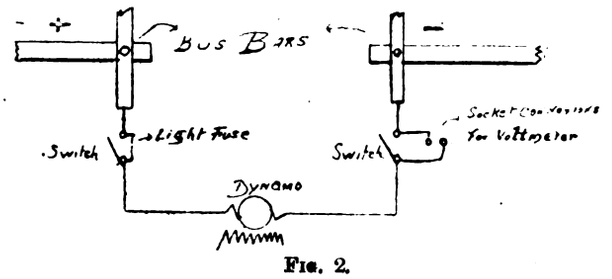
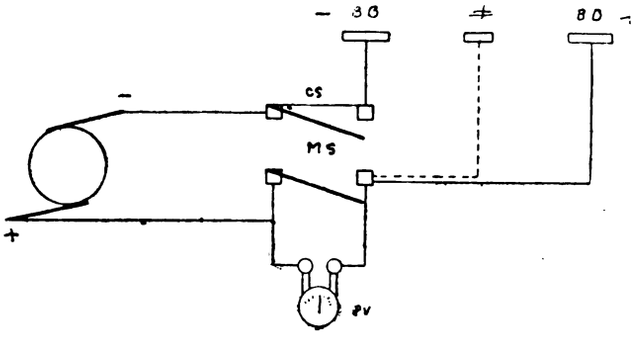


Fig. 2.

the voltage is applied to the terminals. The ordinary type of voltmeter does not indicate on the wrong side of zero, because they are not made to, and do not, therefore, indicate a reversed current. In the case of the electrostatic voltmeter it is positively dangerous, for who is to know when the magnetism of the dynamo is reversed—a state of affairs which, fortunately, is not of very frequent occurrence. With the ordinary type of voltmeter, time may be wasted endeavouring to excite the dynamos when it may possibly be exciting in the wrong direction, or, indeed, the voltmeter connections may have been reversed. I, therefore, consider it a matter of safety as well as necessity that a proper paralleling voltmeter should be used for paralleling dynamos on all switchboards.—C. H.

Answer to No. 382 (*awarded* 5*s.*).—A paralleling voltmeter is used for ascertaining the exact moment for switching on a dynamo in parallel with another, or others already working. It usually consists of a portable instrument with coils of high resistance, and spring balance to keep needle at zero when no current is passing. It has plug terminals, so that it can be connected up to any machine by suitable contact sockets arranged close to the main dynamo switches, so that the attendant can see and use same in switching on machine. It is calibrated with zero in centre of dial, and reads to either way to a voltage suitable for station. There is a double-contact key attached. On making first contact circuit is closed, and either way will read, say, 200 volts, each division being 10. On making second contact, either way will read, say, 20, and each division will equal one. The reason of this will be explained later. It is connected up as follows. I think the diagram will explain itself, and



shows one machine across the outers in a three-wire system. If two machines in series were used it could either be connected in series with them if put on together, or else if machines were being put on one side at a time it could be connected as shown by dotted line to neutral, and whichever side, as case may be. The reference letters on the diagram are: B B, 'bus bars; M S, main dynamo double-pole switch; P V, paralleling voltmeter; C S, light spring contact strip used to complete voltmeter circuit.

It will be seen from sketch that there is (when voltmeter key is closed) a complete circuit from one 'bus bar through voltmeter to machine, from machine to main switch, through contact strip to other bar. So the machine is practically "on," but the voltmeter being of such high resistance, little or *no* current passes. Therefore, when machine volts = bar volts, the counter E.M.F.'s tend to keep the needle at zero. If, however, either machine volts are higher or lower than bar volts, the needle will swing to left or right as case may be. The method of using is as follows: As soon as oncoming machine starts generating, make first contact; needle will swing to one side. As machine volts rise, it will come up gradually to zero. When about 20 volts from zero, make second contact, and needle will go back and come up rapidly again to zero, each division reading one volt, therefore giving a larger scope for putting "on" at the exact voltage, which should be about one volt above bar volts. As soon as needle is up, switch on, and there should be practically no "bobbing" of the lights or volts. No; it is not an absolutely necessary instrument, although a far better way of working than any other method, such as watching machine voltmeter and 'bus-bar voltmeter and switching on when they show a like voltage, as they may read a little out, and so cause "bobbing."—M. H. V.

APPOINTMENTS VACANT.

Draughtsman. Details in our advertisement columns.

Pupil, London works. Details in our advertisement columns.

Switchboard Attendant, corporation electric tramways. Details in our advertisement columns.

Electrical Engineer, to take charge of the manufacture of meters. Details in our advertisement columns.

Shift Engineer. Huddersfield Corporation tramways, £100 per annum, July 1. Details in our advertisement columns.

Car-Shed Superintendent, Sheffield Corporation, £150 per annum, June 24. Details in our advertisement columns.

Engine-Driver, Huddersfield Corporation tramways, 5s. 10d. per eight-hour shift. Details in our advertisment columns.

Lecturer and Demonstrator, Hull Municipal Technical School, £150 per annum. Details in our advertisement columns.

Manager, copper tube works of English Electro-Metallurgical Company, Limited, Leeds. Details in our advertisement columns.

Assistant Superintendent of Mains, Edinburgh Corporation, about £100 per annum, July 1. Details in our advertisement columns.

Chief Clerk in the consumers' department, London electricity supply company, £120 to £150. Details in our advertisement columns.

Electrical Engineers, Dewsbury, £250 per annum, to be increased at the end of 12 months to £300, July 4; tramways, Council of the city of Wellington, New Zealand, July 20. Details in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brighton.—The Guardians require tenders for the wiring of the workhouse.

Taunton.—The Corporation invite tenders for free wiring. Tenders by July 1.

Stepney.—The Borough Council invite tenders for supply of arc lamp carbons for the year ending June 30, 1902. Tenders by June 26.

Manchester.—The Tramways Committee invite tenders for the supply of tramway rail bonds. Tenders by July 1. Details in our advertisement columns.

Dudley.—The Electric Light and Tramways Committee invite tenders for the supply and erection of a steam engine and dynamo. Tenders by July 6. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of condensing plant, boiler feed pump, and steam and water piping, etc. Tenders by July 1. Details in our advertisement columns.

Nelson.—The Electricity and Tramways Committee invite tenders for supply, etc., at their electricity works of a travelling crane. Particulars may be obtained from Mr. W. Alan Fraser. Tenders by 25th inst.

Whitehaven.—The Water and Lighting Committee invite tenders for the purchase of about 20 tons of second-hand rubber-covered cables. Tenders by June 24. Particulars in our advertisement columns.

Leigh.—The Tramways and Electricity Committee invite tenders for the supply of electricity meters for a period of 12 months ending June 30, 1902. Tenders by June 22. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for electric motors (enclosed type), of 4½ h.p., 7 h.p., and 10 h.p., for a period of 12 months commencing Nov. 1, 1901. Tenders by July 4. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of multiple-core lead-covered feeder and network cable and accessories for mains extensions. Tenders by July 2. Particulars in our advertisement columns.

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West Ham.—The Council invite tenders for two 500-kw. continuous-current tramway generators, coupled direct to three 850-i.h.p. steam engines, and 11 water-tube boilers. Tenders by June 25. Details in our advertisement columns.

Madrid.—The Public Works Department of the Department of Agriculture, Madrid, invite tenders for the construction and working for 60 years of an electric tramway from Santiario de la Yedra to Balza. Tenders by July 26. Particulars at that office.

Nelson.—The Corporation invite tenders for steam engine and dynamo, balancer, two 30ft. by 8ft. Lancashire boilers, feed pumps, economiser, etc., condenser and steam pipes, cables, and switchboards. Tenders by July 1. Details in our advertisement columns.

Pontypridd.—Tenders are invited by the Guardians for the lighting of the union workhouse, infirmary, and other buildings in connection therewith by electricity. Tenders must be received by Mr. William Spickett, clerk, Union Offices, Pontypridd, on or before July 23.

Brighton.—The Town Council invite tenders for the supply and fixing of all the wiring and fittings necessary for the electric lighting of the new floral hall of the market. Specifications, etc., may be obtained at the office of the borough engineer and surveyor, Mr. Francis J. C. May, M.I.C.E. Tenders by July 26.

Manchester.—Tenders are invited by the Electricity Committee for the supply of the following stores during 12 months ending June 30, 1902—viz.: brass and iron castings, coal slack, cement, cotton waste, flags, incandescent lamps, meters, oils, timber, etc. Particulars, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department. Tenders by July 2.

Birkenhead.—Tenders are invited by the Corporation for the construction, supply, and delivery of 15 electric tramcar bodies, complete electrical equipments for 15 cars, and trucks and trolleys complete for 15 cars. Specifications, etc., may be obtained on application to Mr. Arthur R. Fearnley, tramways manager, Sessions House, Brandon-street, Birkenhead. Tenders by July 16.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

Epsom.—The Urban District Council invite tenders for supply of meters (direct-current) and cut-outs. Specifications, etc., can be obtained from Mr. E. G. Wilson, clerk, High-street, Epsom, on deposit of £2. 2s. for each specification, returnable on receipt of a bona fide tender. Specifications may be seen at, but not obtained from, the offices of Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C. Tenders by 12 noon on 22nd inst.

London, N.E.—Tenders are invited for the erection and construction of mechanical coaling apparatus for the municipal electricity works, for the Electric Lighting Committee of the metropolitan borough of Hackney. Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W., on payment of £1. 1s. Tenders by 4 p.m. on July 4.

London, S.E.—The Borough Council invite tenders for the supply of electricity meters, demand indicators, and main fuses. Specifications, etc., can be obtained at the Town Hall, Spa-road, Bermondsey, on payment of a fee of £3. 3s., which will be returned on receipt of a bona fide tender. The specification may also be inspected (but not obtained) at the offices of the engineers, Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by noon on July 1.

Mansfield.—The Corporation invite tenders for the supply and erection of—boiler-house plant: three Lancashire boilers, mechanical stokers, steam pumps, economiser, and motor; engine-house plant: three 200-kw. high-speed steam generators, motor transformer, balancing motor transformer, and accessories; Korting condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains; public lighting: arc lamps, posts, and accessories; meters, and workshop equipment. Tenders by July 12. Details in our advertisement columns.

Erith.—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, economiser, feed pumps, etc.; pipework, etc., in engine and boiler house; surface-condensing plant, three steam alternators (vertical enclosed high-speed engines direct coupled to three-phase alternators), main switchboard and connections, 10-ton engine-room travelling crane, transformers, sub-stations, and equipment, underground mains, conduits, roadwork for private and public lighting, arc lamps (open type), posts, and station lighting. Tenders by June 24. Details in our advertisement columns.

Cleckheaton.—The Urban District Council invite tenders for the supply and erection of the following plant: (Section C) engines, dynamos. Tenderers must tender for the whole of the section, and not for part of it. Specifications, etc., may be inspected at the offices of Messrs. Gibbings and Baker, Piccadilly-mansions, 17, Shaftesbury-avenue, London, W., and Old Bank-chambers, Cheapside, Bradford, on and after 8th inst., and may be obtained on application to the Clerk of the Council, Town Hall, Cleckheaton, on payment of the sum of £2. 2s., which sum will be refunded on return of specification with bona fide tender. Tenders by 22nd inst.

Hurst (Lancs.).—The Urban District Council invite tenders for the construction of the permanent way of the tramways, including the supply of labour and material (except granite setts, which will be provided by the Council) for the concrete foundations, and other contingent work; also the fixing of grooved steel girder tramway rails, points and crossings, fishplates, tiebars, bolts and nuts, together with the material and labour required in the electric copper bonding of the rails, points, and crossings, etc., and all other work connected therewith. Specifications, etc., may be obtained at the office of Mr. Edward Garside, A.M.I.C.E., Town Hall-chambers, Ashton-under-Lyne. Tenders by 12 noon on 28th inst.

RESULTS OF TENDERS:

Keynsham.—The Parish Council have accepted the tender of the Electric Lighting Company, at £188. 10s., for lighting the parish.

Dundee.—The Corporation have accepted the tender of the International Electric Company, of Liege, at £4,283, for a three-phase direct-coupled engine and dynamo, according to specification.

Oldham.—The Electrical Company, Limited, Charing Cross-road, W.C., have received an order from Messrs. Asa Lees and Co., Oldham, for one three-phase generator, 350 kw., and the necessary motors for driving their shops electrically.

Fulham.—The Borough Council of Fulham have accepted the tender of the General Electric Company (1900), Limited, for the supply of Robertson lamps, arc lamps and accessories, fuse wire, tape, etc., as required until March 31, 1902.

Lowestoft.—The tender of the Wheeler Condensing and Engineering Company for plant to condense for 130-h.p. and 230-h.p. engines combined, or to deal with either separately, or the 330-h.p. engine now on order, is recommended for acceptance.

Cape Colony.—The Allgemeine Elektricitäts-Gesellschaft, Berlin, have received the contract from the Cape Town Government for the Table Bay Harbour plant, consisting of three 250-kw. direct-current dynamos, coupled direct to Belliss and Morcom engines, Davey-Paxman and Co.'s boilers and cranes, from three tons up to eight tons carrying capacity, and 11 capstans. The mechanical part of the cranes is supplied by Messrs. Stothert and Pitt, Limited, Bath.

Dublin.—The Lighting Committee have recommended to the Council the acceptance of the following tenders: Specification 4: Section E (condensers), Alley and Maclellan, £3,030; Section F (pipework), Babcock and Wilcox, £4,805; Section G (feed pumps), D. Stewart and Co., £395; Section H (superheaters), Part 1, J. Musgrave and Sons £832, Part 2, Babcock and Wilcox £705; Section J (coaling plant), Graham, Morton, and Co., Limited, £5,475; Section K (overhead crane), Carrick and Ritchie, £670; Section L (workshop plant), Easterbrook, Allcard, and Co., £795. Specification 5: Section M (main switchboards), General Electric Company, £3,814; Section N (sub-station switch gear), Brush Electric Engineering Company, £5,800; Section O (transformers), British Westinghouse Electric Company, £6,320; Section P (arc lamps), Verity's, Limited, £6,198; Section Q (arc lamp pillars), Verity's, Limited, £6,042. Specification 6: Section R (motor and motor-generators), Witting Bros., £3,970; Section S (accumulators), Electric Power Storage Syndicate, Limited, £751; Section T (meters), British Westinghouse Electric and Manufacturing Company, £4,670; Section U (works wiring), W. Coates and Sons, £967. Specification 7: (the building of the 19 small sub-stations around the city), J. and W. Stewart, Belfast, at £275 each, or a total, if all should be required unaltered, of £5,225. The total of the tenders recommended amount to £60,566, the original estimate of Mr. Hammond for these portions of the work being £62,551.

BUSINESS NOTES.

TRACTION.

Llandudno.—The District Council have approved further plans in connection with the proposed Great Orme tramway.

Darlington.—The General Purposes Committee have approved the form of agreement for the purchase of the tramways.

Hill of Howth.—The electric tramway between Sutton Station and the summit of Howth Head is now open to the public.

West Cumberland Tramways.—In the House of Commons the West Cumberland Electric Tramways Bill was read a third time.

Hindley.—Mr. W. J. Lomax, C.E., of Bolton, has been retained to value the tramways in Hindley on behalf of the District Council.

Lancaster.—The Corporation have decided to proceed with two sections of their electric tramway scheme—viz., to the Lancaster Park and to Scotforth.

Easdale.—The Parish Council have unanimously resolved "to do all in their power" to forward the proposal to construct a light railway from Oban to Easdale.

Ayr.—The Town Council have authorised the surveyor to purchase an additional quantity of 20 tons of tramrails, with corresponding quantity of fishplates, etc.

Southend.—It is expected that the new electric tramway system will be formally opened within a few days, the preliminary trials having proved quite satisfactory.

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Greenwich.—The Borough Council have decided to dissent from the proposal of the light railway promoters to apply for an order authorising a light railway from Woolwich to Eltham.

Norden.—The ceremony of "laying" the first rail of the new electric tramways between Rochdale and Norden was performed at the end of last week by the chairman of the Tramways Committee.

Molesey.—The District Council have agreed to withdraw their opposition to the London United Tramway Company's Bill now before Parliament on terms, one condition being that wood paving shall be laid.

Ramsbottom.—The District Council have signified their approval of the arrangements come to between the Tramways Committee and the promoters of the two schemes of light railways in the district.

Motor Vehicles and Horses.—A meeting of the Church Society for the Promotion of Kindness to Animals has passed a resolution urging that the more general adoption of motors would alleviate much animal suffering.

Hornsey.—A public meeting of owners and residents at Muswell-hill has unanimously resolved to oppose the application of the Middlesex County Council for an order to construct light railways in the district.

British Electric Traction Co.—The directors of this Company recommend a dividend at the rate of 12 per cent. per annum for the half-year ended March 31, making, with the interim dividend, a total distribution of 9 per cent. for the year.

Tower Wagons.—Messrs. J. H. Heathman and Co. have just issued another price list of their telescopic tower wagons, which are now being extensively used for a variety of purposes, including the erection of electric tramway overhead wires, etc.

Islington.—The Borough Council, having arranged satisfactory clauses with the promoters of the Islington and Euston Railway and of the Charing Cross, Euston, and Hampstead Railway (No. 2) schemes, have withdrawn their opposition to the Bills.

Stoke Newington.—With reference to the proposed North-East London "tube," the Highways Committee are of opinion that the line will afford great and necessary facilities to the inhabitants of the borough desirous of travelling to the City or West-end.

Islington.—The City and South London Railway Company, in reply to a letter from the Borough Council requesting a station to be placed at Highbury-corner, state that, in view of the cost involved, the directors do not see their way to accede to the request.

Blackburn.—During the month of April the Corporation cars ran 47,500 miles, carried 486,869 passengers, the total receipts being £2,381. 3s. 7d. On the Darwen section the figures were: miles run, 15,099; passengers carried, 186,936; and receipts, £790. 0s. 11d.

Surbiton.—In the agreement between the District Council and the London United Tramways Company, the company have agreed to widen the Ewell and Ditton roads so that a space of not less than 9ft. 6in. should be left between the kerb and the nearest rail of the tramway.

Middlesex.—The Highways Committee of the County Council have decided to grant a motorcar for their chief surveyor of main roads, believing he can cover twice as much ground as he could with horses, and obtain a more thorough appreciation of any defects in the roads.

Manchester-Liverpool Electric Express Bill.—This Bill was before the Examiners for the Investigation of Standing Order Proofs at the House of Commons on Tuesday, it having passed the Lords, and was found to have complied with the Standing Orders of Parliament.

Oldham.—The Park-road, Glodwick-road, and Lees-road sections of the Corporation tramways were formally declared open on Saturday. These lines form part of a scheme for the construction of 25 miles of electric tramways within the borough, and the portions now open are 2¾ miles in length.

Wembley.—In connection with the proposal of the Middlesex County Council to obtain powers to construct light railways in the district, the Urban District Council have resolved, subject to satisfactory arrangements being made as to road widening, not to oppose the construction of a tram or light railway line between Stonebridge and the Swan Inn.

Ashton.—The contract for the rails for the proposed Corporation electric tramways has been placed with Messrs. Dick, Kerr, and Co., Limited. Tenders are to be invited for the necessary points and crossings. The Corporation have accepted the offer of the Hurst District Council to lease to them the proposed tramway lines for Hurst for 10 years upon terms.

Wolverhampton.—Progress continues to be made with the work of laying the electric tramlines in New Hampton-road and the Whitmore Reans. Further advances in all departments may be anticipated, and as the work of putting in the connecting cables gets on, a start will be made with the laying of the supply cable and its adjuncts down the edge of the footpath.

St. Paul's Cathedral and Tube Vibration.—Mr. Wm. Emerson, the president of the Royal Institute of British Architects, writing on the subject of the proposal to carry the Piccadilly and City Railway close to St. Paul's Cathedral says, it is not the particular violence of the vibrations that might be set up, but the constant quantity that would probably eventually affect the structure.

Loughborough.—The Town Council have sealed an agreement with the Loughborough and District Electric Traction Company, Limited, with regard to the contribution by the Corporation to the company of the sum of £10,000 towards the proposed railway in the district, and also a supplemental agreement with the same company containing clauses for the protection of the Corporation.

Whitehaven.—The Parliamentary Committee reported at the last meeting of the Town Council that they had obtained a clause in the West Cumberland Electric Tramways Bill to the effect that if the tramways from Cleator Moor to the boundary of Workington parish were not substantially commenced within two years from the passing of the Act the powers for making them should cease.

Doncaster.—The Tramways Committee has accepted tenders for rails for the proposed electric tramways. It has been decided in regard to the route through the wool market to take part of the market, and one of the bays will be used as a car-shed. It has also been decided to make a double line from the clock corner in High street to the Race Common at an additional cost of £5,000.

South Shields.—At the last meeting of the Town Council it was proposed that the Corporation obtain powers in the next session of Parliament for laying down and working a complete system of electric tramways in the borough. It was pointed out that the Tramways Committee had the matter under consideration, and an amendment that the question be referred back to them was carried.

Newcastle.—At a meeting of the Tramways Committee an interesting report was submitted, containing the recommendations of the General Purposes Committee, relative to sections and stopping places, in regard to the new tramways. It is proposed to have halfpenny fares for each section. The sections will be 1,277 yards in length, or an average of little less than three-quarters of a mile.

Swiss Electric Railway.—The Limmat Valley Electric Road Railway, which is eight miles in length and connects a number of large villages with the town of Zürich, Switzerland, was opened for traffic in April last. The line has been constructed under the direction of Dr. Du Riche Preller, M.I.E.E., as managing director and chief engineer, the contractors being Brown, Boveri, and Co., Limited, of Baden.

Glasgow.—A breakdown of the overhead wires in connection with the Corporation electric tramway system occurred on Saturday last in the Sandyford district of the city. A number of the cars were brought to a stop in consequence. There were no passengers on the car at the time of the breakdown, and the accident happening at night, there was little traffic on the street and very few people were about.

Damages for Personal Injuries.—Some months ago Mr. Fitzgerald obtained a verdict in the court of first instance in Dublin against the Dublin United Tramways Company for £1,000 damages for personal injuries, he having been pitched from his trap owing to his horse slipping and falling on the tram tracks. The Court of Appeal have now upheld the verdict, on the ground that the company were negligent in failing to keep the track well sanded.

Bath.—No further delay is anticipated with regard to the introduction of electric tramways into Bath. The Corporation and the promoters have joined hands, and the Light Railway Commissioners have issued the necessary order. Discussion took place at the Council meeting on Tuesday upon the advantages of the conduit as compared with the overhead system, but the chairman of the committee declared that the former was impossible in Bath.

Private Bills.—In the House of Lords the following Bills have been read a second time: Derbyshire and Nottinghamshire Electric Power, Tottenham and Hampstead Junction Railway, and Shannon Water and Electric Power. In the Commons the following Bills have been read a second time: Birmingham (City) Tramways, Wigan Corporation Tramways, and Metropolitan District Railway; and the following a third time: Notting Hill Electric Lighting, and Metropolitan Electric Supply.

Finchley and Hendon Tramways.—The Select Committee of the House of Lords presided over by Lord Pirbright on Tuesday concluded the consideration of the Bill under which powers are sought to construct tramways from Golder's Green to Hendon and Finchley in conjunction with the Charing Cross, Euston, and Hampstead Tubular Railway. The idea is to connect these outside districts with the heart of London by a continuous and expeditious service. The preamble of the Bill was found to be proved.

Liverpool.—A return for the fortnight ended June 8, submitted by the general manager of the Corporation tramways, shows that the total mileage run was 428 012, being an increase of 82,455 on that of the same period last year. The number of passengers carried during this fortnight was 4,221,716 being an increase of 893,866 over that for the corresponding period last year, and the receipts for the fortnight amounted to £19 748 19s. 5d., being an increase of £2,407. 14s. 9d. over that of the corresponding period last year.

Bradford.—The receipts on the various lines of city tramways during the week ended June 16 were: Bolton, £161, or 12 09d. per mile run; Horton £505, or 15 72d. per mile; Lidget Green, £139, 12·12d. per mile; Whetley Hill, £206, 13·31d. per mile; Thornton, £67 6 22d. per mile; and Stanningley, £63 9·08d. per mile. The receipts per mile run for the various lines from or subsequent to April 1 last have been: Bolton, 12·58d.; Horton, 12·24d.; Lidget Green, 11·97d.; Whetley Hill, 13·34d.; Thornton, 6·92d.; and Stanningley, 9 2d.

Stirling.—At the Town Council's meeting on Tuesday a letter was read from the Stirling and Bridge of Allan Tramways Company in regard to the negotiations for the transference of the line to the

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British Electric Traction Company, which have been broken off in consequence of the Town Council, in order to safeguard their interests, giving notice of their intention to purchase the part of the line within the burgh. A remit was made to the Lighting Committee to ascertain the value of the undertaking within the burgh, with powers to open negotiations with a new electric company.

Southampton.—The question of the new electric tramways was raised at the last meeting of the Town Council, when it was stated that the Corporation were now running an enormous mileage, and the committee had come to the conclusion that the cars were equipped with the wrong kind of wheels, and that those at present in use were too soft. The wheels at present in use were American, and they found they were constantly getting flats and chips. The committee were going to try the experiment of using steel-tyred wheels, and hoped to get better results. The new wheels would be of English make, and entail much heavier expense.

Burnley Tramways.—At the final meeting of the shareholders of the Burnley and District Tramway Company, now in the hands of the Corporation, it was explained that after paying the shareholders 21s. in the pound with interest, there would be left a balance of about £2,500 to meet any contingent claims. The directors had made the manager, Mr. H. Mozley, a grant of £200 for extra work, and they had all reason to congratulate themselves at the satisfactory winding-up of the company. The report was unanimously adopted. It was stated that the money would be paid to the shareholders in one lump sum, probably in August.

Manx Tramways.—A circular issued to the shareholders in the Isle of Man Tramways and the Electric Power Company, Limited, impresses the importance of the purchase by the shareholders of the company's concern from the liquidator, and suggests that the shareholders should subscribe the capital, which, added to £175,000 debentures which could probably be raised, would be sufficient to purchase the undertaking and to pay the preliminary expenses. Shareholders are asked to subscribe 5s. per £100 of holding. It is stated that there is no probability of the shareholders receiving anything from the realisation of the company's assets.

Aberdeen.—Very satisfactory progress has lately been made with the construction of the electric tramway route to the bathing station, and the permanent way and overhead equipment of the part of the track from Castle-street to the east end of Constitution-street being now completed, a trial run has been made with one of the new cars, 12 of which have been obtained for this route. It is expected that a trial run will be made on the remaining portion of the route to the beach—the third-rail section, across the Links—in a few days, and after the sanction of the Board of Trade has been received the ordinary traffic on the route will be commenced.

Harrow.—It is reported that Dr. Wood, headmaster of Harrow School, has called a meeting of townspeople to protest against the Middlesex County Council's scheme for a line of electric trams to pass down the Harrow-road and round in a semi-circle to the Edgware-road, along which it would return to the starting point. The trams would pass over Harrow Hill and between many of the schoolhouses and buildings. The plans show that it is proposed to lower the crest of the hill in a manner that would expose the foundations of the school, chapel, and speech-room, and the scheme is meeting with the strongest opposition from the school authorities, as well as from many of the townspeople.

Warrington.—Colonel von Donop has held a Board of Trade enquiry into the application of the Corporation for powers to borrow £66,000 for the purpose of laying tramlines from Sankey Bridges to Latchford Swingbridge, and a branch line from Warrington Bridge to the swingbridge, Stockton Heath. It is proposed to have the overhead system, with eight cars for the main line, and an additional three cars for the branch line. There was considerable opposition to the application on the ground that the tramways would not pay. Mr. Preece, who was the chief witness, said it would require 10½d. per mile to make it pay, and, judging by the number of passengers by the 'buses, there was a probable margin of profit.

Sunderland.—At the monthly Town Council meeting the Tramways Committee reported that notice had been received from the British Electric Traction Company of intention to apply for an order authorising the construction of light railways from Sunderland to South Shields, and, by instruction of the committee, the town clerk had given notice of dissent from the laying by the company of any portion of their proposed tramways in Whitburn-road within the borough boundary. The Villette-road extension at Hendon of the Corporation tramways is now ready for the Board of Trade inspection. The traffic receipts for the fortnight ended June 5 amount to £2,500, an increase of £1,800 on the corresponding period of last year, when horse traction was in vogue.

Wallsend.—At the monthly meeting of the District Council a lengthy report was read as to the Tyneside Tramways Bill. It stated that a formal undertaking had been given that if the Bill passed the electric trams would not be run over the Willington Gut Bridge until it had been widened as agreed with the County Council, the width to be 40ft. 9in. The promoters agreed to pay the cost of the Council, and they had struck out the provision relating to the minimum charge of 2d., the maximum fare being 1d. per mile. A clause had been inserted to run a proper and sufficient service of cars for artisans, mechanics, and daily labourers each way, the charge for such trams not to exceed ½d. per mile. An undertaking with regard to the compulsory purchase clause as required by the Council had also been given.

Halifax.—The proposal of the Corporation to secure the vacant land in Commercial-street, with a view to making a tramway centre for the city, has created much interest and some adverse criticisms among the citizens. The purchase of the land will amount to £68,000, and its development, including the making of new streets, etc., would, it is thought, bring the cost up to close on £90,000. It is estimated, however, that £40,000 would be realised by the sale of surplus land. The Corporation, it is said, have reached the limit of borrowing powers for improvement purposes generally sanctioned by the Local Government Board, having regard to the ratable value to which Halifax can lay claim. A parliamentary Bill therefore would be necessary, and one thing essential in the promotion of a parliamentary Bill is the assent of a meeting of ratepayers.

Scarborough.—The town clerk has been instructed to write to various tramway experts and enquire their terms as advisers to the Corporation in connection with the proposed electric tramways for the town. The borough engineer will be instructed to prepare plans, when the expert is engaged, to be laid before Parliament. It is expected that the requisite documents will be deposited in time to enable the Bill to come before the next session of Parliament. The town clerk has drawn up a report relative to the procedure which might be adopted by the Corporation in dealing with the question of the tramways. Having considered the advisability of promoting a Bill in Parliament or obtaining a provisional order, it has been decided to adopt the former course. The feeling is that when the Bill is passed the Corporation should not lay down and work the tramways, but that the undertaking should be leased to a company.

The Reported London Monorail.—It was reported on Tuesday that the South-Eastern Railway Company intended shortly to adopt the Behr monorail system between London Bridge and Cannon-street in order to relieve the congested traffic. The report further stated that Cannon-street, as a wayside station, would be partially abolished, and that it would be treated as the terminus of a branch line. Charing Cross, greatly enlarged, would then become the terminus, and trains would run direct from London Bridge. Communication between London Bridge and Cannon-street would be maintained by electricity on the Behr monorail system, the track running above the existing lines sufficiently high to clear the tops of the carriages. By this means, it was said, the chief cause of the delay on the South-Eastern would be removed. Mr. Vincent Hill, general manager of the South-Eastern and Chatham Railways, however, has informed a *Daily Chronicle* representative that his directors do not contemplate making the change indicated above. The matter was brought before them by Mr. Behr, and talked over; but there the matter ended. In the meantime the company will continue to do its best to serve its travellers with the means now at its disposal, the monorail system being, in the opinion of the directors, a dream of the future.

Cardiff.—The work of laying the crossing in Cowbridge-road is practically completed, and all is ready for the inspection of the Board of Trade representative. For the Royal Show an arrangement has been agreed upon between the tramway company and the Corporation, under which the company shall be allowed to run their trams through Cathedral-road on payment of a royalty. At a meeting of the Tramways Committee on Friday the correspondence that had taken place between Mr. Harpur and Mr. Glenn (the latter acting on behalf of the tramways company) was read. The Mayor said there seemed to be some misunderstanding with regard to the Bute-street Bridge. All that was wanted was 1ft. difference in order to meet the Board of Trade requirements for the cars to pass under. The Electrical Engineer presented a report, which contained a statement to the same effect. He also produced designs showing alterations in the double-decked cars to meet the Board of Trade requirements with regard to the bridges. It was decided that Bute-road should be reduced 13in. under the bridge. The committee also decided to adopt single-decked cars for the Splott and Grangetown route, and not to go through Wood-street, etc., until after further consideration. The Cathedral-road section was inspected on Tuesday by Major Druitt on behalf of the Board of Trade.

Blackpool.—Mr. Quin, the electrical and tramway engineer, made a statement at the last Tramways Committee meeting relative to the breakdown of cars on the new Marton route. He had taken nearly 300 measurements of the new tramway, he said, and he found that in only five places was the line of the standard regulation gauge of 4ft. 8½in. At 273 places the line was from ⅛in. to ¾in. under the standard gauge. Most of the curves where greater width would have been beneficial were rather tighter than the rest of the line. The Borough Surveyor told the committee that the gauge used for this line was one of three that had been used by his predecessor. As a matter of fact, this gauge was only 4ft. 8$\frac{5}{16}$in. wide. It also transpired that the promenade line had been tested, and this was not of the standard width either. It was proposed that the wheels should be altered to the gauge of the rails. The committee also considered what developments of the system were desirable, and decided upon two extensions. The line from Talbot-square is to be continued along Talbot-road and New-road as far as the cemetery gates, this to be a single line and to form a 1d. stage. A connection is also to be made between the Lytham-road tram and the new line round Marton by way of Waterloo-drive. It was also decided to have about 20 new cars, but the question of whether they should be bogie cars was left over. A letter was read from the Board of Trade intimating to the Corporation that under no circumstances must they lay down any more tramway lines with the wide groove.

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Salford.—The Salford Corporation, it is stated, are not at present inclined to decide upon a working agreement with the Manchester City Council upon the tramways question. The proposed arrangement between the two Corporations has, it is stated, fallen through after several private consultations, and it is understood that the Salford Corporation propose to run their cars independently of Manchester. The clause in the proposed agreement upon which the issue turned, it is said, runs thus: "The service of cars run by Salford in Manchester and the fares charged to be subject to the approval of the Manchester Corporation, and, similarly, the service of cars run by Manchester in Salford and the fares charged to be subject to the approval of the Salford Corporation." The clause was inserted with the object of protecting Manchester from any diversion of traffic from lines partly in Salford and partly in Manchester to lines wholly in Salford, and to prevent Manchester from neglecting those Salford routes which it had undertaken to work. The view taken by the Salford Corporation appears to be that the obligation to satisfy Manchester might prove burdensome, much more burdensome than the corresponding obligation upon Manchester. We trust that the two Corporations will shortly come to a settlement upon the point, in order that what threatens to prove a serious disorganisation of the tramway system in the district may be avoided.

London United Tramways.—The Select Committee of the House of Commons presided over by Sir John Kennaway has been engaged this week in considering the Bill promoted by the London United Tramways Company to construct further tramways in the neighbourhood of Putney, Richmond, Hammersmith, Shepherd's Bush, Kew, Hampton Court, etc. During the enquiry it was stated that the total number of passengers who had travelled over the 7½ miles of the company's line now being operated by electric traction during the past 10 weeks had been 5,048,200, which practically represented the entire population of London. The average number per day was 71 260. Mr. Clifton Robinson, managing director and engineer of the company, said that at present eight miles of line were being electrically worked with 100 cars. By July, 16 miles would be worked with 150 cars. If the present proposed extension were granted witness estimated that the company would carry 50,000,000 people, and if the whole of the company's scheme—involving 40 miles—were authorised, 150,000,000 passengers per year might be carried. Among the petitioners against the Bill are several of the water companies, whose chief objection is that the clauses which were to protect their pipes from electrolytic action were not sufficient. With regard to the opposition of the London County Council, it is possible that an arrangement may be come to with the promoters. It was stated on Wednesday that if the company were prepared to allow the piece of line over Hammersmith Bridge to fall in with other spurs in 1909, the Council would not object to the company's making the line, and in the face of this evidence the chairman adjourned the enquiry to see if a satisfactory settlement could be come to with regard to the point in question.

London County Council Tramways.—At next week's meeting the London County Council will be invited by its Highways Committee to seek powers in the next session of Parliament for the construction of the following new tramways: North of the Thames—(1) Seven Sisters-road (existing lines), *via* Amhurst-park to Upper Clapton-road (existing lines). (2) Chelsea Bridge (north end), *via* Grosvenor-road, to a point near Lambeth Bridge. (3) Hampstead-road (tramway terminus), across Euston-road and along Tottenham Court-road, to a point near Oxford-street. (4) Edgware-road (from a point near the Marble Arch), to the county boundary at Cricklewood. (5) Harlesden (near the county boundary), *via* Scrubbs-lane, Wood-lane, Shepherd's Bush-road, Brook Green-road, and Fulham Palace-road, to Putney Bridge. (6) Uxbridge-road (near the railway station), *via* Richmond-road, Netherwood-road, and Westwick-gardens, to Shepherd's Bush-road. South of the Thames—(7) (*a*) Clapham Common, south side (London County Council tramways), *via* Clapham Common, Battersea-rise, Wandsworth Common, north side, and East-hill, to West-hill; (*b*) West-hill, *via* Kingston-lane, to the county boundary. (8) (*a*) Deptford (London County Council tramways), *via* Blackheath road and hill and Shooter's Hill-road, to the Herbert Hospital; (*b*) Herbert Hospital, *via* Woolwich Common-road, the road to the west of St. George's (Garrison) Church into New-road, and thence along Thomas-street and Green's End, to Beresford-square, Woolwich, and returning along New-road and Mill-lane, to a point in Woolwich Common-road near Nightingale-place. (9) New Cross-road (London County Council tramways), *via* Lewisham High-road, Loampit hill and vale, Lee High road and Eltham-road, to a point near Wellhall-lane at Eltham. (10) Streatham High-street (London County Council tramways terminus), *via* Streatham High-road, to the county boundary at Norbury. The total mileage included in this scheme is 28 miles, which, with street widenings, is estimated to cost £1,326 206.

Metropolitan District Railway.—The Court of Referees, presided over by Mr. Parker Smith, at the House of Commons on Wednesday, heard an application on behalf of the Middlesex County Council for a *locus standi* to be heard against the Metropolitan District Railway Bill to empower the company to work their railway by electric traction. Mr. Balfour Browne, K.C., in support of the application, said the County Council had not appeared against the Bill when it was before the committee, as they did not know it would affect them in any way. Since the construction of the Central London Railway, however, and the serious complaints of the damage caused to buildings by the vibration, the Council had become afraid that by the introduction of electricity on the District Railway the County Hall at Westminster, under which the railway passed, would suffer damage. The railway company had applied to Parliament for further powers in regard to the raising of money, and the County Council considered it an opportune time to apply for leave to be heard, with the view to obtaining the insertion of such a clause as would make it absolutely necessary for the company to carry out their works in such a way as to cause no damage whatever. He believed this was possible by a system of multi-motors, motors distributed throughout the train, instead of having a locomotive. Counsel contended that the object of the company in introducing electric traction was to increase the speed of trains, and with that increase of speed there was certain to be a great deal of vibration. A similar application on behalf of the Corporation of the city of London was also made. It was stated for the promoters that the speed would not be greatly increased. On certain sections of the line they had already a three-minute service, and it was hardly possible to put on more trains than they had at present. The *locus standi* was disallowed in both cases. Counsel on behalf of the London County Council, however, was granted leave to appear on the point of the provision of workmen's trains, and the city of London obtained a *locus standi* on the question of construction, of ventilation, and running of workmen's trains.

London Underground Railways.—The Joint Parliamentary Committee which has under consideration the question of routes for new tube railways in London resumed its sittings on Friday last, when Sir Alexander Binnie, engineer to the London County Council, gave evidence. On the plans, he said, there were 24 authorised lines. All tube railways hitherto had a gauge of 4ft. 8in. It was desirable to carry the tubes through the clay, but portions of the City and South London were carried through water-bearing strata, and had to be worked on the compressed-air principle, which added enormously to the expenses. He was at present constructing tube railways through Essex Marshes, under the River Lea. To be successful, underground railways must run trains frequently and at considerable speed. As to interchange stations, the most frequented points were Piccadilly-circus, Charing Cross, the Law Courts, near Somerset House, the junction of Tottenham Court-road and Oxford-street, the Bank, and the Liverpool-street Station of the Great Eastern Railway. Therefore a central station was not necessary. Geologically there would be difficulty in the subsoil at Barking in the gravel, chalk, and intermediate and miscellaneous strata. Financially, entirely new lines and proposed new lines would require £19,226.000; new lines, not "entirely new" or "proposed," £5 728 000; other divisional items, £6,318,000, £5 259,000, £11,701,710—total, £48,638,000. This, witness considered, was a prospect too vast to contemplate. Many of the lines were in conflict with each other, and incompatible with any scheme. But the cost of practical lines was compatible with low fares and fair return to the investor. Total cost of construction would in some cases be £400,000 per mile. On Tuesday was heard the case for the Charing Cross, Euston, and Hampstead Railway scheme, to which there was no opposition offered. It was stated that whatever conditions the Vibration Committee may impose, the promoters will be prepared to insert clauses to that effect in the Bill. Mr. Cripps, parliamentary agent to the London County Council, then continued his evidence. The Council wanted to see that every £100,000 of capital represented 100,000 sovereigns put into the works. He was of opinion that the existing underground railways of London should be taken into consideration in sanctioning the proposed lines, and should be afforded protection, as a great deal of money had been expended upon them. The London County Council would like to see the Charing Cross, Euston, and Hampstead Railway constructed. Witness said the north-eastern district was more in need of railway accommodation than was Hampstead. It would be difficult to raise the capital for tube railways in the ordinary way, and it might be necessary, therefore, that outside assistance should be sought. The committee adjourned.

LIGHTING AND GENERAL.

Dumbarton.—The Town Council intend to petition against the Clyde Valley Electric Power Bill.

Kirkintilloch.—The Council are continuing their opposition to the Clyde Valley Electric Powers Bill.

Kinning Park.—The electric lighting of the burgh by the Glasgow Corporation is under negotiation.

Southend.—The Town Council have obtained sanction to borrow £40,000 for electric lighting purposes.

South Shields.—Mr. J. H. Cawthra, borough electrical engineer, Swansea, has been appointed borough electrical engineer.

Cleveland and Durham County Electric Power Bill.—This Bill has been read a third time in the House of Commons.

Bacup.—The Council have accepted the offer of the Lancashire Electric Power Company for a supply of electricity in bulk.

Seaton Delaval.—The proposal to light part of the district will be discussed at a meeting of the Parish Council in November.

Birstall.—The Bill to confirm the Birstall electric lighting provisional order has been read a first time in the House of Lords.

Swadlincote.—The Urban District Council have resolved to provide additional electric lighting accommodation at Stanton.

Lichfield.—The Bill to confirm the Council's provisional order has been reported to the House of Commons without amendment.

St. Austell.—The Bill to confirm the provisional order relating to electric lighting at St. Austell has been reported for second reading.

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Brierfield.—We understand that Mr. A. G. Cooper, of Colne, is preparing an estimate of the probable cost of electric lighting for the Council.

Copper.—It is reported that the shipments of copper to the United States for electrolytic purposes have for the time being entirely ceased.

Share Market.—During the past week there was little change in electric shares, with the exception of traction preference shares and debentures.

Ashton.—The electrical engineer is preparing specifications, etc., for a surface condenser to be installed at the Corporation electricity works.

Ormesby.—The Urban District Council have decided to petition in favour of the Cleveland and South Durham Electric Power Bill in the House of Lords.

W. T. Glover and Co., Limited.—The debenture stock transfer books of the Company will be closed to June 30 for the preparation of the interest warrants.

Abersychan.—The Westlake Brewery Company, Cwmavon, are making enquiries with regard to their power to supply Cwmavon with electric light. Lamps of 16 c.p. will be used.

Stratford-on-Avon.—The Bill to confirm the Council's electric lighting provisional order has passed through the Unopposed Committee of the House of Commons without amendment.

Chelsea Electricity Supply Co.—The transfer books of the preference shares, ordinary shares, and debenture stock will be closed to July 2 for the preparation of dividend and interest warrants.

Dundee.—The Dundee Horticultural Society have resolved to light the forthcoming flower show on Magdalen Green with electricity, the work being given to Messrs. James Maxwell and Son, King's road.

Stock Exchange.—The Stock Exchange Committee have ordered Castner-Kellner Alkali Company's further issue of £100,000 4½ per cent. first mortgage debenture stock to be quoted in the official list.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, free of income tax, payable on the 15th prox.

Penzance.—An offer from Edmundsons' Electricity Corporation, setting forth the terms on which they would be prepared to take over the electric lighting in Penzance, is being discussed by the Electric Light Committee.

Orrell.—At last week's Council meeting a letter was read from the Lancashire Electric Power Company, asking for an early interview with reference to the supply of electric power to Orrell. It was decided to leave the matter over for the present.

Argentine.—The Argentine Government has decided to ask Parliament for a credit of £70,000 for the construction of a cable between Chilecito and the Famatina Mines. This undertaking is regarded as real progress in mining industry in Argentine.

Llandudno.—The District Council have decided to apply to the Local Government Board for power to borrow £3,621 to cover money expended over and above the loan received for electric lighting purposes, and the probable amount required within the next two years.

Weston super-Mare.—We understand that Mr. Hawbayne has been asked to prepare specifications of the works of lighting the new pavilion with electric light. The District Electric Supply Company have also been requested to quote a price for supplying current to the pavilion and new swimming-baths.

Heywood.—The Electric Lighting Committee have resolved to undertake the wiring of consumers' premises and the supply of electrical fittings, including motors, on the deferred payment system. The clerk of works is endeavouring to obtain from manufacturers of electric motors particulars of price.

Teddington.—The London United Tramways Company have informed the Council that they are unable to give any further definite information at present as to the supply of electric current for lighting purposes. A letter from Edmundson's Electricity Corporation is before the Electric Lighting Committee for report.

Heating.—It is reported that the majority of the bed and dressing rooms in the King's apartments at Windsor are to be heated by electric stoves, each consisting of four large incandescent burners about 1ft. long. The burners are set in a burnished copper reflector, similar to the reflecters used in some forms of gas-stoves.

Blackrock.—The Dublin Electric Lighting Committee have informed the Urban District Council that they are prepared to enter into arrangements for the supply of current for the purpose indicated on the completion of the new electrical plant at the Pigeon House, which they hope will be in working order in a little over 12 months from now.

"Photographic Chronicle."—The first number of this new journal, devoted to the commercial and recreative branches of photography, has just been published, and promises to be an acquisition to the ranks of technical journalism. It will be published on the 1st and 15th of each month, at 2d., by Dean's Publishing Company, Chancery-lane.

Grimsby.—Mr. Vignoles in his last report states that since the last meeting 1,000 lamps had been connected, and he knew of nearly 1,800 more that would be required. The total number of lamps being wired and connected was 7,914. Financially, the committee had made a profit of £34. 17s. 6d. on the working expenses for the 8½ weeks ending May 30.

Bo'ness.—At a recent meeting of the Town Council it was agreed to suspend negotiations with Messrs. Crompton and Co., in connection with their proposal to light the town by electricity. It is proposed to appoint an electrical engineer to visit the burgh and report as to the advisableness of adopting the electric installation in Bo'ness; also to give the comparative cost of gas and electricity.

Tyne Commission.—The War Department have obtained permission to lay two submarine electric cables on or across the bed or foreshore of the River Tyne at the Narrows, also underneath the Commissioners' railway leading to the south groyne, and thence across the northern end of the Herd Sand, the total distance to be traversed by the submarine electric cables to be about 2 010ft.

Greenwich.—The Borough Council have, in view of the application of the City of London Electric Lighting Company, Limited, to the Board of Trade for a provisional order to empower that company to supply electric energy for all purposes throughout the whole of the area of the borough, referred to the General Purposes Committee to consider the whole question of electric lighting of the borough.

Harnessing the Mountain Torrents.—The Davos power scheme is being revived, and it is stated that the powers governing that famous health resort are seriously contemplating the total abolition of all forms of fuel in favour of an electric installation on a gigantic scale. The scheme, which will cost £340,000, is to utilise the motive power of two neighbouring mountain torrents to generate sufficient electricity.

Wakefield.—The Electric Lighting Special Sub-Committee have recommended that, in order to adopt the present plant for power purposes, the electrical engineer be instructed to have the No. 4 engine altered to a two phase plant, at an estimated cost of £600, and that tenders for carrying out the work be obtained and left in the hands of the chairman, deputy-chairman, and engineer to deal with.

Aldrington.—The Hove Town Council have appointed Messrs. Handcock and Dykes, Westminster-chambers, 1, Victoria-street, S.W., to prepare plans sections, estimates, etc., to support an application to the Local Government Board for sanction to borrow the necessary amount required to give effect to the Aldrington electric lighting order, and also to obtain the consent of the Board of Trade to the scheme.

Kingstown (Dublin).—We referred last week to the plans which have been prepared for an electric light installation in the township. The engineer estimated that the scheme would cost £50,000, but the contractor was prepared to execute the work for £45,000. When the matter came before the Council this week the scheme was discussed at length, and ultimately a motion was carried postponing its consideration for a month.

Stafford.—The accounts of the electricity department for the year ended March 31. 1901, show that the electrical energy generated amounted to 261,599 units, being an increase of 143,250, or 121 per cent. over the previous year; the equivalent in 8-c.p. being 10,813, or an increase of 2 255. The total revenue amounted to £2,532 16s. 6d., being an increase of £760. 0s. 11d.; the expenditure was £1,925. 0s. 11d., of £718. 18s. 10d. The gross profit is £607. 15s. 7d.

Personal.—Mr. W. W. Alston, of the Bury Corporation electricity works, has been appointed assistant electrical engineer at King's Lynn under Mr. John Pilling, A.M.I.E.E.—Mr. A. J. Ostler, of West Ham electricity works, has been appointed to the post of charge engineer at the electricity works of the Bristol Corporation under Mr. Faraday Proctor, A.M.I.C.E. and M.I.E.E.—With reference to a personal paragraph in last week's issue, we are informed that Mr. L. P. Greig was, before his appointment to Bury St. Edmunds, assistant installation inspector under the superintendent of mains at Edinburgh.

Wireless Telegraphy.—The Admiralty have ordered some 60 sets of wireless telegraphic apparatus to be made according to their own system and specifications for use on battleships and cruisers. The delicate part of the work has been placed with Mr. W. H. Sullivan, of Great Winchester-street. According to the *Globe*, Colonel Pilsoudski, of the Russian army, has just succeeded in transmitting a telegram without the use of a wire by utilising the conductivity of the earth. The journal says that the insignificant force which will transmit through air a distance of only 50m., will allow transmission through the earth for a distance of 550m.

Nantwich.—The Council have adopted a report of the Electric Lighting Committee recommending that the engineers be informed that the committee would be prepared to recommend the Council to approve the preliminary plans, estimates, and report of the engineers as to the proposed electric light works, mains, and refuse destructor subject to the modifications agreed upon by the committee with the engineers as follows: an accumulator to be put in instead of the small set of engine and dynamo for night load in connection with the sewage pumping station; eight arc lamps to be taken out of the scheme of street lighting. The total cost to be as follows: electric light works and mains. £12 505; refuse destructor. £1,275—total capital outlay, £13,780. The laying of such of the mains included in the report and estimates as the Council on the recommendation of the committee or otherwise might determine not to proceed with in the first instance to be deferred for such period as might be determined; and that the engineers be requested to furnish a revised report in accordance with the terms of that resolution.

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Buxton.—Electricity has much to answer for. When at a recent meeting of the Urban District Council it was mentioned that a summons had been served upon the clerk to appear before the magistrates for a nuisance arising through the chimney of the electricity works sending forth black smoke, one of the councillors said he had white cows at Fairfield, and it had turned them into black ones. Enough to turn anyone's hair grey.

Holidays in the Eastern Counties.—We beg to acknowledge receipt of an advance copy of the Great Eastern Railway Company's new hand-book, "Holidays in Eastern Counties," by Percy Lindley. Prominence has been given to some less known districts in East Anglia, and the illustrations throughout the little volume are many and of beautiful execution. Detailed information is given as to fares, hotels, golf links, etc.

Rowley.—At the last meeting of the District Council the Electrical Supply Committee reported that they had had an interview with Mr. McLean, the representative of the Midland Electric Corporation, to discuss matters connected with the carrying out of their undertaking provided in the provisional order passed in 1898. It was reported that a distributing station was about to be erected at Reddall Hill-road, Old Hill. The matter was referred back to the committee for further consideration.

Morecambe.—The Chairman of the Electricity Committee stated at the last meeting that there had not been much more than half the current consumed that they expected owing to the bad season and other causes. A great hardship to the undertaking was that the repayment of the loans had to be made in 25 years. For the gas undertaking a period of 50 years had been allowed, and if the same period had been allowed to the electricity undertaking, it would have been relieved to a very great extent.

Beckenham.—The Electric Lighting Committee are willing to extend arc lighting in main roads as soon as the new machinery (on order) rendered such extension possible. The British Insulated Wire Company, Limited, have offered to charge 2d. per unit for current used for motors, with a reduction of 1½d. per unit where so used on an average for six hours a day. The company have also agreed to reduce the charge for current to the institute and baths to 4½d. per unit. It is stated that the electric light extension will be ready by next January.

Hull Telephones.—The Hull Corporation Telephone (Special) Committee have resolved to recommend the City Council to make application to the Postmaster-General for a license to establish a municipal telephone exchange to expire in 1911. They will also approach the Post Office as to the terms on which they would be prepared to sell their telephone plant. In reply to the canvass, 354 persons are prepared to become subscribers for 1,029 instruments, and it is stated that the Local Government Board are prepared to sanction the borrowing of a loan for the purpose of establishing the exchange.

Leyton.—Mr. Hawkes, of Leyton, recently obtained an order in Chancery restraining the Leyton Urban District Council from continuing a nuisance arising from the use of gas engines for the generation of electric light. The Council abated the nuisance in part by substituting steam-engines for some of the gas-engines, but Mr. Hawkes obtained a sequestration order for non-compliance. The Council then obtained an extension of time. Lords Justices Rigby, Collins, and Romer have now granted the Council a further extension for 18 months on the ground that it would take that time to replace all the gas-engines by steam-engines.

Walsall.—The last report of the Electric Light Committee shows that the total number of consumers supplied on May 31 last was 186. The total output from the main generators was 26,406 units. The machinery has been run for 423 hours during the past month. The committee have approved of part of the corporate land fronting Freer-street, forming part of the pig market, with the building thereon formerly used as a weights and measures office, as a site for the new transformer sub-station, and instructions have been given for tenders to be obtained for carrying out the structural alterations necessary to make such building suitable for the purposes for which it is required.

Inverness.—The Town Council have adopted a recommendation of the Electric Light Committee with regard to the question of obtaining water power for electric lighting purposes in the burgh. The burgh engineer submitted a plan in connection with the proposal to obtain a supply of water from Loch Dochfour, and said he thought the cost of bringing the water in a conduit or series of pipes to the works would be within £20,000. Mr. James Fraser, C.E., Inverness, has been instructed to prepare a preliminary plan, section, and outline of a water-power scheme that would enable the Council to treat with the Caledonian Canal Commissioners and owners of land; and also, if Mr. Fraser saw fit, to report on any other source of water power.

Bedford.—The Urban District Council propose to alter the present method of payment to the electrical engineer of salary and commission to a fixed annual salary, but have not come to terms as yet. The electrical engineer has been instructed to obtain one dozen five-ampere meters at £45, and 50 pairs of service cut-outs at an estimated cost of £14. The following motions will come before the next meeting of the Council: "(1) That it be an instruction to the Electric Lighting Committee not to contract any debt on account of capital expenditure to be provided for out of loans, until such loans shall have been sanctioned by the Council and the money received. (2) That until the present capital expenditure of £85,000 be made remunerative, no further loans be applied for."

Alloa.—Mr. Hogarth, of Messrs. Buchan and Hogarth, Edinburgh, the Council's electrical engineers, made a statement at the last meeting of the Town Council with reference to the progress of the arrangements relative to the introduction of the electric light, and he also submitted estimates for the cabling of the scheduled parts of the town, and for a supply of electric lamp pillars. The tenders recommended for acceptance by him were approved of, and it was mentioned that the work of laying the cables would be proceeded with in the course of the next two months. Authority was also granted the Electric Light Committee to arrange as to the formation of private connections, and also obtain an estimate for the lighting of the town hall and the municipal buildings.

Keighley.—The mayor and the mayoress (Mr. and Mrs. H. C. Longedon) the deputy-mayor and the deputy-mayoress (Alderman and Mrs. B. S. Brigg) on Saturday assisted at the opening of the electric lighting of the town. About 9 45 the mayoress proceeded to the box opposite the end of Hanover-street, and switched on current to Cavendish street, Low-street, East-parade, the railway bridge, and Church-green. The party afterwards drove to the electric lighting station at Low Bridge, where further ceremonies were performed. The two engines and dynamos were started by the deputy-mayoress and the mayoress respectively, whilst Mrs. W. Clough (wife of Alderman Clough) set the electric motors into motion from the switchboard. After the usual toasts had been proposed and responded to, the party made a tour of inspection through the works under the guidance of Mr. J. M. Smyth, the electrical engineer.

King's Lynn.—Applications have been received from private consumers for 8,629 lamps of 8 c.p. or equivalent, being an increase of 100 lamps during the month and the street lamps for Wisbech-road and Diamond-street have been fixed. The chairman and electrical engineer have been asked to report in reference to additional lamps required for lighting Gaywood-road; the engineer is also to submit a report showing the cost of lighting the public walks. Eight lamp posts are to be erected for lighting Hardwick-road. Under the revised charges for current to churches and chapels the price per unit will average about 4 6d., this price comparing favourably with the prices in other towns where special rates are offered. The engineer has reported that Mr. E. T. Williams had sent in his resignation he having been appointed assistant engineer at Belfast electricity works, and that advertisements had been issued for an assistant engineer to fill the vacancy at a salary of £80 per annum. Three candidates are to be selected to appear before the committee.

Coventry.—The annual report of the Electric Light Committee contains the following: "The number of customers has increased from 226 to 331 during the year, and the lamps connected from 17,906 (8 c.p.) to 23,637, and further connections are being made. The number of units sold has increased from 229 697 to 341,810, and the revenue from sale of current and meter rental from £4,188. 16s. 7½d. to £6 053 17s. 3½d. The increase in units sold to private consumers has been from 169 056 to 268,982, and the revenue from this source is £5 120 18s 6d, against £3 500 8s. 4d. The profit on working is £1,528. 18s. 2½d., against £786. 19s. 8½d. This would have been substantially greater but for the rise in the price of coal. The capital charges amount to £3,789. 14s. 2d. The sinking fund charge has been increased by the amount payable in respect of the capital expended during the previous year. The net charge on the rates is £2 250. 15s. 11½d., against £1,745. 5s. 5½d. last year. The whole of this sum, except £553. 10s. 3d., has been raised by means of rates already made."

Indian Bills and Telegraphic Transfers.—In the House of Commons on Monday Sir Edward Sassoon asked the Secretary for India whether he was aware that the difference of a sixteenth of a penny ordinarily made by the India Council between the sale of bills and telegraphic transfers represented a charge of 9½ per cent. per annum; and whether, in view of this impost upon banking and commercial transactions, he would give instructions for reducing the difference by one moiety, except on occasions when conditions of financial stringency prevail in India. Lord George Hamilton replied that the difference of a sixteenth of a penny per rupee between the price of bills on India and that of telegraphic transfers represented a charge of 9½ per cent. per annum, if it could be assumed that all such bills, whether drawn on Calcutta, Madras, or Bombay, could be presented in 15 days, but this was not the case. To give the telegraphic transfers at only one thirty-second of a penny more than bills, would, with the present rates of discount, be in effect to lend the money at cheaper rates than that at which the Presidency banks were lending it.

Newark.—Colonel Durnford has held an enquiry into an application by the Town Council for sanction to borrow £30,000 for the purpose of the electric light. Mr. Vesey Brown gave some particulars as to the scheme, which is estimated to cost £27,250, with £2,750 engineering expenses and contingencies. The supply will be on the three-wire continuous-current system, with 460 volts between the outer conductors. The cables will be laid solid in wooden or iron troughing. Three engines of the high speed enclosed type are proposed, the dynamos being coupled direct. An economiser will be used in conjunction with the three boilers. A storage battery will also be provided, also the necessary switchboard and motor-generators. The number of 8-c.p. lamps which the installation will be able to supply will be approximately 16,000. The estimated number of consumers when the plant is completed is 300. An estimate has been made by which it has been shown that the annual expense of maintaining the plant, including interest and sinking fund, will be £4,000 per annum, when 250,000 units are sold, and the revenue at an average price of 5d. per unit will be slightly over £5,200 per annum. The public lighting will be by means of incandescent lamps.

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Yarmouth.—The Town Council have adopted a report from the Electric Lighting Committee, containing the following report of the borough surveyor: "Since the last report applications have been received from 46 customers for 1,399 lamps, making a total of 521 customers for 25,968 lamps of 8 c.p. The borough accountant has now made up the accounts for the past year, and instead of submitting an estimate of the quarter's working, I am able to present the actual results of the 12 months, which I regret are not so satisfactory as I had hoped. The income for the year has been £7,225, the working expenses £5,406, leaving £1,819 to pay interest and sinking fund, and as these, with some other small items, amount to £2,570, there is a deficiency of £751. This will not fall upon the rates, as there was a balance last year of £371; and a sum of £380 will be carried forward to next year's account. This result has been caused by the high price of coal, which has made the production more costly by about £650, and the reduction in price to customers—made before coal was increased in price—amounting to £900; but this reduction resulting in the large number of additional lights put on by existing customers, and the 111 new customers obtained during the year, will in the end quite recoup the Council, and with the reduced price of coal I anticipate that this loss will be fully met in next year's account. The capital outlay on the works on March 31 last was £44,392, and the sinking fund towards its repayment £5,789. Of this sum £3,896 has been paid out of the profits earned, and £1,893 in the first three years' working, paid out of the rates. The sum contributed to the rates of the town this year on the assessment of the undertaking has been £201." Loans to the amount of £67,000 have been sanctioned, of which £43,995 has already been borrowed.

Sheffield.—At the last meeting of the council of the Sheffield Chamber of Commerce the reply of the Postmaster-General to a letter sent to him on the subject of the interruption of telegraphic communication by storms was read. His Lordship, after pointing out that it was the practice of the Department whenever the service was interrupted by a storm to give notices of delay for public information, and that by the use of stouter timber and reserve wires much had been done to provide against interruptions, referred to the provision of underground lines. The great costliness of guttapercha-covered wire and its electrical defects had until recently stood in the way of its being used except to a limited extent. The introduction of the paper-insulated cable, which was both cheaper and better from an electrical point of view, had, however, enabled the Department to construct the important experimental underground line between London and Birmingham, and the line had already proved of great advantage during the storms which occurred last year. It was subject to some drawbacks, but the Postmaster-General felt justified in extending it further northward, and sanction for the necessary expenditure would be sought. He was not without hope that some of the difficulties and drawbacks still connected with an underground system would be surmounted, and that the Department would be justified in further extending it. But it was necessary to proceed with caution. Another letter mentioned the places on the Continent to which telephone and telegraph cables and direct wires are now laid, and stated that the Government was in negotiation with the Italian Telegraph Administration respecting a direct wire to Milan. The amount of telegraph traffic was not sufficient to justify the establishment of a direct wire to Munich, nor did the Postmaster-General feel that he could with propriety make representations to the French Telegraph Administration respecting the provision of direct wires between Havre and the cotton-manufacturing towns in the North and East of France. As regarded telephonic communication between provincial towns in England and France, he was in communication with the authorities, and hoped it would be possible before long to bring this extension of the service into operation. The question of a decentralisation of the central telegraph office in London had for some time been receiving careful attention. No definite decision had yet been arrived at in the matter, but all that was possible would be done for the acceleration of the foreign telegraph traffic at present passing through London. On the question of the provision of direct wires from provincial centres in England to the Continent, he did not see his way to arrange for the establishment of any additional wires of this description, with the possible exception of one between Liverpool and Paris.

Wolverhampton.—The Town Council on Monday adopted the following report from the Lighting Committee on the past year's working of the electricity undertaking: "The net result, after payment of interest and sinking fund charges, is a loss of £130. 16s. 6d. In explanation of this, it should be pointed out that the sum of £545. 18s. 3d. has been expended during the year out of the revenue of the department in respect of the 'change over' of the system of supply, sanctioned by the Council in November, 1898. In addition to this, the average price obtained per unit during the past year has been only 4·31d., as against 4·815d. during the previous year, and this decrease in the selling price of the electrical energy produced during the year ending March 31, 1901, represents a loss of revenue amounting to £1,166. This decrease in the price obtained is due to the reduction in the charge for electricity made by the Council on July 9, 1900. It will be seen that if the cost of the change over (£545. 18s. 3d.) is included, the net profit for the year would have been £415. 1s. 9d. It should also be pointed out that the increase in the price of fuel has had a most adverse bearing upon the financial result. This item alone accounts for an additional expenditure of £592. 2s. 5d. over the amount that would have been paid had the price remained as during the previous year. Moreover, owing to the non-delivery of the new generating plant, ordered in October, 1899, your committee have been unable to complete the change over of the system of supply, and it has therefore been necessary to keep two distinct systems in operation during the whole of the past year, with a consequent increase in the working costs. The amount charged to revenue in respect of the sinking fund on capital, has been increased during the year by £845. 3s. 11d. in respect of the first instalment on the £28,870 loan, which loan is, as yet, only partly productive. Having regard to the foregoing facts, your committee are of opinion that the result of the year's working is very satisfactory, and shows that the undertaking is in a sound financial condition. It is hoped that the change over of the system will be completed during the ensuing year, and that the current year will be the last occasion upon which the revenue of the department will be charged with any costs in respect of this. Your committee again desire to call attention to the satisfactory growth of the undertaking. From the following figures it will be observed that the amount of electricity sold, the increase in the number of consumers, and lamps connected compare very favourably with previous years:

Year.	Consumers.	Increase. %	Lamps connected.	Increase. %	Units sold.	Increase. %
1st ...	113 ...	— ...	8,941 ...	— ...	191,701 ...	—
2nd ...	154 ...	36 ...	11,307 ...	26 ...	224,709 ...	17·2
3rd ...	208 ...	35 ...	14,151 ...	25·2 ...	291,233 ...	29·55
4th ...	276 ...	32·7 ...	19,932 ...	40·8 ...	371,830 ...	27·5
5th ...	364 ...	32 ...	25,184 ...	26·3 ...	482,247 ...	29·7
6th ...	461 ...	26 ...	33,833 ...	34·42 ...	633,508 ...	31

The supply of electricity for motive power purposes is also increasing in a satisfactory manner, and your committee have reason to hope that this branch of the undertaking will prove both a great convenience to the users of power within the borough, and also be a source of profit to the Corporation. Rapid progress is being made in the electric lighting branch of the undertaking, especially in the residential districts, 19 private consumers having been connected to the mains during the past year's working. Your committee are contemplating considerable extensions of mains in various portions of the borough during the present year, and it is expected that the results obtained therefrom will fully equal, if not exceed, the results achieved by the progressive policy of your committee in the past."

London County Council.—The Council at Tuesday's meeting agreed to lend the Hackney Borough Council £50,000 for electric light installation and street-lighting purposes; the St. Pancras Borough Council £50,000 for electric light installation; the Southwark Borough Council £13,980 for the same purposes; the Hampstead Borough Council £9,525 for the same purposes; and Stepney Borough Council £380 for electric light extensions. The Highways Committee recommended that the Council should instruct the Parliamentary Committee to prepare the draft of a Bill, on the lines of the suggested clause agreed to at the recent conference of local bodies, relative to the purchase by local authorities in combination with each other, or by the London County Council, of undertakings for the supply within the county of London of electricity in bulk; and that such Bill should be submitted, in draft, for the consideration of the Corporation of the city of London, and the respective councils of the city of Westminster and of the several metropolitan boroughs. This report was adopted. The Parliamentary Committee desired to be authorised to seek legislation in the next session of Parliament to empower local authorities in London supplying electricity for lighting purposes to wire and fit consumers' premises for electric lighting, on such terms as they may decide upon, and to empower the Council to lend, and the local authorities to borrow, money required for carrying out such work. The same committee also recommended that a petition be sealed and presented, if necessary, against the Notting Hill Electric Lighting Company's Bill in the House of Lords. The following notices under Electric Lighting Acts and Orders were agreed to: Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, to lay low-tension mains along Wemyss-road, Royal-hill, and Ulundi-road. Charing Cross and Strand Electricity Supply Corporation (1) under the Strand District Order, 1896, to lay mains from the company's station in Maiden-lane, along that thoroughfare and Chandos-street; (2) under the St. Martin's District Order, 1889, to lay mains along Chandos-street, Bedfordbury, New-street, and St. Martin's-lane, to the company's station there; (3) under the City of London Order, 1899, to lay mains along the Queen Victoria-street subways from Lambeth-hill to the eastern end of Queen Victoria street, and to make connections from the subways at certain points. County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, of intention to lay low-tension mains along both sides of Chumleigh-street, and to lay high and low tension mains across Rye-lane and along a portion of Elm-grove, and to construct a transformer box in Elm-grove; also under the Wandsworth Order, 1892, to lay high and low tension mains along Venn-street and across High-street, and low-tension mains along Clapham Common (south side), and to construct a transformer box in Venn-street. Metropolitan Electric Supply Company, under the Paddington Order, 1890, to lay high-tension mains along Sutherland-avenue, Foscote-road, and Amberley-road. St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along portion of James-street and Gordon-square. County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Order, 1892, to lay power and low-tension mains along Hermes-street, from Pentonville-road to Hermes-hill. The London Electric

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Supply Corporation, under its order of 1889, to lay distributing mains along Mermaid-court, Tennis-court, Bowling Green-lane, and across Newcomen-street. The Metropolitan Electric Supply Company, under the Paddington Order, 1890, to lay high-tension mains across and along a portion of Harrow-road, across Westbourne Park-road, along a portion of Talbot-road, and along Porchester-terrace; under the West London Order, 1889, to lay low-tension mains across and along a portion of Edgware-road. The Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1889 and 1895, to lay mains of low and extra high tension along Napier-road, and low-tension mains along Addison-road, Kensington-road, Russell gardens and road, and Holland-road. St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along a portion of Gaisford-street. The Council further received notices as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works: from the Hammersmith Borough Council, under the Hammersmith Order, 1893, to lay mains along Coverdale-road, along Ravenscourt lane and square, Ashchurch-grove, Askew-crescent (south and east sides), Poplar-grove, Cromwell-road, Richmond-gardens, Roseford-gardens, Camden-gardens, and Cambridge-road, Aide-road, Agate-road, and Beauclerc-road; from the South London Electric Supply Corporation, under the Lambeth Order, 1892, to lay mains of high and low tension along both sides of Rosendale-road, Dalmore-road, Eastmearn-road, Buccleugh-road, Chancellor-road, Mytton-road, Martell-road, Paget-road, Carson-road, Park-road, and Chestnut-road; from the Woolwich Borough Council, under the Plumstead Order, 1899, to lay mains along portions of Cambridge-place, High-street, Plumstead, and Walmer-road.

PROVISIONAL PATENTS, 1901.

JUNE 10.

11838. Improvements in regulators for electric or other meters operating air or other fluid compressors. Philip Middleton Justice, 55, Chancery-lane, London. (The "Long Arm" System, United States.)

11845. Improvements in or relating to electric wire switch couplings. Alfred Jewell Adkins, 59, Walham grove, Walham Green, London.

11847. Improvements in or relating to electrostatic instruments. George Leonard Addenbrooke, 37, Essex-street, Strand, London. (Complete specification.)

11854. Improved automatic electric cut-out for overhead wires or conductors. David Alaxanda Lowery, 18, Buckingham-street, Strand, London.

11857. Improvement in armature windings for dynamo-electric machines. Engelbert Arnold and Friedel Collischonn, 47, Lincoln's-inn-fields, London.

JUNE 11.

11922. Improvements in or relating to electric meters, meters, and methods of compensating for phase-displaced currents. Ludwig Gutmann, 6, Lord-street, Liverpool. (Complete specification.)

11925. Improvements in apparatus for connecting the ends of electric cables and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Francis H. Stillman, United States.) (Complete specification.)

11931. Improved method of regulating and controlling the speed or power of electric motors. Walter Lacy Allcroft, 166, Fleet-street, London.

11949. Improvements in electric telegraph apparatus. Freeman Howard Littlefield, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

11951. Ampere-meter for the registration of the maximum consumption of electrical energy. Hugo Helberger, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 12.

11992. Improvements in means for accentuating electrical contacts. The British Thomson-Houston Company, Limited, Bush-lane House, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

12016. Framework for alternating-current electrical machines. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

12020. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

12023. Improved mechanically-operated and electrically-controlled alarm apparatus. Wladislaw Kielpinski, 322, High Holborn, London. (Complete specification.)

JUNE 13.

12061. Improvements in etheric telegraphy. The Scottish Wireless Electric Syndicate, Limited, and Walter Jamieson, 53, Bothwell-street, Glasgow.

12069. Improvements in automatic electrical signalling apparatus for railways. James Ernest Spagnoletti, 53, Chancery-lane, London.

12071. Electrical ignition and valve-operating mechanism for oil or petrol engines for motor cycles. Silvain de Jong, 5, Budge-row, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 22, 1900, being date of application in Belgium.) (Complete specification.)

12088. Improved method of and means for taking electric current from transformers. Gustave Weissmann, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 5, 1900, being date of application in France.)

12094. Improvements in electric cables. Francis Tremain, 70, Palace chambers, Westminster, London.

12119. A new or improved method of and combination of apparatus for translating and relaying telegraph cable signals. John Peter Gorton, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

JUNE 14.

12121. Machinery for pressing the copper segments and insulating strips of electric commutaters into annular form. Albany Francis Petch, 42, Florence-road, Finsbury Park, London.

12134. Improvements in or relating to electric arc lamps and electrodes therefor. Charles Andrew Lee, 56, Paulton's-square, Chelsea, London.

12139. An improved device for the prevention of accidents from overhead trolley wires. Clarence Jones, 8, Clayton-street, Blackburn.

12153. Improvements in electrically-propelled cycles, auto-cars, and other like vehicles. Charles Adams-Randall, 5, Salters' Hall-court, London.

12195. Improvements in and in the construction of electrodes. William Phillips Thompson, 322, High Holborn, London. (Robert Jacob Gülcher, Germany.)

12210. Improvements in electrostatic separators. Clinton Emerson Dolbear, 46, Lincoln's-inn-fields, London. (Complete specification.)

12218. Improvements in electric clocks and automatic alarm transmission. G. B. Bowell, 40, Chancery-lane, London.

12220. Improvements in electric telegraphy. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Complete specification.)

12223. Improvements in or connected with the field regulation of electro-dynamic machinery. James Cooper Wilson, Norfolk House, Norfolk-street, Strand, London.

JUNE 15.

12229. Improvements in ceiling roses for use in electric lighting. John William Gilbert, 60, Newhall-street, Birmingham.

12241. Improved manufacture of electric illuminating bodies. Wilhelm Boehm, 111, Hatton-garden, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on July 6.

1900.

4719. Electric meters. Marr and Laidler.

10940. Incandescent electric lamps. Swinburne.

12531. Positive electrode for accumulators. Von Sedneff.

12739. Dynamo brush. Ringsdorff.

12855. Manufacture of bulbs for electric incandescent lamps. Junge. (Oberlausitzer Glashüttenwerke Otto Hirsch.)

13081. Means for grinding and truing-up dynamo commutaters and the like. Purdy.

13722. Contact devices, chiefly designed for use in connection with electrical counting or recording devices. Staveley and Parsons.

14422. Switches and apparatus for use in starting and controlling electric motors. Adams.

14552. Conduits for electric conductors, water, or the like. Tugby.

14704. Transmitters for electrical waves or like apparatus. Braunerhjelm. (Date applied for under International Convention, Jan. 26, 1900.)

17379. Electric meters. Lake. (Soc. pour L'Exploitation des Compteurs Electriques Rittener et Cie.)

22851. Apparatus for automatically electrically collecting and conveying letters and other postal matter. Gordon.

1901.

367. Multiple wall connections for electric lighting, heating, and the like. Lundberg and Lundberg.

4494. Process for making electrodes for accumulators. Thompson. (Akkumulatoren und Elektricitäts-Werke Aktiengesellschaft, formerly W. A. Boese and Co.)

6870. Coin-controlled apparatus for telephones. Lewis.

6940. Audible electric telegraphy. Oxlade and Richardson.

8962. Switch apparatus for use in a surface-contact system of electric traction and operating switches used in such system. Parker.

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9265. Electric arc lamp. Young.
9266. Telephone transmitters. Wise. (Yocam.)
9268. Electric arc lamps. Lane.
9267. Electric cables. Gould.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 15	705	724	− 19	—	—
Birmingham Trams.	,, 15	4,640	4,450	+ 190	—	—
Blackburn Corp'rat'n	,, 14	553	461	+ 92	11,096	10,061δ
Blackpool Corporatn.	,, 13	747	1,238	− 491	7,702	5,826
Blackpool-Fleetwood	,, 15	553	990	− 437	8,425	8,715
Bolton Corporation..	,, 16	1,337	1,550	− 227	33,441	24,188
Bradford City Trams	,, 16	1,144	577	+ 567	—	—
Bristol Tramways Co.	,, 14	4,504	3,180	+1,324	—	—
Carlisle Tr'mw'ys Co	,, 8	185	—	—	3,272	—
Central London Ry.	,, 15	6 239	—	—	148,770	—
City & South London	,, 16	1,862	1,480	+ 382	47,071	30,735
Cork E. T. and L. Co.	,, 13	536	439	+ 97	9,881	8 574
Darwen Corporation	,, 14	216	149	+ 67	4,280	3,545
Dover Tramways ...	,, 15	217	214	+ 3	4,388	4,072
Dublin & Lucan E.R	,, 15	114	112	+ 2	2,231	2,100
Dublin U.T., elec. cars	,, 14	3,778	3,665	+ 113	—	—
Dublin S.D. Electric	,, 14	913	1,005	− 92	—	—
Dundee Tram Co.	—	—	—	—	—	—
Glasgow Corporation	,, 15 1	1,419	9,986	+1,433	—	—
Halifax Corporation	—	—	—	—	—	—
Huddersfield Corp'n.	,, 15	931	722	+ 209	9,623	7,845
Hull Corporat'n E.S.	,, 15	1,661	1,303	+ 357	74 677	38,671
Liverpool Corporat'n	,, 8	9,590	9,391	+ 199	193,714	165,933
Liverpool Overhead	,, 16	1,607	1,424	+ 183	—	—
Oldh'm-Asht'n-Hyde	—	—	—	—	—	—
Portsmouth Corpn....	,, 15	636	—	—	—	—
St. Helens Tramwys.	—	—	—	—	—	—
Sheffield Corporation	,, 16	3,583	—	—	—	—
Southampton Trams	,, 13	845	610	+ 235	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—
Wolverhampt'n C'p'n	—	—	—	—	—	—

δ Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £96 decrease.

Barcelona Ensanche y Gracia, £36 decrease. Barcelona, £447 increase.

Brisbane, £30 increase.

Buenos Ayres and Belgrano Electric, £673 increase.

Calcutta, £155 increase.

Cape Town (month of May), receipts, £12,700; expenditure, £6,070.

Mexico Electric (month of May), receipts, £18,500; expenditure, £10,600.

Perth Electric, £213 increase.

Port Elizabeth (month of May), receipts, £3,298; expenditure, £1,818.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	1-1
Arco Electricity Meter. 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	1-1
—— Ordinary, 1-125,000	1	..	1-1
British Electric Works, Ordinary, 50,001-60,000	1	—	1/16-3/32
—— 6 per cent. Cum. Pref., 1-50,000	1	—	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	100	—	85-90
British Insulated Wire, Ord., 1-75,000	5	—	9½-10½
—— 6 per cent. Cum. Pref., 1-45,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	103-106
—— 4½ per cent. 2nd Debenture Stock	100	—	101-104
Callender's Cable, Debentures	100	—	109-113
—— Ordinary	5	—	14-15
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	3	—	3½-4
—— 5 per cent. Debentures	—	—	103-105
Edison and Swan United, Ordinary	3	—	1-1½
—— 5 per cent. Debentures	5	—	2-3
—— 4 per cent. Deb. Stock, Red.	100	—	87-89
—— 5 per cent. Second Deb. Stk., Prov. Certs.	—	—	94-96
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1½-2½
—— 7 per cent. Cumulative Pref.	3	—	2½-3
—— 5 per cent. Perp. 1st Mort. Deb.	100	—	100-103
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	9½-10 xd
—— 4 per cent. '88 Mort. Deb. Stock	100	—	99-101
W. T. Henley's Telegraph Works, Ordinary	5	—	15½-16½
—— 4½ per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	—	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22 xd
—— 5 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	26-40
—— 5 per cent. Bonds	100	—	103-105
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-6
Williams and Robinson, Ordinary, 1-80,000	5	—	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	—	103-105
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	¾-⅞
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75	—	70-75
Bournemouth and Poole, Ordinary	10	—	11½-12½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	103-106
Brompton and Kensington, Ordinary	5	—	7⅞-8¼
—— 7 per cent. Preference	5	—	8½-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5	—	7-7½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	5¾-6¼
—— 4½ per cent. Debentures	100	—	109-113
City of London, Ordinary	10	..	21-24
—— 6 per cent. Cumulative Pref.	10	—	12½-13½
—— 5 per cent. Debenture Stock	100	—	123-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	103-104
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	—	103-106
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	5½-6½
—— 6 per cent. Cum. Pref.	5	—	6½-6¾
—— 4½ per cent. First Mort. Deb.	100	—	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	—	4½-5½
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5½-6½
Hove Electric Lighting, Limited, Ord., 1-11,000	5	—	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-22,000	5	—	11½-12½
—— 4 per cent. Debenture Stock, Red.	100	—	103-105
Kensington and Knightsbridge and Notting Hill	100	—	102-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1½-1⅝
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	96-100 xd
Metropolitan, Ordinary	10	—	13½-14½
—— ,, 85,001-98,760	5	—	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	110-113
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-99
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1½-1⅝
—— £5 Shares	5	—	6¾-7¼
—— £4½ Shares, New	4½	—	5-5⅛
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	68-75
Royal Electrical Company of Montreal, 6½ per cent. First Shares Mortgage Debentures	100	—	103-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	—	80-90
South London, Ordinary	5	—	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,000	5	—	15-16
—— 7 per cent. Pref.	5	—	9-10
—— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
Electric Railways.—			
Central London, Ordinary	10	—	9½-9¾
—— Pref. Half-Shares	5	—	4½-5
—— ,, ,, deferred	5	—	4½-5½
—— 5 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	—	113-118
City and South London, Consolidated Ordinary	100	—	55-57
—— Ordinary	10	—	5½-5¾
—— 4 per cent. Debenture Stock	100	—	111-116
—— 5 per cent. Pref. Stock '91	100	—	132-137
—— ,, ,, ,, '96	100	—	123-127
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
—— Ordinary, 1-50,000	—	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	102-104
Waterloo and City, Ordinary	100	—	93-96
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	4-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	—	125-130
Blackpool and Fleetwood Tramroad	10	—	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	—	2½-2¾
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	—	4½-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	—	99-101 xd
British Columbia Electric Railway Co., Ord., Nos. 1-80,000	10	—	6½-7
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	—	9½-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40	—	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-80,000	10	—	15-16
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	121-124
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	—	1½-1¾
—— "A" 6 per cent. Cm. Pf., 1-60,000	5	—	5½-5¾
—— "B" 6 per cent. Cm. Pf., 1-37,500	5	—	5-5½
—— 5 per cent. Deb. Stock, Red.	100	—	102-105 xd
—— Prov. Cert., all paid	100	—	95-98
Cape Electric Tramways, Shares, Nos. 1-400,000	1	—	1½-1¾
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	13-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	98-102
Imperial Tramways, Ordinary	all	—	23-23½
—— 6 per cent. Cum. Pref.	all	—	14½-15½
—— 4½ per cent. Deb. Stock	100	—	113-114
Kidderminster and District Lighting and Traction, Pref.	5	—	3½-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	—	105-107
New General Traction, Ordinary	5	—	3-3½
—— 6 per cent. Cum. Pref.	10	—	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10¾
—— 5 per cent. Cum. Pref.	10	—	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	105-107
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	—	1
—— £51,123 6 per cent. Preference	6s.	—	5/16
—— £50,000 ,, ,,	1	—	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	—	80 p.c.
Wolverhampton Tramways Company	—	—	—
Telephones.—			
National Telephone, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. First Pref.	10	—	11-12
—— 6 per cent. Cum. Second Pref.	10	—	11-12
—— 5 per cent. Non. Cum. Third Pref.	5	—	4½-4¾
—— 4 per cent. Deb. Stock, Red.	100	—	93-96
—— 3½ per cent. Deb. Stock, Red.	100	—	89-92
Oriental Telephone and Electric Company	1	—	¾-1

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NOTES.

Long-Distance Telephony.—A French electrical engineer, one Mr. Maiche, claims to have solved the question of telephoning by submarine cables to great distances. He has recently been carrying out some exhaustive experiments on the point, and it is stated that at Calais last Saturday Mr. Maiche succeeded in transmitting a telephonic message with perfect distinctness through a cable 400 miles long.

Royal Meteorological Society.—The closing meeting of this society for the present session was held on the 19th inst., when a paper by Mr. H. Helm Clayton, of the Blue Hill Observatory, U.S.A., on "The Eclipse Cyclone, the Diurnal Cyclones, and the Cyclones and Anti-Cyclones of Temperate Latitudes," was read, followed by a paper on "The Seismograph as a Sensitive Barometer," by Mr. F. Napier Denison, of Victoria, British Columbia.

Society of Arts.—We are informed that the council have awarded the society's silver medal to the following, among other, readers of papers during the session of 1900-1901: Mr. Fritz B. Behr, for his paper on "The Proposed High-Speed Electrical 'Monorail' between Liverpool and Manchester"; Mr. G. Marconi, for "Syntonic Wireless Telegraphy"; and Lieutenant Carlyon W. Bellairs, R.N., for "The Coal Problem: Its Relations to the Empire."

The American Institute.—The *Transactions* of the American Institute of Electrical Engineers for May include Dr. Arthur E. Kennelly's paper on "The New Edison Storage Battery," which was described in a recent issue of this journal, and which has aroused such widespread interest. Other features of this issue are the discussions on Prof. W. E. Goldborough's paper on "Air-Gap and Core Distribution," and Mr. Wm. Vansize's paper on "A New Page-Printing Telegraph."

Board of Trade.—The President of the Board of Trade has appointed Sir Alfred Bateman, K.C.M.G., the Comptroller-General of the Commercial, Labour, and Statistical Departments of the Board, to be chairman of the Advisory Committee on Commercial Intelligence in the place of the late Sir Courtenay Boyle, K.C.B., and Mr. H. Llewellyn Smith, deputy comptroller of the above departments, to be deputy chairman of the committee.

Dutch Automobile Endurance Contest.—An endurance contest, the date of which has yet to be decided upon, has been arranged by the Dutch Automobile Club of Holland. It is proposed to cover a distance of 330 miles, and the time allowed for the run will probably be four days. Speed, however, is quite a secondary consideration, for it has been decided that the highest average speed at which the cars may travel shall be 12½ miles per hour. The vehicles taking part in the trials will be judged according to the number and length of stops. Besides being open to all members of the Dutch Automobile Club, the contest, we understand, may be participated in by members of recognised foreign organisations of a similar character.

A New York Experiment.—An interesting experiment is now being made in New York in connection with the matter of obtaining a water supply for the condensing plant of the Edison Company at their new electrical power-house in course of erection at Thirty-ninth-street and East River. A huge 250ft. steel tunnel measuring 12½ft. in diameter and weighing over 1,000 tons has been built, and the intention is to sink the tunnel some 23ft. under water and to use it as a huge aqueduct to lead water from the river to the condensing plant referred to above. This experiment is looked upon by New York engineers as the forerunner of a scheme to tunnel the North River, and it is estimated that for an expenditure of about £750,000 the tunnelling of the river could be accomplished.

Telephones for the Police.—The question of connecting the police stations throughout the Metropolis with the telephone service was the subject of a question to the Secretary for Home Affairs in the House of Commons a few days ago. Answering Captain Norton, Mr. Ritchie said the matter had already been considered by the Department, and that it appeared that the existing efficient system of telegraphic communication between all the police stations, which was entirely under police control, met all police requirements. In view of the smart captures which have resulted from the introduction of the telephone into the provincial police stations, it is somewhat surprising to find the authorities adverse to the adoption of the system for police purposes within the metropolitan area.

Rapid Transit in Germany.—The elevated track of the military road from Berlin to Zossen, it is stated, will be the scene of the experiments which are to be carried out in August in connection with the projected electric railways in Germany. The proposal is to obtain a speed of 125 miles an hour on these lines. The elevated track in question has been specially strengthened to permit of the tests being made, and although it may be found that such a high speed as suggested is not feasible, the experiments will no doubt prove of the highest importance for the improvement of rapid transit. We understand that two cars will be employed, the construction and equipment of the one differing from the other in order to allow of manifold experiments being made. Each car will have four motors, aggregating from 1,100 h.p. to 3,000 h.p., two three-axle movable trucks, and the necessary transmitters, switching apparatus, etc. The cars will be 71½ft. long, weigh about 90 tons, and carry some 40 or 50 passengers.

The Telephone Company and Municipalisation.—The telephone competition at Tunbridge Wells is becoming keener and keener, with the result that the National Telephone Company has announced its intention of giving "an unlimited service for a penny a day" to its subscribers in that town. It was not until the introduction of the municipal telephone system into Tunbridge Wells that the company would listen at all to the idea of a reduction of the high tariff in vogue, and then its charge to subscribers was reduced from £8 to £4 a year. This concession, however, would not appear to have had the desired result, and apparently a further reduction of charge has become necessary in order that the company may offer any successful competition to the Corporation. It is stated, however, that the burgesses remain firm for the municipal undertaking, the number of subscribers on the Corporation list at present being 500. The charge for a connection with the municipal system now stands at the comparatively moderate figure of £5 a year, but there is reason to believe that this figure will be appreciably lowered before long.

Third-Rail Construction.—The *Electrical Review* of New York describes a new electric railway system which has just been patented by Mr. B. W. Tucker, of Newark, N.J., the improvement claimed relating more particularly to the construction of the third rail. In this case the third rail is composed of a casing made of non-conducting and non-magnetisable material, such as wood, and having a longitudinal groove formed therein. A U-shaped trough of suitable insulating material is placed in the groove, which is covered by a sectional conductor, each section being insulated from the others by interposed blocks of insulating material. Within the groove of the rail is placed the feed

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wire, composed of a good conducting and magnetisable metal, preferably iron. This wire is made continuous, and to permit of its necessary expansion and contraction it is coiled or looped at intervals, these coils or loops fitting in depressions arranged in the lining of the rail. The car is provided with a magnet that attracts the wire and draws it into engagement with the sectional conductor or covering, a suitable brush being provided, which is in contact with the casing, for conducting the current to the motor.

Sports at Chelmsford.—At the invitation of Messrs. Crompton and Co., Limited, a large party of ladies and gentlemen journeyed down to Chelmsford on Saturday, the occasion being the annual race meeting of the Arc Works Athletic Club. Special saloon carriages were attached to the 10.55 a.m. train from Liverpool-street Station, and the 30-mile run to Chelmsford was made in good time. Here carriages were in waiting which conveyed the party to the extensive works of the company, and the best part of an hour was spent in looking over the shops. The site for the large extensions which are about to be taken in hand was pointed out, and we understand it is the intention of the company when the new buildings are erected to devote them solely to what is known as "precision" work, which at the present time is almost entirely left to our American cousins. An excellent luncheon was served at the old works close by, and the company then proceeded in carriages to the sports ground. Exceptionally warm weather favoured the excursion into the country, and if the heat was somewhat fatiguing, interest in the proceedings was in no way lacking. The day was a great success.

The Electrolysis Question. — The question of electrolytic action on water and gas mains arising from the introduction of electric tramways or an electricity supply into a locality, has been raised on several occasions this session before the House of Commons Committees appointed to enquire into Bills dealing with these matters. If we remember rightly, however, the applications of the gas and water companies for the insertion of clauses in the Bills for protection from possible electrolysis of their mains have failed in practically every case, and in this the London United Tramways Bill has proved no exception. In this case the Chelsea Water Company asked for protection against possible electrolytic action on their mains from the working of the electric tramways proposed to be introduced into the district under the Bill. It was a test case, and expert evidence was called to show that the only effectual protection against electrolysis was by using insulated returns on the tramways. On behalf of the promoters, however, it was urged that the Board of Trade regulations sufficiently protected the interests of the gas and water companies concerned, and this view was in the end fully endorsed by the committee's decision in their favour.

Aerial Transportation.—"Flying Machines and their Commercial Uses" is the subject of a short article in the current number of *Cassier's Magasine*. To begin with, we are told that the underlying principle of maintaining equilibrium in air is that the centre of pressure upon the sustaining surfaces shall at all times be upon the same vertical line as the centre of gravity due to the weight of the apparatus. In regard to the shape of surfaces to be employed, Lilienthal demonstrated that concave-convex wings, like those of birds, are far superior in supporting power to planes, and the latter have now been practically abandoned by all experts. The propeller is the next thing to be considered after the equilibrium has been secured, and a reliable motor worked out. Both Hargrave and Lilienthal gave preference to flapping vanes over the screw propeller, but other experimenters prefer screws. It is yet too soon to draw definite conclusions on this question, and it opens a field for further experimenting. In the author's opinion, we are now sufficiently advanced in the design of flying machines to perceive some of their limitations. They will be comparatively small and cranky, require much power, carry little extra weight, and depend for their effective speed on each journey whether they go against the wind or with it, so that they cannot compete with existing modes of transportation in cheapness or in carrying capacity. It is true that high speeds may be attained, and this may serve in war, in exploration, etc., but the loads will be very small, and the expense will be great.

Proposed Anglo-Italian Telegraph.—The want of direct telegraphic communication between Genoa and Milan, on the one hand, and London, on the other, has been felt for some considerable time, but although the question had been on the *tapis* for the past three or four years nothing definite was done. As the result of repeated representations from the British General Post Office, the Italian Administration are now moving in the matter, and we note that the proposal has been put before the Italian Parliament to establish two wires from Genoa and Milan respectively to the French border, by means of which telegraphic communication between Genoa and London and Milan and London could be maintained. Under the same Bill a credit of £2,000 for the construction of an international telephone line between Italy and Switzerland is also asked for. At present there is a telephone line in course of construction between Italy and France, and, if passed, the line between Italy and Switzerland will be the second international telephone in Italy. Reverting to the former proposal to establish a direct Anglo-Italian telegraphic communication, it is interesting to note that whilst in 1898 the number of telegrams which passed between Genoa and London hardly exceeded 230 a day, in 1900 this figure had reached 350 a day, and the messages between Milan and England now exceed an average of 260 per day. It is in consideration of these figures and the fact that the commercial relations between Genoa, Milan, and London are continually on the increase, that the Italian Government have agreed to put the proposal before Parliament.

Electricity in Nova Scotian Steelworks.—The cheapest iron and steel in the world is now said to be turned out from Canada's new iron and steel works at Sydney, Cape Breton, in Nova Scotia, and this is no doubt due in a great measure to the large part which electricity plays in the operations of the vast undertaking. According to the *Electrical World* of New York, electricity as a motive power is used in every conceivable form all over the steel plant. In the winter season, when ore and limestone are used from the stock piles, they are gathered up with scoop buckets worked from a trolley traveller, which delivers its load, two or three tons at a lift, into the bins by the furnaces. All the scooping and carrying is done by electric power. Three of the electrically-worked travellers serve four blast furnaces, up the sides of which the loaded buckets are hauled to a height of 85ft. by electric power also and dumped automatically into the furnaces. Nothing in the great plant bears an earlier date than 1900. Much of it will bear the date of 1901. It is typical of the latest and best that experience and practice of the great steel plants of Pennsylvania, Ohio, and Illinois have yet evolved, and it is only necessary to spend a couple of hours, it is said, about the first of the Sydney furnaces which have been put into blast to realise that the design of these modern plants, chiefly by the use of gravitation and electricity, have done away with nearly all of the hard, exposing

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labour, and with much, if not all, of the smoke and fume which is associated with the making of pig metal at furnaces in Lancashire and Yorkshire in this country.

Canadian Electric Railways.—The electric roads in Canada are steadily increasing in number. According to the latest Government statistics, there were 35 electric railways in operation at the close of 1900. These aggregate 681 miles of track, an increase of 49 miles as compared with the previous year. Altogether these lines carried 118,129,862 passengers, which is equal to carrying every man, woman, and child in the country 21 times. The increase in this respect over the previous 12 months was 14,097,203, while the increase in the car mileage run was 1,277,508, the figure for 1900 standing at 30,924,355 miles. From this record it is shown that for each mile run there were 3·8 passengers carried in 1900 as against 3·5 in 1899. Some £4,126,600 of paid-up capital is invested in the electric railways in Canada, and the bonded debt amounts to about £2,523,884. For the 12 months under review the total receipts amounted to £1,084,508, and the expenses £653,600. As showing the great predominance of electric railways over steam in Canada, it may be mentioned that the passenger record for 1900 was a little over 87 per cent. by electric and a little under 13 per cent. by steam. On the steam railways the running expenses, also, were heavier than on the electric roads, the figures being 67·5 per cent. of gross earnings in respect of the former and 60·27 in the case of the electric railways.

Canadian Telegraphs and Telephones.—Some interesting information relating to the telegraphs and telephones in Canada has recently been published by the Board of Trade, which shows that the telegraph system of Canada comprises 3,906 miles of land and cable lines owned by the Dominion Government, and 30,717 miles in the hands of private companies. Thus the total number of telegraph lines is 34,623, and the wire mileage is put at 84,510. During the past five years the mileage of the lines under Government control has increased by 1,182 miles, and the total sum voted for construction, operation, and maintenance of telegraph lines last year was £105,480. An interesting point is that the messages of the signal, quarantine, and meteorological services, and also the bulletins giving the movements of the fish in the waters of the Gulf of St. Lawrence and other shore lines, are transmitted free of toll. Last year the company lines conveyed 4,960,414 messages. In 1891 the average number of messages carried annually per office was 1,700, and in 1900 it was 1,850, the number of offices increasing in the period by 198. Per mile of line the number of messages sent annually increased from 151 in 1891 to 161 in 1900. Turning to the telephone system in Canada, in 1900 there were 52,417 instruments in use, which is an increase of 18,917 over 1895. At the present time there are 38 companies in the Dominion carrying on a public telephone business, and these dispatched no less than 156,217,627 messages. While in 1895 the average was $5\frac{9}{10}$ messages per diem for each subscriber, the latest figures taken give an average of $8\frac{2}{10}$ messages, which speaks well for the progress made in this direction during the past five years.

The Overhead Trolley Wire Danger.—From Switzerland we hear of some particularly interesting experiments which a Swiss professor has been making on the question of the extent of injury which would result to a passenger on an electric tramway from coming into contact with the overhead trolley wire. The soles of the boots prove an effective obstruction to the passing of the current to earth, and, according to the report we have seen of the experiments, currents up to 800 volts had no effect upon the experimenter, even when grasping the wire tightly. When, however, the current came to 2,000 volts, the skin of the hand tended to burn when the wire was only lightly touched. These results were obtained when standing on moist gravel, but when the professor stood on clay covered with moist coal-dust, the effect of touching the wire is said to have been unbearable at a voltage of 1,000. The experimenter's conclusion, therefore, is that the voltage of overhead trolley wires should in no case exceed 1,000. The tests described above, however, do not meet the case of a passenger coming into contact with the wire while he holds a conducting medium, as, for instance, a brass rail, and accordingly the experiments were extended to ascertain the effect under such conditions, especially the effect on a workman who, with wet hands, might catch hold of two wires—one in each hand. The results obtained under these conditions were that at 10 volts a slight trembling was experienced in the finger muscles, while at 40 volts the whole arm was paralysed. With the hands dry the effects were not so serious, the dangerous voltage being put at 90. But, it is said, the difference between 80 and 90 volts was very pronounced. The experimenter estimates that while there is great danger from touching a trolley wire under these circumstances at 100 volts, death would result with a current of 240 volts.

Artificial Indiarubber.—A new process for making artificial indiarubber, emanating from France, appears in the *Electrical Review* of New York. We gather from this that the inventor mixes the fibre of ramie with the milky juice of a Chinese plant, known commercially in England as Pontianak gum. The synthesis of rubber is undertaken by the assimilation of gums and fibres of the same family which, under certain conditions, seem to have a natural affinity for one another and give an elastic material having the properties of rubber. The ramie fibre is, preferably, first dried, and the oily and volatile matters which it contains are removed. The gummy juice is then mixed with the fibre and the mixture crushed between cylinders heated to a temperature of 50deg. C. It is passed back and forward between these until the two constituents are completely incorporated in one another. The mass is then placed in an oven, the temperature of which is 150deg. C., and this temperature is raised gradually to a point between 175deg. and 205deg. After about four hours this process is completed. When the mass is cooled, it is seen that although the fibrous structure remains, its textile resistance is completely destroyed. The mixture is then worked at a temperature of 50deg. in a mixing mill until the fibrous structure is entirely destroyed and the mass is uniform. During this last treatment substances giving off oxygen, such as borate of manganese or permanganate of potassium, are introduced, to the proportion of from 5 to 8 per cent., and, if desired, a softening material, such as balata gum, up to about 10 per cent.; sulphur may also be added. This process being completed, the mass is allowed to cool for about 40 hours to permit thorough assimilation, and the mass is then cooked by steam under a pressure of 50lb. to the square inch for about three hours. When the product is cool it is said to have all the qualities of indiarubber. As the result of experiments it is stated that the following proportions give a good marketable quality of flexible rubber; gum, 80 per cent.; fibre, 15 per cent.; sulphur, 5 per cent.

Technical Education.—We are pleased to see Mr. Briscoe, principal of the West Ham Technical College, breaking a lance in support of that excellent institution. The *casus belli* was an article in the *Times*, in which it was said that there was no provision in West Ham for technical education. The writer might have known, as

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Mr. Briscoe points out, that West Ham is not within the county of London, and, therefore, no report is made by the Technical Education Board of the London County Council as to the provision made there for technical education. West Ham is one of the county boroughs that has adopted the right policy of never allowing one penny of its receipts from the Custom and Excise duties to go in relief of the rates. These, on the contrary, were allowed to accumulate until the sum of £40,000 was available. Two loans of £35,000 and £23,000 respectively were raised on the security of the technical instruction rate, and this money was applied to the building and equipping of a technical school, which, Mr. Briscoe claims, is one of the best equipped in London, especially for the teaching of engineering and applied chemistry On the equipment of the engineering laboratories and workshops a sum of about £6,000 has been spent, and on the equipment of the chemical department a sum of about £2,000. At present there are something like 450 to 500 students attending the evening classes in civil, mechanical, and electrical engineering, of whom a fair proportion are doing work above matriculation standard. Provision is also made for the teaching of engineering and chemistry in the daytime, but this part of the work has not yet had a fair start, owing to the disastrous fire which occurred 18 months ago. We cannot emphasise too strongly the importance of allowing the unspent portion of the Custom, Excise duties, etc., to accumulate instead of applying it to the relief of the rates, and we agree with Mr. Briscoe that had London been content to do as West Ham has done in this matter, there would now be an unlooked-for sum of money—Mr. Briscoe puts it at over one million sterling—available for the further advancement of higher education in the Metropolis.

New Process of Sterilising Water.—The sterilisation of water is of ever-increasing importance, and many inventors have come forward in recent years with devices for the attainment of this object. It is only comparatively lately, however, that ozone has been used in the process. Messrs. Abraham and Marmier are the latest inventors to devise a method which is said to overcome the difficulty previously experienced of obtaining ozonised air in sufficient quantities. In the first place, air is ozonised in a specially-constructed air-tight chamber by means of a silent electric discharge. The electrodes are made of cast-iron hollow plates, and are hung side by side in this air-tight chamber in such a manner as to allow of plenty of air-space between them. The plates are isolated from one another by thick sheets of plate glass. Cool water is passed through the hollow electrodes so as to keep the chamber at the right temperature, and to prevent risk of a short-circuit. Further insulation is insured by causing the cooling water to enter the electrodes in drops and to leave in drops. A passage pierces all the electrodes but the last. Air is forced by means of a fan through an opening at one end of the chamber, circulates through the passage and around the electrodes, and leaves by a pipe at the other end in an ozonised condition. Only 2 or 3 per cent. of the oxygen of the air should be in the form of ozone, owing to the risk of forming oxides of nitrogen, which would render the water acid. The ozonised air is then forced up a tower, down which the water to be sterilised passes in the form of a spray. Recent experiments by this process in connection with the water supply of the town of Lille gave satisfactory results. Whereas Lille water usually contains from 1,000 to 4,000 organisms per cubic centimetre, after sterilisation by this process it showed only 60 to 100 non-pathogenic organisms per cubic centimetre. These trials, it is estimated, render it probable that water drawn from a river adjacent to a town, filtered by sand and then treated by this process, would cost much less than water conveyed from a spring or other source through mains over considerable distances. No reliable figures as to cost, however, have yet been obtained. In times of drought the use of such a process would undoubtedly prove of much value.

Electrical Plant on the "Deutschland."—A good description of the electric light and power installation on the steamship "Deutschland," one of the largest and fastest vessels of the many engaged in the Transatlantic traffic, appeared in a recent issue of the *Electrical World* of New York. The entire plant was designed and constructed by the Allgemeine Elektricitäts-Gesellschaft. Altogether there are some 550 incandescent lamps fitted in the different parts of the "Deutschland," while 23 electric motors are used for operating the various supplementary machines. Five steam dynamos are installed in this ship for generating the current, of which four are in the dynamo-room behind the main engine-rooms, and the fifth in a second smaller dynamo-room, which is likewise accessible from the main engine-room, but situated on the main deck above the water-level. The main circuit is composed of three principal parts—viz, what is known as the pilot lighting plant, comprising all the lamps that are required for service; the general lighting plant; and the plant for transmission of power. The circuits of the pilot lighting plant are fed from the switchboard in the upper dynamo-room, while the general lighting and the power circuits are fed from the main switchboard in the lower dynamo-room. Since the dynamos are not worked in parallel, they can be connected up in such a manner that any desired combination of circuits and dynamos can be obtained. The arrangements allow of any dynamo being readily substituted for another. The great advantage of such a system, especially on a big ocean-going liner like the "Deutschland," will be easily appreciated, as in the event of a breakdown in one part of the installation sufficient illumination could always be obtained from the other machines. Another point of interest is that wires provided with a strong seamless rubber insulation, and laid in impregnated wood casing, serve as main conductors in the remaining compartments. Where these conductors enter water-tight bulkheads, they are fixed in metal stuffing boxes mounted in the bulkhead. The power transmission plant of the "Deutschland" comprises 23 motors. From the drawings which appear in our contemporary we see that the motors are not inclosed. We think that for ship work, although the enclosed motor weighs heavier, it is really more advantageous in the long run. More than half of these 23 motors serve for driving fans for the ventilation of the different lower rooms of the vessel. Two of these ventilators, which are erected on the upper deck, provide for the fresh-air supply in the cabins of the engine drivers and stokers. Four other larger fans serve for ventilating part of the stokehold. The motors, the shafts of which are coupled directly to the shafts of the fans, are suspended from the ceiling of the boiler-rooms. Notwithstanding the coal dust, which is, of course, always present, and the unavoidable accumulation of moisture and dirt, the motors run constantly and quite satisfactorily without special attention or supervision. Besides various elevators for coal, provisions, mail bags, and the like, a kneading machine in the confectionery department is operated by a motor with worm gearing. The starting resistance is situated close to the motor. In the engine-rooms there are two electrically-driven drilling machines used for making small repairs during the voyage. A special set of men attend to the entire electrical apparatus on board under the supervision of two electrical engineers.

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THE DIVISIBILITY OF ATOMS.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

It may very reasonably be urged that the title of this article involves a contradiction in terms. If we define an atom as the smallest portion of a substance which could be produced by repeated divisions (*a, privative*; and *τεμνω, to cut*), it is clear that the expression "divisibility of an atom" implies the division of the indivisible. Nevertheless, experimental facts are stronger than human definitions or etymologies, and if we are forced to conclude that in certain circumstances atoms may be split up into simple components, we must revise our definition of an atom, rather than repudiate the inferences derived from experimental evidence. It is well, nevertheless, to remember that we are here brought very near to the boundary of human knowledge. Atoms and molecules have never been directly observed, and the inferences of their existence and qualities must to any thinking being range amongst the greatest triumphs of the scientific imagination. Cuvier inferred from the tooth of an unknown animal the structure of that animal down to the minutest details. But to infer the structure of an atom or molecule is even more difficult. A single drop of water comprises a number of molecules greater than the human mind can well grasp. Thus Lord Kelvin estimates that if a drop of water were magnified up to the size of the earth, the constituent molecules if magnified in the same proportion would probably be larger than ordinary shot, but smaller than cricket balls. The effects which we observe are the statistical results of the action and reactions of almost innumerable assemblages of molecules. From these effects, nevertheless, many properties of atoms and molecules may be inferred.

The proof of the existence of atoms rests ostensibly on the law, derived from chemical experiments, that if one element combines with another in different proportions to form several distinct compounds, the higher proportions are invariably simple multiples of the lower. Thus, in carbon dioxide, the ratio of the masses of oxygen and carbon is exactly double the ratio of the masses of the same elements in carbon monoxide. Dalton's explanation was that both these substances consist of molecules, each molecule of carbon dioxide comprising one atom of carbon and two of oxygen, whilst the molecules of carbon monoxide each comprise one atom of carbon and one of oxygen. The simplification effected in chemistry by the introduction of these ideas of atoms and molecules can scarcely be overestimated. The kinetic theory of gases, which gives a simple and fairly complete explanation of the physical properties of a gas in terms of the motions of its constituent molecules, gives further support to the molecular theory. Perhaps the best proof of the approximate truth of these theories lies in the number of researches which they have suggested, and which have led to the conclusions anticipated.

According to Prout's hypothesis, all the elements consist of combinations of different numbers of hydrogen atoms. This hypothesis was suggested by the fact that the various atomic weights were supposed to be exact multiples of the atomic weight of hydrogen. Thus, oxygen would consist of 16 atoms of hydrogen combined in some unknown manner. But research has shown that, taking the atomic weight of hydrogen as unity, the atomic weight of oxgen is not 16, but 15·96 (Meyer and Seubert). Hence the only evidence adduced in favour of Prout's hypothesis is found to be defective, and our only course is to abandon it. Moreover, no one has ever been able to convert one element into another.

In the kinetic theory of gases we generally begin by considering molecules to consist of perfectly elastic spheres. In doing this, it is realised that the structure of a molecule is really, in all probability, much more complicated. The spherical form is assumed as being that most easily dealt with mathematically. Various other kinds of atoms have also been assumed, as, for instance, Lord Kelvin's "vortex atoms." The vortex rings blown from a smoker's lips possess the property that the smoke forming one of them remains distinct from the surrounding air for a long time; in a frictionless fluid, a vortex ring would be indestructible, since the ultimate loss of form of a smoke ring is due entirely to friction. But the formation of a smoke ring is also due to friction. Hence a vortex ring in a frictionless fluid, such as we assume the ether to be, would be both uncreatable and indestructible by human agency. Such rings would, therefore, possess one property of atoms. Vortex rings can also rebound from each other, and exert attractive and repulsive forces on each other. The chief difficulty in regard to the vortex ring theory of atoms is to account for gravitation; this difficulty has never been completely overcome.

Turning from theories, we can gain valuable suggestions as to the structure of an atom from spectrum analysis. A particular element is not, as is sometimes stated, associated with one and only one spectrum. Thus nitrogen can be caused to give a spectrum consisting of a number of broad bands, termed flutings, these being found, by the aid of a powerful spectroscope, to consist of hundreds of fine bright lines arranged with a certain regularity. Under other conditions, nitrogen can be caused to give an entirely different spectrum, consisting of a comparatively small number of bright lines. No two elements give the same spectrum. To this fact we owe our knowledge of the chemical constitution of the sun and stars.

To each line in the spectrum of an element corresponds a certain definite wave-length of light radiated by that element. The waves of which this light consist are transmitted by the ether, and must have been produced, as disturbances of the ether, by the atoms of the element. Now, the velocity with which a molecule moves varies continuously with the temperature, and the shortness of the time elapsing between two collisions varies in a similar manner. Hence we cannot suppose that the lines in the spectrum (which are independent of the temperature of the element) are due to the motion of the molecule as a whole. Further, to account for the great number of bright lines found in some spectra (the spectrum of iron comprises over 500 lines) we are forced to assume a large number of different motions as the origin of the disturbance. We have no reason to suppose that the iron vapour in the electric arc consists of molecules comprising great numbers of atoms; hence we are forced to conclude that an atom itself comprises a large number of movable parts. When these parts are set in violent relative motion, each moving part produces a disturbance of the ether which results in the radiation of light of a certain wave-length. In recent years the bright line spectra of many elements have been decomposed into a limited number of "series" of lines. The characteristic of these series is, that the lines of which they are composed occur in a certain orderly succession. Thus the wave-lengths, λ, corresponding to a large number of the lines in the spectrum of hydrogen, can be found from the formula, due to Balmer,

$$\lambda = A \frac{m^2}{m^2 - 4}.$$

A is a constant determined by experiment. A succession of nine lines can be found by giving m the successive values, 3, 4, 5 . . . . . 11.

Our knowledge of these "series" is as yet limited. Further study in this direction may eventually lead to a great addition to our knowledge of the structure of atoms. For supposing that an atom consists of movable parts, if we know the law connecting the motions of these parts we can imagine a mechanical system of a similar nature. This aspect of atomic science is, however, as yet in its infancy.

Larmor has worked out mathematically a theory of atomic structure which is extremely suggestive. An atom is supposed to consist of a number of electrified particles revolving in orbits under the actions of their mutual attractions, just as the earth and the planets revolve round the sun. Thus an atom would consist, on a small scale, of a system of mutually attracting and repelling bodies greatly outrivalling the solar system in complexity of structure. Whether or not the ultimate constituents of any particular atom should be considered as common to all chemical elements, the distinctive characters of these latter resulting only from differences in the number and method of combination of the constituents, can hardly be settled at

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present. Considering the fact that no one has ever as yet been able to transform one element into another, it would appear probable that the constituent particles of an atom have themselves distinctive characteristics.

A most important advance in our knowledge of atomic structure is marked by the discovery of Zeeman, that the spectrum of sodium, which normally consists of two bright lines in the yellow (the D lines), becomes modified when the source of radiation is placed between the poles of a powerful electromagnet. If a Bunsen flame, containing a strip of asbestos moistened with a solution of common salt, is placed between the poles of an electromagnet, each of the D lines is itself converted into a triplet, the distance between the central line and either of the outer components varying with the strength of the field in which the flame is burning. Further, the central line and the outer components are polarised. If the flame is viewed in a direction perpendicular to the lines of force of the magnet, then the central line and the two outside components are plane polarised, but in perpendicular directions. If, on the other hand, the flame is viewed along the direction of the lines of force of the magnet, then the central line is wanting, whilst the outside components are circularly polarised.

A simple explanation may be given of this interesting result. Let us suppose that each of the D lines in the spectrum of sodium is due to an etherial vibration, produced by the harmonic motion of a charged constituent of the sodium atom, the time of vibration, T, of one of these particles being connected with the wave-length, λ, of the resulting radiation, and the velocity of light, v, by the equation $\lambda = v\,T$.

The harmonic motion of a charged particle in any particular direction can be decomposed into two component vibrations, one parallel and the other perpendicular to the lines of force. Hence the resulting radiation can be explained as due to charged particles, some moving parallel and the rest moving perpendicularly to the lines of force. Further, a charged particle moving in any particular direction is equivalent to a small element of an electric current. Thus the magnetic field will produce no effect on the charged particles moving parallel to the lines of force, but will affect the motions of the particles vibrating perpendicularly to the lines of force. To understand the influence of the magnetic field on the motions of the latter particles, it must be remembered that a rectilinear harmonic motion is exactly equivalent to two circular motions, executed in opposite senses, in the same period as the original rectilinear vibration. Hence each particle vibrating perpendicularly to the lines of force can be replaced by two equal and similarly charged particles, revolving in circles in opposite directions round the lines of force.

Now it has been proved that a small charged body revolving in a circular orbit will behave, in a magnetic field, in a manner essentially similar to a small circular electric circuit, carrying a current equal in magnitude to the product of the charge into the velocity with which it is moving. Let us suppose that the lines of force of a magnetic field pass vertically downwards through the paper, and consider the action of this field on a positively-charged particle revolving in a clockwise direction in the plane of the paper. The magnetic lines of force due to the field will be in the same direction as the lines of force due to the electric circuit equivalent to the revolving charged particle. Hence, since an electric circuit always tends to embrace as many lines of force as possible, the diameter of the equivalent electric circuit will tend to increase, or the particle will revolve in a circle of greater radius than before. But the velocity of the charged particle will remain constant, so that it will complete a revolution in a period longer than T, its previous period of vibration.

Similarly, a positively-charged particle revolving in an anti-clockwise direction in the plane of the paper will be caused by the agency of the magnetic field to revolve with its previous velocity in a circle of smaller radius than before, so that it will complete a revolution in a time smaller than T. All particles revolving in the plane of the paper will produce etherial disturbances in the plane of the paper, the wave-length of the resulting light being proportional to the time of revolution of the particle. Hence, to an eye placed in the plane of the paper, the particles revolving in that plane will produce two distinct plane polarised rays—one of wave-length greater than the undisturbed wave-length, and the other less. This accounts for the two outer polarised components of either of the D lines, when the flame is viewed in a direction perpendicular to the lines of force.

A charged particle vibrating normally to the plane of the paper will be unaffected, since the lines of force due to the magnetic field are parallel to the path of the particle. Hence its time of vibration will be the same as without the magnetic field, and it will produce etherial vibrations perpendicular to the plane of the paper. This accounts for the central polarised component of one of the D lines, when the flame is viewed in a direction perpendicular to the lines of force.

When the flame is viewed parallel to the lines of force, no radiations will reach the eye from the particles vibrating parallel to the lines of force, since light consists only of transverse vibrations. This explains the absence of the central component under the conditions specified. The circularly polarised outer components are due to the particles revolving in opposite directions and unequal periods in the plane perpendicular to the lines of force.

The above results had been predicted by Lorentz from theoretical considerations before the performance of Zeeman's experiments.

The interest of Zeeman's discovery does not stop here. He was able to calculate the ratio m/q, where m is the mass of the charged particle and q is its charge. We know the value of this ratio in the case of electrolytic decomposition of a sodium salt. In this connection it is equal to the electro-chemical equivalent of sodium—*i.e.*, to $2{\cdot}4 \times 10^{-4}$. In the optical experiment, Zeeman found the ratio m/q to be equal to 10^{-7}, which is about $\frac{1}{1000}$ of the value obtained from electrolytic experiments. To explain this, the late Prof. Fitzgerald suggested that the part of the atom which carried the electric charge, and which, by its motion, produced the characteristic yellow light emitted by a sodium flame, is only one two-hundredth of the total mass of the sodium atom.

Thus we have obtained evidence that small parts of an atom, carrying electric charges, are capable of relative motion within the atom itself. We must now examine the evidence in favour of the theory that these charged particles can, under certain conditions, be forcibly torn away from the atom, and can exist by themselves for a limited time before they once more become absorbed in an atom.

Our evidence in this connection is mainly due to the researches of Prof. J. J. Thomson. Some suggestive evidence may, however, be obtained from the previous work of Lenard. Lenard experimented with a vacuum tube of special construction (represented in Fig. 1). T is a glass tube, closed at one end by a metal cap, C. In the centre of this cap is a small window, 1·7mm. in diameter, closed by a thin sheet of aluminium. A plane circular aluminium disc, K, acts as cathode, whilst a cylinder, A, acts as anode.

It was long ago proved that when a vacuum tube at sufficiently low pressure is connected to an induction coil, certain rays—named *cathode rays*—are emitted from the cathode. The effects observed can be best explained by supposing that these consist of streams of charged particles violently projected from the cathode. These rays produce phosphorescence if they strike against glass and some other substances. It is found that their path is deflected by a magnet placed near the tube, a fact which is explained consistently with the law previously mentioned, that a moving charged particle acts like an element of an electric current with respect to a magnetic field. When a sufficiently strong magnetic field is used, the rays form circles around the direction of the lines of force. When these rays strike against a piece of platinum the latter is heated. Further than this, the peculiar radiations discovered by Röntgen, and generally known as X-rays, are in certain circumstances emitted from substances which the cathode rays strike.

In Lenard's experiments the cathode rays strike against the small aluminium window in the metal cap of the tube.

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In a dark room it is seen that faintly luminous rays radiate into the air from the aluminium window. These rays, named after Lenard, produce phosphorescence in many substances, and can be deflected by a magnet. This latter fact suggests that they consist of streams of charged particles. X-rays are not deflected by a magnet, and must, therefore, be explained otherwise. It was found that a positively or negatively charged body rapidly lost its charge when exposed to Lenard rays.

After proceeding a certain distance in the air, the Lenard rays apparently become absorbed; phosphorescence can only be produced within a certain limited distance from the aluminium window. Lenard found that the distance which they could travel was increased by rarefying the gas through which they passed. Using different gases it was found that the distance they could travel depended only on the density of the gas; thus hydrogen and oxygen produced the same absorption when the pressure of the oxygen was one-sixteenth of that of the hydrogen.

Lenard also found that the rays which he discovered could traverse thin layers of solid substances, such as aluminium, mica, glass, etc., the opacity of these substance varying to a very close approximation simply with their densities.

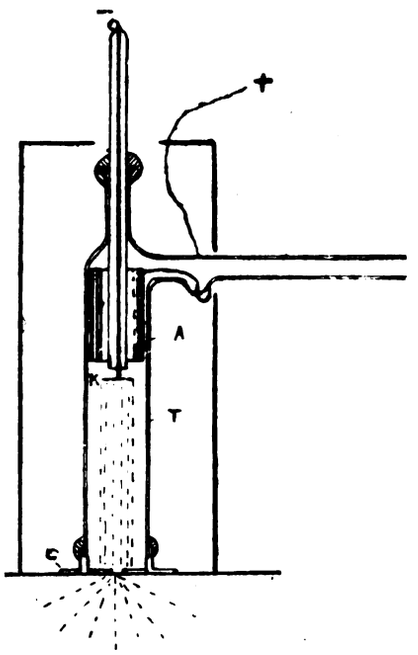

FIG. 1.

The simplest explanation of Lenard rays appears to be that they are cathode rays which have traversed the thin aluminium window in the cap of the tube. The deflection of cathode and Lenard rays in a magnetic field can be explained only on the supposition that both consist of streams of charged particles moving with considerable velocities. The question now arises, are these charged particles atoms, or collections of atoms, or particles smaller than atoms?

If the charged particles were atoms, they would lose their velocities when passing through a gas in a distance comparable with the mean free path of the molecules of that gas. The mean free path in air at half an atmosphere pressure is of the order 2×10^{-5}cm. But Lenard found that the rays which he discovered could penetrate to a distance of about ·5cm. in air at half an atmosphere pressure. Hence the atomic theory of Lenard rays must be abandoned. If the charged particles are larger than atoms, the distance which they could penetrate in a gas would be inversely proportional to the coefficient of viscosity of that gas, and this is independent of the density of the gas. But Lenard found the distance which the rays could traverse was inversely proportional to the density of the gas. Hence the charged particles cannot be larger than atoms.

The remaining alternative is that the charged particles are smaller than atoms. The comparative transparency of solids to these particles can be explained by assuming that they can actually traverse an atom, slipping in between the particles which, on Larmor's hypothesis, compose an atom, just as a comet can pass between the planets revolving around the sun.

Prof. J. J. Thomson has attacked the problem from other points of view. As already remarked, cathode rays can be caused to move in a circle around the lines of force of a magnetic field. In this case the centrifugal force due to the velocity with which the particle is moving, must be just balanced by the central force exercised by the magnetic field on the moving charge.

Let m = the mass of the particle;
" v = the velocity of the particle;
" r = the radius of the circle in which it moves.

Then the centrifugal force $= \frac{m v^2}{r}$.

A magnetic field, H, will exert a force of $H q v$ on a charge, q (in electromagnetic units), moving with a velocity, v. Hence

$$\frac{m v^2}{r} = H q v. \quad \therefore \frac{m v}{q} = H r \quad . \quad . \quad . \quad . \quad (1)$$

The value of H was known, and r, the radius of the circular path of the cathode rays, was observed.

Prof. J. J. Thomson then allowed the cathode rays to pass through a small aperture into a metal cylinder placed in the vacuum tube. After passing through this aperture they struck against a thermo-junction, which became heated. The rise of temperature of the thermo-junction was observed, and the water equivalent of the latter being known the heat produced became known, and from this the kinetic energy, E, of the moving particles entering the cylinder was calculated. Let us suppose that n particles entered the cylinder during the experiment, and were brought to rest on striking against the thermo-junction. Then,

$$\tfrac{1}{2} n m v^2 = E \quad . \quad . \quad . \quad . \quad . \quad (2)$$

From (1) $$\frac{m^2 v^2}{q^2} = H^2 r^2 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Dividing (3) by (2) we get:

$$\frac{2 m}{n q^2} = \frac{H^2 r^2}{E},$$

$$\therefore \frac{m}{q} = \frac{n q H^2 r^2}{2 E}.$$

But $n q$ is equal to the charge which entered the cylinder during the experiment. This was determined by observing the rise of potential of the cylinder, which was connected to a condenser of known capacity. Let $n q = Q$.

Then, $$\frac{m}{q} = \frac{Q H^2 r^2}{2 E}.$$

In a particular experiment,

$Q = 2{\cdot}4 \times 10^{-6}$ electromagnetic units of electricity;
$E = 6{\cdot}3 \times 10^{5}$ ergs.

r, the radius of curvature of the rays in a field, H, of 35 units, was equal to 9cm. $\therefore H r = 315$.

$$\therefore \frac{m}{q} = \tfrac{1}{2} \cdot \frac{2{\cdot}4 \times 10^{-6} \times (315)^2}{6{\cdot}3 \times 10^{5}} = 2 \times 10^{-7}.$$

This value of m/q is of the same order of magnitude as was found by Zeeman. The value of m/q was found to be independent of the nature of the residual gas in the vacuum tube. If we suppose the charge, q, on one of the charged particles to be equal to the charge usually associated with an atom, then the mass of the charged particle would be equal to about $\frac{1}{500}$ of the mass of the atom. Another explanation might, however, be given by assuming the particles to be atoms, each carrying a charge about 500 times as great as the normal atomic charge. To obtain further evidence on this point, Prof. J. J. Thomson attacked the problem from another standpoint.

It was found by Hertz, in the course of his classical experiments on electromagnetic waves, that ultra-violet light falling on the spark-gap of his radiator induced a spark

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when the potential difference between the knobs was insufficient to produce a spark otherwise. It was also found that ultra-violet light, falling on an insulated body carrying a negative charge, caused the leakage of that charge. Various explanations might be proposed to account for this fact; one is that small particles of the body, carrying negative charges, are thrown off under the action of the ultra-violet light.

It had previously been proved by Aitken that a supersaturated vapour is unable to condense into a mist, unless fine particles are present to act as nuclei for the condensing vapour. Thus the production of a fog depends on the presence of small particles floating in the atmosphere.

Hertz found that if the negatively-charged body was surrounded by a supersaturated vapour, a mist was formed near the body immediately after ultra-violet light fell upon it and leakage of the charge had commenced. This result was considered to afford strong evidence that the leakage was really due to the projection of negatively-charged particles from the body.

But if charged particles are really projected from the negatively-charged body under the action of ultra-violet light, these particles should be deflected by a magnetic field. Prof. J. J. Thomson found this to actually be the case. A disc of zinc was negatively charged, and it was found that the rate of leakage under the action of ultra-violet light was greatly diminished when the disc was placed in a strong magnetic field, of which the lines of force were parallel to the disc. The cloud formed by the condensation of supersaturated vapour was in this case found to be confined to a narrow stratum near the disc. The charged particles projected normally from the disc were twisted round the lines of force, and thus prevented from moving far from the disc. The thickness of the stratum of cloud depended on the strength of the field. From observations of the actual thickness of this stratum, corresponding to a given magnetic field, a relation similar to equation (1) above was obtained.

Mr. C. T. R. Wilson had previously found that when a saturated vapour is suddenly caused to expand, a cloud is not formed unless foreign particles are present to act as nuclei round which condensation may occur.

Prof J. J. Thomson utilised this result as follows. He enclosed a negatively-charged zinc disc in a vessel, the space contained by which was saturated with aqueous vapour, and allowed ultra-violet light to fall on the disc. Negatively-charged particles were thrown off, as previously explained. On allowing the saturated vapour to expand, a cloud was formed. The total mass of the condensed vapour could be calculated from the temperature of the saturated vapour, and its initial and final volumes. Hence if the size of the minute drops of water were found, the number of drops formed could be calculated. If each drop was formed by the condensation of vapour round one of the charged particles, the number of these particles projected from the negatively-charged body in a given time, under the action of ultra-violet light, would be known. The total quantity of electricity which had leaked from the disc being known from the fall of potential of the disc, the charge on each particle could be determined.

The size of the small drops of water composing the cloud was estimated by observing the rate at which the cloud sank. Let R be the radius of a drop, V the velocity with which it sinks, μ the coefficient of viscosity of the medium in which the cloud is formed, and g the acceleration due to gravity.

Then $$V = \frac{2 g R^2}{9 \mu}$$

The charge, q, carried by each particle was thus found to be of the same order as the charge carried by the hydrogen atom in electrolysis. The value of $\frac{m}{q}$ was found to be of the same magnitude as in connection with the cathode rays. Hence it follows that the mass of each charged particle must be about $\frac{1}{1000}$ of the mass of the hydrogen atom.

The mass of the particle which carries the negative charge under the action of ultra-violet light was found to be independent of the nature of the substance from which the particle was projected.

There thus appears to be weighty evidence that particles can be split off from atoms, and can lead an independent existence for a limited time. These particles are apparently identical, from whatever atoms they may be derived. Concordant numerical results have been obtained, under conditions which were widely different. Thus, though the weight of evidence derived from a single experiment may be small, the whole series possess an importance which cannot be neglected in framing a theory of atomic structure. We may hope for still further light on this interesting subject from the future researches of Prof. J. J. Thomson.

MUNICIPAL ELECTRICAL ASSOCIATION.

Glasgow Congress.

(*Continued from page 904.*)

Bailie W. MACLAY, the convener of the Glasgow Corporation Electricity Committee, then read his paper on

Notes on Street-Lighting.

BY BAILIE W. MACLAY, CONVENER OF THE GLASGOW CORPORATION ELECTRICITY COMMITTEE.

At the present time, when the incandescent gaslight is being so prominently forced upon the public notice, it may not be out of place to offer this paper upon street electric lighting. One reads of statements being made by gas engineers and others interested in gas undertakings which might lead the innocent public to suppose that the days of electric lighting, at any rate for street purposes, are numbered. Perhaps, however, the public have by this time learned sufficient of the "gassy" nature of the statements which are apt to come from those who seem now at any rate to consider us serious competitors, not to place implicit trust in their statements. Whatever else electricity may have accomplished, there can be no doubt that since its advent in 1880 there has been a steady and even rapid improvement in the standard demanded for street illumination. Until electric light was first introduced experimentally into the city of London, the public were contented with ordinary gas-burners consuming two to four cubic feet per hour. Some of the lamps at important places contained groups of burners which shewed evidence of an attempt to give a better standard of illumination. It may be taken that these gas lights gave an average of from 8 c.p. to 16 c.p. each. When the contract for the experimental electric lighting of some of the main thoroughfares of the city of London terminated, and the street-lighting again reverted to gas, the amount of illumination which had sufficed in previous years was found to be absolutely unbearable in comparison with the electric light, to which the public had now grown accustomed, and larger gas-burners, and increased numbers of them, had to be fitted along all the routes which had been electrically lighted. Even this improvement, however, was not considered satisfactory, and in due time electric arc lighting was reinstated along all the principal routes of the city of London. It is doubtless true that at the time these operations were carried out the incandescent gas mantle had not reached its present stage of perfection, but until electricity had forced the pace there seemed to be no serious demand for a higher standard of illumination at all. To-day, however, the public perpetually cry for more light in their streets, and the statement has appeared in one of our Glasgow evening newspapers that if there is one thing over and above pure water and effective sanitation which is absolutely necessary in a large city, it is efficient public lighting, and to offer bad lighting in order to save money is to waste both. Even supposing electricity had done nothing more than prove the immense advantage of properly lighted streets, it must be admitted on all hands that in that point alone it has served an extremely useful purpose.

Although electricity has been content up to the present to smile good-naturedly upon the laboured enthusiasm which it sees its elder sister displaying with regard to the incandescent gas mantle, in her attempt to get somewhere near her younger rival in the matter of efficient street-lighting, it may be well not to remain too long silent lest it should be thought that in reality the end of the street electric lighting was already in view. Everyone will admit the enormous improvement which is made by substituting incandescent gas mantles for the ordinary flat plain burner, at any rate, while the mantles are new, and during the prevalence of calm, fair weather, and it is hoped that the extra expenses, which will doubtless fall to be borne by the ratepayers, in regard to the renewal and up-keep of mantles and other accessories of the improved system, together with the extra time required to light

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lamps not fitted with by-passes as compared with the older arrangement, will be cheerfully borne without a murmur in consideration of the improved illumination. There is nothing, however, in all this to show that for main thoroughfares, where a really brilliant illumination is desired, incandescent gas can in any way equal, far less surpass, electric light. A great deal has been made of the argument that electric lighting is "patchy," giving a brilliant illumination within a certain radius from the lamp and a comparatively poor illumination at points midway between, and great efforts have been made to show that by converting the ordinary flat-flame gas lamps into incandescent mantle lights, the illumination is much more evenly distributed although it may not be so intense at points near the lamps. This, however, has been investigated by electrical engineers, and it has been found that an equal standard of lighting measuring the light at points midway between the lamp columns cannot be obtained in this manner, except by using such a number of incandescent gas mantles that the cost will be more than that of electric lighting to give the same result. Apart from this, however, it is interesting to note that the gas people themselves are devoting their greatest energies to developing incandescent mantles, which they hope will give as large, concentrated, and brilliant a light as can be obtained from the electric arc. It would seem, therefore, that their anxiety in this direction goes entirely to disprove their own arguments.

On a recent occasion the question of lighting the Great Western-road, which may be styled the most fashionable promenade in Glasgow, was very prominently before the public, and was discussed very fully by the Town Council as well as by the sub-committee dealing with the matter. The question in this case was to some extent mixed up with that of lighting the tramway poles which had been fixed along the centre of the road at distances of about 40 yards apart. There was a very strong feeling amongst the public in favour of electric lighting, although incandescent gas lighting had been proceeded with along a considerable portion of the route and was showing a great improvement over the previous state of affairs. It was ultimately decided to do the lighting by means of electric lamps placed at a height of 27ft. from the road level to the centre of the arc, each lamp being constructed to take 7 or 7½ amperes and to give about 700 c.p. Counter proposals were made that gas mantles should be placed upon the tramway poles, but even supposing that the vibration of the poles did not have disastrous effects upon the mantles, it was found impossible to produce an equal standard of illumination at any reasonable cost in this manner, except by introducing side lamps at intermediate points, and even then it was found that the cost for the same amount of illumination at the darkest points would be greater with gas than with electric light. In every case full benefit was given to the incandescent gas mantle, as it was credited with 50 c.p. per mantle, this being a figure which doubtless may be obtained at the first start, but which public experience goes to prove is not maintained for very long. Of course, no variations occur with electric arc lights due to the deterioration of the illuminants, and provided the supply of current remains the same the light is the same, year in, year out.

Probably a point which has to some extent escaped notice is the fact that lights placed high up give a much more pleasing effect than when fixed low down, even though the illumination may be uneven. It is possible that a very even illumination might be gained with a large number of closely spaced lamps of low candle-power placed low down, but the effect would also be depressing in the same way that the lighting of a large hall is depressing unless the illumination extends to some extent upwards as well as downwards, or, more correctly, unless the whole cubic contents of the hall are illuminated. In this way when walking along a large street or thoroughfare lighted with electric lamps at a considerable height, one feels a sense of airiness and magnitude which is missing if the lights are fixed low down.

It is not the object of this paper to discuss in any way the question of comparative costs, but it may be well to state that the seven-ampere lamps before referred to will be charged for at the rate of £12 per lamp per annum, every lamp burning the whole night through. This charge includes the maintenance of the lamps, supply of carbons, trimming, cleaning, and the supply of current, but the capital expenditure, except so far as the mains are concerned, is borne by the police department, and is not provided for in these charges. Gas has been taken at the present price of 2s. 6d. per 1,000 cubic feet, and what is known as the ordinary 50-c.p. mantle has been allowed its fullest efficiency, which, in the author's opinion, is considerably more than it is entitled to. The prices which will prevail in Glasgow next year for 10-ampere arc lamps under similar conditions to the above will be £14 per lamp per annum. So far it would seem that incandescent gas lighting in streets is not unlikely to have the same result as it has had in house lighting. It has been observed by those in a position to know best that the ordinary consumer of electric light goes through three stages: (1) ordinary gas, (2) incandescent gas, and (3) electric light; and for this reason electricity supply authorities cannot but welcome the improvement over ordinary gas which the gas mantle promises. No one who has used incandescent gas is satisfied to go back to ordinary gas, and when thoroughly sick of incandescent gas the final plunge is taken into electric light, from which no one ever goes back. We may, therefore, take it that street-lighting is now entering upon the second stage, from which the only possible development must be an upward one—*i.e.*, into electric light. In other words, the incandescent gas mantle is now acting in a similar manner towards electricity to that in which electricity itself acted towards gas in 1880.

Extract from the "Gas World," March 16, 1901.

THE LIGHTING OF THE MEAN STREETS.

I desire to take this opportunity for urging the acceptance by the responsible authorities of a higher standard for the lighting of the streets of London—not only at show places and centres of traffic, although that is needed, but also, and especially, in the unornamental, thickly-populated quarters where the poor live. The people have a right to this better service. Think of the proportion of their income spent for lodging, and consider what they get for it. Let the humble streets be brightened, and the result will be something positive done towards that humanising of the town which is the cause that lies at the back of the plea for the better housing of the people. The gas lamp has long been called the policeman's best ally; but I wish to put its reputation higher than that. Above the prevention of crime and the facilitation of the arrest of the criminal is the cheering influence of good light, and plenty of it, on the moral and social sides of the people's life. I believe that personal smartness, cleanliness of body and surroundings, good temper, and harmless gaiety, are promoted by ample public lighting; and we want to see British people enjoy more of this boon than has hitherto been vouchsafed to them. If our climate is sometimes dull and depressing our gas is cheap and brilliant; wherefore let this British speciality be set off against the other. This can be easily done if the proper authorities will only rise to the occasion and put their minds to the work. The means are all ready to hand. To improve the public lighting of any locality that might be named would only be an affair of a week or two. Local authorities have frequently shown a remarkable twist in this connection. While heedless of the means at their disposal, they have readily increased their public lighting bill three or four fold for the purpose of stringing a few electric lamps sparsely along some chosen main thoroughfare. This is unjust to the mass of ratepayers who do not live in the favoured spots, and they are further injured by the extravagance of their representatives, in that it deprives them of all chance of getting good lighting for the back settlements and mean streets, which need it most.

Bailie MACKENZIE, of Edinburgh, opened the discussion, and expressed himself as being generally in agreement with the author. He did not, however, approve of the aggressive criticism of the gas undertakings which the author had given, as two departments of a corporation should not be at variance. He believed that unless they were prepared to pay three times as much for street-lighting by electric as for gas lighting, they should not convert from one to the other. In his opinion, the main routes should be electrically lighted, but he did not advocate electric light for side and unimportant streets. Thus with arc lamps, say, 40 yards apart it cost about £500 per mile to light streets with arc lamps. In Edinburgh they had had good experience of the effect of street-lighting. The hotel owner in Princes-street, with other gentlemen, had tried to get the electric lighting of the city into their own hands, and being unsuccessful, declined to take the light when the municipal supply was started. The arc lighting of that street made these gentlemen's premises seem so dark that now all were consumers.

Alderman PEARSON, of Bristol, was also substantially in agreement with the author. They in Bristol had competed so strongly with the gas company that the price of gas lighting for the streets had been reduced to a very low figure. Thus indirectly they had ensured a better and cheaper light for the side streets at what, he believed, was less than cost price. He believed that they slowly educated the public from the old batswing burner to the incandescent gas, and hence to the arc lamp.

Mr. C. H. WORDINGHAM believed that arc lighting for the main streets was an essential. In the side streets incandescent gas lamps were formidable rivals to the incandescent electric, but the public would, he thought, in the long run judge in favour of electric street-lighting. At first people

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were apt to judge by the apparent brightness of the row of lights in view, but the proper way to value street-lighting was to look at the roadway. The claims for new gas lamps were extravagant, and in some cases the mantle used was not at all serviceable. He did not hold with placing the lamps too high, as then vertical surfaces were not then well lighted.

Dr. ALLFREY, of Hastings, said he was interested in both systems of lighting. The gas company were extremely active at Hastings, and they had installed incandescent gas in the side streets. The main streets were lighted with arc lamps, and the gas engineer had told him that he had used 100-c.p gas-burner to get a good comparative effect. They paid for public lighting on the same scale as for private supply—*i.e*, 10s. per lamp and 2d. per unit used. He did not believe in placing the lamp high up except in open spaces and at street crossings. Otherwise 15ft. to 20ft. was high enough.

Mr. HAYDN HARRISON did not agree with Mr. Wordingham respecting the light of arc lamps. The higher they were put, the better would be the distribution of light. In fact, an even distribution in candle-power feet was required. Vertical surfaces under one lamp would be lighted by the two adjacent lamps. In narrow streets and courts incandescent lamps should be used, and the light given out confined to the useful direction by condensers and reflectors. Although it was difficult to show on paper a commercial advantage for the electric incandescent over gas, it would be found on trial that the public preferred the electric system, as it was permanently better.

Bailie MACLAY, who had to leave to attend a council meeting, then replied briefly to the speakers up to this point. He was in favour of a keen competition between the electricity and gas departments of a corporation, but did not wish to be harsh on the gas industry. He was, in fact, a member of the Gas Committee of Glasgow. He thanked those who had taken part for letting him off so lightly.

Alderman RADFORD, of Plymouth, continuing the discussion, explained that in that town they had designed and erected their own incandescent gas lamps for the side streets. They paid the gas company 5 per cent. less than ordinary consumers. He thought that incandescent electric lamps for street work had yet to be much improved to compete with the Plymouth incandescent gas lamp, which only took 2½ cubic feet per hour.

Councillor ELVY ROBB, of Tunbridge Wells, deprecated the spirit of funk displayed by some speakers over incandescent electric lighting for streets. In his town they had found it to be a great success. The gas company offered a 50-c.p. incandescent burner for £3. 17s. 6d. per annum, while the Electricity Committee got the work at £3. 7s. 6d. for two 16-c.p. electric lamps per post. They had now the major portion of the street-lighting in their own hands.

Alderman BRUCE, of Sunderland, said that their Corporation did not own the gasworks. Some three years ago they started arc lighting the streets, and they so arranged the pillars in the main streets that the side streets were partially lighted too. They found 21ft. the best height for the lamps, and placed the same 60 yards apart. The better lighting increased the ratable value of these main streets, and this should be considered with the increased cost.

Alderman POTTER, of Taunton, referred to the bitter competition which the Taunton Gas Company had instituted to the municipal electrical undertaking. This had advertised this undertaking, and conduced to its success. He did not agree with Bailie Mackenzie's statement that electric street-lighting cost three times more than gas, as it could only be so if the gas lighting had been very poor and ineffective. It was not fair, for instance, to compare the present cost in Taunton of electric street-lighting with the cost of gas lighting the same streets by gas 10 years ago. In fact, a magistrate had once said that the safest place for a burglar to hide in Taunton 10 years ago was under a lighted gas lamp. They gave £3 per annum for their incandescent electric lamps as against £2. 17s. 6d. offered by the gas company. They had the permission of the Corporation to displace all gas lamps whenever they extend their electric mains, and this was always done. In spite of the low price of street-lighting, they had for the last two years returned to the Corporation the equivalent of a penny rate from the profits of the electricity department.

Bailie FINDLAY, of Glasgow, believed in a fair field and no favours, and letting the best system win. One great advantage of a gas company was that the engineer could write to the papers and be answered, which was better than a fight in the dark. They had not encouraged electric street-lighting in Glasgow as they should have done, but he hoped for more of it in future. When they put arc lights up along their first electric tramway there had been a marked decrease in crime. In Glasgow they never used any profits to reduce rates.

Mr. TREMLETT CARTER explained how the human eyes worked most efficiently with a uniform illumination.

Mr. E. E. HOADLEY, of Worcester, described the success they had secured in lighting courts and side streets with improved electric incandescent lamps.

Alderman IVEY, of West Ham, showed how unfair it was to light main streets with arc lamps at a low cost. This light improved the value of the shops at the expense of shopkeepers in side streets. He advocated a flat rate all round, rather than creating a preferential rate in favour of residents on main routes.

Mr. NEWINGTON, of Edinburgh, said they had replaced the gas lamps in the main streets by arcs. The cost of lighting had gone up from £3,200 to £11,000 per annum, but for the increased cost they got from 25 to 30 times more light. He thought £13 per lamp was the lowest possible charge per arc lamp when half were turned off at midnight. It cost them £13. 2s. last year at Edinburgh. At the price mentioned in the paper (£12), he thought the department would lose money.

Mr. W. A. CHAMEN explained that the electricity department had not to pay the capital charges on the lamps, which made a difference.

Mr. J. H. RIDER, the chief electrical engineer of the London County Council, then read his paper on

Uninsulated Returns in a Tramway System.

BY JOHN H RIDER, CHIEF ELECTRICAL ENGINEER, LONDON COUNTY COUNCIL TRAMWAYS

The general regulations prescribed by the Board of Trade, under the provisions of the Tramways Acts, include, amongst others, clauses which relate to the employment of uninsulated metallic return circuits of low resistance. Such returns, in the shape of the tramway rails, are up to the present in universal use in this country, and consequently the clauses mentioned are of universal application. It is provided that the uninsulated return shall be connected with the negative terminal of the generator, and that all parts of the return circuit which do not consist of the rails shall be insulated, unless of such cross-sectional area as will reduce the difference of potential between the ends of the uninsulated return below seven volts. This is also the maximum pressure allowed between the ends of the uninsulated return farthest from and nearest to the generating station.

Excepting, perhaps, that the maximum allowed is too high, no fault can be found with these requirements, as unless the differences of potential be kept low, excessive earth currents will flow, causing considerable damage to any metal pipes in the vicinity. The earth, being more or less a conductor, practically connects all buried metal near the track to the rails. Unless great care be taken, therefore, the return current leaks out from the rails and flows through any other metal which may be lying in the neighbourhood of the track. Being no respecter of paths, it has been even known to make use of the lead sheathing of the tramway feeders. The mere passage of the current through these irregular paths does no harm, but at all points where the current *leaves* the rails or the pipes or the sheathing, corrosion takes place by reason of electrolytic action. The number of places at which the current flows into or out of the rails or pipes, is entirely a question of relative resistances (or of conductivities) between the various paths open to the current, and at each place of leaving corrosion goes on. The only way to prevent leakage currents is to make the proper path of so low a resistance that the difference of potential between any two points is at all times exceedingly small. The requirements of the Board of Trade in this particular are most reasonable, and the engineer who thoroughly appreciates the position will endeavour to bring the maximum below this amount for other reasons than to comply with the regulation.

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In the opinion of the writer, however, some of the other regulations are not only unnecessary, but even undesirable, as, for instance, those relating to the earthing of the negative 'bus bar. Regulation No. 5 says: "When any part of a return is uninsulated, it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections which shall be placed not less than 20 yards apart. Provided that in place of two such earth connections the corporation (or company) may make one connection to a main for water supply of not less than 3in. internal diameter, etc." Regulation No. 6 says: "When the return is partly or entirely uninsulated, the corporation (or company) shall in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) so connect together the several lengths of the rails; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point, and the potential of the uninsulated return at any other point; and (*d*) so maintain the efficiency of the earth connections specified in the preceding regulation (No. 5) as to fulfil the following conditions—viz.: (1) that the current passing from the earth connections through the indicator to the generator shall not at any time exceed either two amperes per mile of single tramway line, or 5 per cent. of the total current output of the station; (2) that if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return. "In order to provide a continuous indication that the condition (1) is complied with, the corporation (or company) shall place in a conspicuous position a suitable, properly-connected, and correctly-marked current indicator, and shall keep it connected during the whole time the line is charged." Condition (2) is, of course, merely intended to show that the earth connection is maintained in good order.

It will be observed that the current coming back from the rails *vid* the earth to the negative 'bus bar must not exceed a certain value. The strength of this earth current will depend entirely upon two things: (1) the difference of potential between the rails and the negative 'bus bar, and (2) the resistance of the earth path. The former is the fall of pressure on the return feeder, which, although it may be only a small amount from the point of view of economy in transmission, may be enough to send a large current back through the earth, particularly if the resistance of the earth path be low. This may readily happen on account of the existence of water or gas pipes near the return feeder, and particularly when a water-pipe is used as the earth-plate at the generating station. In the case of the Plymouth electric tramways, where the shortest return feeder is 760 yards long, being connected to the rails at their nearest point to the generating station, the resistance between the rails and the earth-plate (water-pipe) is only about 0·5 ohm. It was found that 25 per cent. of the return current came back through the earth. Now the resistance of the earth path can be made practically infinite by the simple expedient of removing the earth connection from the negative 'bus bar.

Regulation No. 6 (1) is apparently intended to protect gas and water pipes by ensuring that no current (or only a very small amount) shall come back through the earth to the generators. Regulation No. 5 practically invites such current, and provides means for its measurement. If the earth connection be removed from the negative 'bus bar, no current can come back through the earth. Why then should the connection be made? The Board of Trade regulations appear to provide for an earth connection at the wrong place. When the return circuit of a tramway system consists partly of uninsulated rails and partly of insulated cables, the insulated part should be kept insulated except at the point where it joins the uninsulated part, and there the earth connections should be made rather than at the other end where it is joined to the negative 'bus bar. With more than one return feeder, negative boosters may be necessary to keep the points of earth connection at the rails at about the same potential. Earth currents would then be practically non-existent. With only one return feeder no negative booster would be needed, unless it were desired to reduce the fall of pressure for economical reasons. In this case it would depend entirely upon the length of the return feeder as to whether it would be better to add to its cross-section or to use a negative booster. In the majority of cases the latter would probably prove the better way.

If the ventilation of this subject by the Incorporated Municipal Electrical Association should result in a modification of the Board of Trade regulations, then this short paper will not have been written in vain.

At the conclusion of his paper, Mr. RIDER announced that the subject of it had practically been removed from the field of controversy by an alteration of the regulation of the Board of Trade. Mr. Trotter had written him on Friday last to say that the clause had been amended to read: "When the generator is at a considerable distance from the tramways, the uninsulated return shall be connected to the negative terminal of the generator by means of an insulated return conductor, and the generator shall have no other connection with earth; and in such case the end of the insulated return connected with the uninsulated return shall be connected also through a current indicator to two separate earth connections, or with the necessary consents to a main for water supply, or with the like consents to both in the manner prescribed in this regulation."

Mr. T. P. WILMSHURST, of Derby, said a similar case as that described had arisen at Halifax, where they earthed the junction of the insulated and the uninsulated return with the knowledge of the Board of Trade. Where many feeders were required, negative boosters were better. He did not agree that the seven-volt limit required lowering.

Mr. C. H. WORDINGHAM congratulated the author on his paper, and on his appointment with the London County Council. He thought it would be well to always keep down the drop below the seven-volt limit, so as to avoid all possible damage from electrolysis. It was absurd to cry out against a statement that damage might result.

Mr. J. F. C. SNELL, of Sunderland, said that they used an earth at the junction of negative feeder and tracks, and also a negative booster. This latter was on a return feeder, which could be connected to any desired part of the track. He had specified the track to have only half the Board of Trade limit of drop, and the contractors succeeded in obtaining such a low drop in the return, even at full load. He hoped that members would collect reliable records of the working of their return circuits for reference at a later date.

Mr. RUTHVEN MURRAY then read a letter from Mr. A. B. Bromley Holmes, of Liverpool, to the effect that the old regulation did not prevent a long connection from the negative pole to earth, and this connection might be the negative feeder.

Mr. MINSHALL, of Croydon, said he was arranging both + and − feeders of the same size, so that either could be used as the + feeder. He noticed that the Americans were adopting our seven-volt limit.

Mr. R. C. QUIN, of Blackpool, said that a 3½-volt drop in return feeders was quite possible. He also believed in bond pipes to the track near the earthing point.

Mr. TURNBULL, of Tynemouth, said he feared there would be electrolytic trouble at the joints of the pipes if they were connected as designed by Mr. Quin.

Mr. TREMLETT CARTER explained that the earth was a conductor, not an electrolyte, and that at seven volts electrolysis did not take place in consequence.

Mr. SAYERS did not agree that the earth could be considered as a homogeneous whole in the way suggested, as local conditions were so varied.

Mr. RIDER briefly replied, regretting that the discussion had been spoiled by the alteration of the Board of Trade regulations.

The members then adjourned to the City Chambers, where they were entertained to lunch by the Corporation of Glasgow. Lord Provost Chisholm presided, and among others present were the Mayor of York, Rev. Dr. Fergus Ferguson, Mr. W. A. Chamen (president of the association), the magistrates and members of the Coryoration, and over 200 others.

The loyal toasts having been given and duly honoured, the LORD PROVOST proposed "The Incorporated Municipal Electrical Association." Although the association was of comparatively recent date, it had grown marvellously, owing to the extension of electrical enterprise in connection with municipalities, and, he hoped, also to the growing sense of the importance of the enterprise, and to growing interest on the part of engineers and of municipalities in the development of municipal electrical

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schemes. The objects for which the association existed were of a patriotic and public-spirited character, as it existed for the purpose of promoting, not the interests of those engaged in the respective undertakings, but the interests of the undertakings themselves. An association which tried to bring together and to unite for a common end interests which otherwise might be found running off at a tangent from each other, was entitled to their heartiest acknowledgements and to their best wishes for its success. The president of the association was their own electrical engineer, who had been brought from London, while Glasgow had sent Mr. Chamen's assistant to be electrical engineer at Brighton, a proof of the cosmopolitan character of electrical undertakings.

Mr. W. A. CHAMEN, in acknowledging the toast, said that the association was unique in its character, and might be called in some sense an experiment. They had tried to combine members and officials of town councils in one association in a way which, he thought, had not been attempted before. He dwelt upon the importance of their aims, and as showing the interest taken in the association he mentioned that they had 140 town councillors and 110 engineers present from all parts of the kingdom..

The LORD MAYOR OF YORK proposed "The Lord Provost and Corporation of Glasgow."

The LORD PROVOST, in responding, said that Glasgow had a very deep interest in the prosperity of municipal electrical enterprises. They had a larger number of these than any other city, having electric lighting, electric power, electric tramways, and telephones all under the management of the Corporation. The Glasgow Corporation had had an arduous struggle with successive Governments, lasting over a series of years, before they got power to instal a municipal telephone system. That power had now been obtained, the system was being established, and the only complaint was, not that they could not get a sufficient number of subscribers, but that they could not put their subscribers sufficiently quickly on the switchboard. The Corporation of Glasgow were thus greatly interested in the prosperity of municipal electrical undertakings, and had much reason to welcome to the city this congress, which sought to promote the excellence and the success of such undertakings.

The proceedings then terminated, and the members afterwards visited the following works: the Pinkston generating station of the Glasgow Corporation tramways department, the Dalhousie-street electric sub-station of the tramways department, and the Port Dundas generating station of the electricity department.

ANNUAL DINNER.

The annual dinner of the members of the association was held in the Windsor Hotel in the evening. The President, Mr. W. A. Chamen, occupied the chair. Altogether about 200 gentlemen attended. After the loyal toasts had been proposed and pledged,

Alderman PEARSON proposed "The Lord Provosts and Corporations of Glasgow and Edinburgh."

Lord Provost CHISHOLM, in replying, said the Corporation did not proceed upon the theory that it was their duty to municipalise everything. They proceeded upon these three general lines. If an article was in its production something like a practical monopoly, if it was at the same time something like a practical necessity, and if it required for its production and distribution the use of the streets of the city, then the Corporation held that it ought to be under their management, and they did not rest satisfied till they got it.

Mr. NEWINGTON (Edinburgh) also replied to the toast.

Mr. T. P. WILMHURST proposed "Scientific Institutions."

Dr. MAGNUS MACLEAN and Mr. WM. FOULIS acknowledged the toast.

Lord Provost CHISHOLM afterwards proposed "The Incorporated Municipal Electrical Assocation," and said, while emphasising the friendly relations between the electricity and gas departments in Glasgow, he would like electricians to understand that there was a veritable and real competition between gas and electricity. He illustrated his contention by reference to the display of gas lighting in the grounds of the exhibition.

The CHAIRMAN, in his reply, said that he had not the faintest doubt that everything which had been recently achieved in the way of incandescent gas lighting could be equally achieved in due time with electric lighting.

Other toasts followed.

THURSDAY, JUNE 20.

On Thursday, 20th, the members of the above association and the visitors attending the convention left Glasgow by the 8.45 train for Edinburgh. The meeting to discuss papers was held in the Freemasons' Hall, where Bailie MACKENZIE, the convener of the Edinburgh Electricity Committee, welcomed the members in the absence of the Lord Provost. In a short speech he referred to the capture of Glasgow by the Americans, and, in passing, expressed his opinion that the present tramway system with its overhead equipment was only a temporary makeshift. The Edinburgh electricity supply was having a hard fight to keep up with that of the Glasgow Corporation, but they were not handicapped in the first instance by having to buy out an electric light company. They had in Edinburgh some 570,000 equivalent 8-c.p. lamps connected, while of that there were some 2,100 h.p. of motors. They had a flat rate of 3½d. for light and 1½d. for power, which at least was comprehensible. Bailie Mackenzie proceeded to chaff the president on the Glasgow system of charging, saying that few could understand it. One case had actually occurred in which a consumer with an annual bill of £22 could have reduced it to £18 by taking twice the quantity of energy. He heartily welcomed the association to Edinburgh, and hoped that the weather would be at least as good as that in Glasgow the day before.

The PRESIDENT (Mr. W. A. CHAMEN) thanked the bailie for his kind welcome, and complimented him on the success of the Edinburgh electricity undertaking. The curious case he had quoted against the Glasgow system of charging would not occur again, as the new rates in force made a distinction between energy supplied for light and that required for power.

In the absence of Mr. Fell the following paper was read first:

The Equitable Allocation of Costs in Combined Lighting and Traction Stations.

BY W. H. TITTENSOR, ELECTRICAL ENGINEER, DUNDEE CORPORATION.

In bringing this subject before the association, the author feels that the present time and place are particularly suitable for its consideration and discussion. Owing to the rapid development of municipal enterprise in this country within recent years, local authorities, duly armed with the necessary (and in some cases unnecessary) powers, find themselves, as undertakers, face to face with problems upon the proper solution of which the degree of commercial success attending a given undertaking may depend.

The question as to whether power for traction should be generated by a combined lighting and power plant or in a station specially erected and fitted up with plant for that purpose alone, is one of these problems, and it is the one perhaps which at the present moment is most urgently in need of the attention alike of the local authority and the electrical engineer. The two modes of procedure generally adopted in such a case are neither of them quite without more or less serious objections. (1) The outside expert, carefully formed as his opinion may be, is liable to be biassed by the "personal element," and this may be responsible to a great extent for the expert's decision in favour of a separate decision. (2) In the case of the resident engineer responsible for the running of the lighting station, the personal element together with a better load factor, larger plant and correspondingly increased allocations to management expenses, may influence his decision in favour of a combined station. In view of these facts it is hardly to be wondered at that local authorities find it difficult to decide which is the better course to adopt.

The author feels that in such cases the ultimate decision is too often due to the engineer's point of view being unduly emphasised, at the expense of the commercial and purely business aspect of the question. Many successful engineering schemes will not bear to be thus looked at, and yet it is undoubtedly the standpoint from which all such questions should be determined. If a local authority were asking for a supply either of electrical energy or of any other commodity

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from two or more outside companies, it would, without hesitation, decide to buy from the cheaper source. The questions that the undertakers have to decide, therefore, are: (1) Can the combined station *generate* as cheaply as the separate station? and (2) which of these two stations can *supply* at the cheaper rate? The first question is one that any qualified adviser *with a knowledge of local conditions* can advise upon and be able to produce facts and figures to support his conclusions. The second question is one that many people would naturally expect to be dependent upon the first, but such is by no means the case, since that unknown element, "policy," has to be reckoned with.

Many people look upon an electric tramways undertaking owned by a local authority as a veritable "municipal Klondyke." If it leak out that the committee which is to be responsible for the running of the future combined station (generally the Lighting Committee) takes this view, even in a modified form, then unfortunately there is every liklihood that the Tramways Committee will put down its own generating plant. The author has always held that supplies of a *purely public nature* should be given at *cost price*. Under this head would be included, for example: (1) public street-lighting; (2) sewage pumping; (3) tramways, etc. On the other hand, however, no public works or department should be run on the lines of a "philanthropic institution."

The particular question dealt with in this paper is the cost of generation in a combined station. When the existing station is provided with *suitable plant*, and the "centre of gravity" of the lighting and traction systems coincide, the cost of generation should be cheaper in a combined station than in a separate station, *if the costs are equitably allocated*. These should be in proportion to the plant used for tramway purposes, and not according to the total output of the station for both lighting and traction; or, in other words, the costs should be allocated on the basis of the maximum demand upon the plant only used for supplying the tramways and not on the whole of the generating plant in the station. The traction department should be treated as an individual consumer, and supplied at a rate proportionate to the cost of generating the power required. Treated in this manner, the tramways are in an unique position, inasmuch as their maximum demand can be pretty accurately foretold and provided for. On the other hand, the cost of supplying a lighting system, spread over some hundreds of consumers with a variable maximum demand, must necessarily be greater than the cost of supply to a traction system.

The method adopted for determining the *selling price* of current to consumers supplied on the maximum demand system is pretty generally understood, and has been fully described and discussed elsewhere. The method of arriving at the *cost of generation* may, however, be dealt with on simpler lines, owing to the fact that in most stations the plant capacity is, or should be, well in excess of the actual maximum demand at any one time, in order to provide against interruption to the supply arising from breakdowns. The cost of "generating" and "supplying" electrical energy constitute two separate and distinct problems, and as such must be treated in accordance with attendant circumstances. In a given station the total standing charges will be the same, whatever the number of consumers connected may be or their total maximum kilowatt demand on the plant, but the cost of generation will vary in inverse ratio to the *number of* UNITS *generated*, and it is unnecessary to take into consideration the maximum kilowatt demand in determining the cost per unit generated. It is, however, necessary in "supplying" individual consumers to differentiate in accordance with their maximum kilowatt demands, in order to arrive at the cost per unit delivered at their terminals.

In considering the present subject, the author deals only with the *cost of generation per unit*, and in order to state the case more clearly an example will be given of a station just commencing operations. One of the first questions asked will be, "What number of units must be generated and sold at the maximum rate charged in order to meet expenses?" To determine this, we will assume that cost of generation = standing + running charges; then let x = number of units which must be sold at the maximum price in order to equal standing + running charges.

a = the maximum price per unit *in pence*;
b = the "running" cost per unit *in pence*;
c = the total "standing" charges *in pence*.

Then $$x = \frac{c}{a-b}.$$

Example.—The standing charges (c) in a particular station were £1,052. 8s. 2d. per annum; the running charges (b) were ·435d. per unit; the maximum price (a) to be charged was 2d. per unit. Then

$$x = \frac{252{,}578}{2\text{d.} - 0{\cdot}435\text{d.}} = 161{,}391 \text{ units.}$$

Therefore, it is necessary *in this particular case* to sell 161,391 units per annum before all expenses are met, after which each unit will cost 0·435d. The station referred to has an annual output of 322,782 units, therefore the total cost per unit generated would be

$$\frac{252{,}578}{322{,}782} + 0{\cdot}435 = 1{\cdot}217 \text{ pence.}$$

It is generally understood that the total cost is divided into standing charges and running charges, and in order to arrive at the relative cost of generating electrical energy for lighting and tramway purposes respectively, it is necessary to remember that the standing charges allocated to the tramways as a consumer are not affected by the actual maximum demand at any one time on the plant, but are dependent upon the total plant capacity *installed for tramway purposes only*. This is owing to the fact that up to the present it has not been found advisable to run tramways and lighting simultaneously from the same generators.

Taking as an example a combined station supplying both lighting and traction, it will be found that certain plant is set aside and used for tramway work only, and it does not matter, therefore, what the load factor may be, the standing charges on such plant will be constant. In determining the cost of generation, the crux of the matter lies in the allocation of costs. For the purpose of comparison the following headings will be used: *Standing Charges.*—Interest; sinking fund; management expenses; insurance; rents, rates; wages. *Running Charges.*—Fuel; oil, etc.; repairs.

Dealing with these headings singly, the amount allocated to the tramways account under each item should be determined on the following lines.

STANDING CHARGES.

(*a*) *Interest and Sinking Fund.*—Charged on the full value of the plant and apparatus in use. Charged on one half of the value of the stand-by plant required and available for lighting purposes also. (*b*) *Management Expenses.*—Charged in proportion to the value of the plant included in the above and inclusive of clerical expenses actually involved. (*c*) *Insurance.*—Charged in proportion to the value of the plant (*a*). (*d*) *Rents, Rates, etc.*—Charged in proportion to the ground space occupied by plant included in (*a*). (*e*) *Wages.*—Charged in accordance with the actual proportion paid to fireman, drivers, and attendants required on each shift during the hours that tramway plant is running.

RUNNING CHARGES.

(*f*) *Fuel.*—Charged on the actual fuel required for the running of the tramway plant. When steam is taken from a common bank of boilers, the cost of fuel per unit must not be obtained by dividing the total weight of fuel used by the total number of units generated; this would be unfair to the traction plant, for assuming that the latter is kept in proper repair, its efficiency will remain practically constant and the fuel consumption will vary but slightly, whereas in the case of the lighting plant the active stand-by losses vary considerably according to the lighting season of the year. By "active stand-by losses" is meant such losses as occur in the winter months, when boilers have to be kept banked for several hours per day in readiness for the peak of the load in the evening. In the author's opinion, it would be to the advantage of the traction plant to have its own boilers separate and entirely shut off from those of the lighting plant, as by this arrangement the proportionate consumption of fuel for traction could be ascertained without any difficulty. Where it is considered desirable, however, to have only one steaming plant for both traction and lighting, periodical tests of the efficiency of the traction plant should be made, when the actual fuel consumption per unit can be ascertained and apportioned accordingly. (*g*) *Oil, etc.*—Charged on the actual quantity used on the plant in operation. (*h*) *Repairs.*—Charged in accordance with the actual material used plus the cost of labour (as shown on time-sheets) necessary to maintain the plant in good order.

As an illustration, let a combined station be taken as follows:

Annual output for lighting	835,000 units.
" " traction	500,000 "
Total output	1,335,000 "

Total capacity of plant, 1,300 kw. Maximum demand for traction purposes, 300 kw. Total capital spent on plant, buildings, etc., £63,662, or an average of £48·9 per kilowatt. The actual value of plant installed for tramway purposes was £15·6 per kilowatt (exclusive of mains and outdoor appliances). The total cost of generation was £11,125 per annum, made up as follows:

	£	s.	d.	d.		
Interest	1,401	15	0	= ·252	per unit generated	Standing charges.
Sinking fund	967	17	6	= ·174	"	
Management	912	5	0	= ·164	"	
Rents, taxes, &c.	1,223	15	0	= ·22	"	
Wages	912	5	0	= ·164	"	
	5,417	17	6	= ·974	"	or £4. 3s. 4d. per kilowatt installed.

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Fuel, etc.	3,726	17	6	= ·67	,,	Running charges.
Oil, etc.	367	2	6	= ·066	,,	
Repairs	1,613	2	6	= ·29	,,	
Total	11,125	0	0	= 2·000	,,	

The cost of generating 500,000 units under these conditions for tramway purposes was

$$\frac{450,000}{500,000} + 1·026 = 0·9 + 1·026 = 1·926 \text{ pence per unit generated.}$$

Under these apparently most favourable circumstances, the tramway plant appears to be charged with a large portion of the capital and standing costs of the lighting plant, and actually earns a profit (£1,312. 10s. per annum), which is appropriated for lighting purposes, whereas if the costs are equitably allocated, the actual cost of generation will be as follows :

	£	s.	d.	d.		
Interest	210	12	0	= ·101	per unit generated	Standing charges.
Sinking fund	140	8	8	= ·067	,,	
Management	158	10	0	= ·076	,,	
Rent, taxes, etc.	219	0	0	= ·105	,,	
Wages	273	0	0	= ·131	,,	
	1 001	10	0	= ·480	,,	
Fuel, etc.	1,041	13	4	= ·5	,,	Running charges.
Oil, etc.	54	3	4	= ·026	,,	
Repairs	608	8	0	= ·29	,,	
	£2,705	14	8	= 1·296	,,	

In submitting the above figures, the author does not wish them to be regarded as model costs to be accepted as station records, as they would be proportionately lower in larger and better-equipped installations. They are, however, intended to illustrate the application of the principles enunciated in this paper to actual working conditions.

Having ascertained in a given case the actual cost of generation, the percentage of profit to be charged on the supply may then be determined. It would be well for those responsible for combined stations to see that the profit charged does not make the cost of the supply to the tramways undertaking too largely in excess of the amount for which the tramway people could generate their own current; or the chances are that this consumer will be lost to the station. In fact, the advocates of the combined station, if they are to successfully combat the counter proposals which are almost sure to be forthcoming from the tramways department, must be prepared to show that they can supply power for traction cheaper than it could be produced by a separate station. The author's contention is that this can be done and profitably. In the combined station economies are effected in management and attendance (especially in the earlier stages), as a better paid and more competent staff can be employed in one station than in two separate stations, sharing the same amount of work between them; the management can, of course, be more efficiently carried out for the same reason. The cost of buildings and stand-by plant will also be less, as the latter, being available for either lighting or traction, need not be installed to the same extent as would be necessary in two separate stations.

Although many resident engineers may not look favourably upon a proposal to supply current for *any* purpose practically at cost price and may recommend separate stations, because of the greater amount of "management" required by the latter arrangement and the consequently increased remuneration likely to accrue therefrom, local authorities can hardly be expected to accept such recommendations, if before doing so they analyse them from a commercial and business standpoint. In bringing forward this subject—and it is one of vital importance at the present time—the author has done so more with the object of gaining for it the benefits of criticism and broader experience than with a desire to lay down any hard-and-fast rules, which might require modifying in order to suit certain localities and conditions.

Mr. J. F. C. SNELL, of Sunderland, complimented the author on bringing such an important subject before the association. He agreed with much in the paper, but, again, there was much with which he did not agree. He deprecated the remarks of Mr. Tittensor on tramway experts, and believed that a much higher standard of professional probity existed than was inferred by the author. As regards combined works, he considered that these were almost always advisable. Of course, in such large towns as Glasgow the conditions were by their magnitude different from those with which most present had to deal, but even in Glasgow he believed there would have been a decided advantage gained from combining the two generating plants. With respect to the price to be charged to the tramway department for electrical energy, some undertakings had adopted a very low figure. Thus, Liverpool commenced supply to the tramways at ·9d., while a Midland town asked 1d. per unit. This latter price had now been raised. He did not consider that it was right to supply at cost price or under, as that was unfair to the rest of the undertaking. As regard the author's division of the stand-by plant charges, he did not think that one half of these was enough to charge to the tramways. Again, the management expenses should be spread equally over all the units generated. He agreed with the author on the rent question, but the rates would certainly not be levied on the space occupied by the respective plants. The figures given in the paper were, as a rule, too low. Thus tramway plant cost nearer £40 per kilowatt than £15. 6s., and he would like to know what the author included in this latter figure. The capital charge being taken too low resulted in erroneous figures for the cost per unit in standing charges. He had tried to ascertain by the author's method what they should charge in the case quoted, and found it would be about 2·73d. per unit with his corrected figures. Capital charges alone came out at 1·08d. On the Sunderland consumption of 1,330,000 units per annum, the cost per unit with the same method came out at 1¼d. per unit, but no depreciation was allowed for. This at 5 per cent. brought up the price to 1·7d., and with margins for coal and rates, which varied continually, they really should not charge less than 2d. The last paragraph of the paper he strongly repudiated and condemned.

Mr. S. E. FEDDEN, of Sheffield, advocated three or two phase plant for combined stations, and that all municipal electrical engineers should be exported to the Continent with a £100 cheque in their pockets, but he did not discuss the paper.

Mr. C. H. WORDINGHAM considered the subject one of vital importance. The author was right in his system of ascertaining the charges by the maximum demand system, but in detail he differed from some of his items. There should be some profit made on the tramway supply, as that department was a profit-earning one. It must be a most extraordinary case where it did not pay to combine the light and traction plants, and could only be due to exceptional conditions in the placing of one of the stations. He did not advocate, as did the author, two separate plants in the one station, but rather a common generation by three-phase plant with the load divided up in the rotaries. As regards details of cost a considerable part of the coal—*i.e.*, that required to keep the boilers heated up—was a standing charge, and certainly part of the wages bill should be considered as a running charge.

Mr. J. A. BELL, of Aberdeen, said that he was a near neighbour of Mr. Tittensor, and the townspeople of Aberdeen wanted to know why he did not supply the tramways at the same price as the Dundee tramways were charged. At Aberdeen they supplied at cost price as ascertained after the energy had been taken. The author's system was fairly equitable in principle, but wrong in detail. He thought they should be very careful not to supply below cost price. On the author's system, Aberdeen tramways would be charged more than at present for electricity. He would ask Mr. Tittensor to explain how in Dundee he could afford to supply at 1½d. per unit and to maintain the feeders and overhead work into the bargain.

Mr. G. H. CORRINGHAM said he had great faith in the maximum demand system, which gave equally reasonable and right results when applied to tramway loads as to lighting loads.

Mr. J. CHRISTIE, of Brighton, said that Mr. A. Wright was putting down a three-phase station in the outskirts of Brighton, from which both lighting and traction loads would be supplied. In the meanwhile, they had had to put in a new plant for the tramway supply in their present station. All consumers were treated alike in Brighton, being charged at the rate of 7d. per unit for the first hour's use per day of their maximum demand and 1d. per unit for all above this. In consideration of the tramway department supplying their own feeders, they had reduced the first charge to 5d. per unit. He thought that one-half of the standing charges could fairly be charged to the tramways.

Councillor SMITH, of Sunderland, as chairman of the Electricity Committee, hoped to get some advantage out of

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the paper, but Mr. Snell had the ear of the Sunderland Council, and might prevail. He believed the supply was being given at cost price, and when the large new station was erected in Sunderland should like to take over the old works for the tramway load alone. In the early years of the undertaking the ratepayers had to make up a deficit, but now a profit was made it was hard to combat the idea that it was made from the tramway department.

Alderman BRUCE, the chairman of the Sunderland Electric Light Committee, said that when this question of charging the tramways for current first came up they had obtained a full report from Mr. Snell, who found that in certain towns interest and depreciation were not taken into account when fixing the price. There should be no difficulty in settling on a fair rate, but it was not right that the electric lighting department should supply at bare cost price so that the tramway department could show a huge profit. They were all working for the good of the townspeople, so that a profit did not hurt anyone.

Mr. R. A. CHATTOCK, of Bradford, referred to the circular letter on the subject of the paper which he had recently sent round to members of the association. He found when he went to Bradford that the tramways were supplied at 1d. per unit, and that that price meant a loss to the undertaking. They maintained the feeders for that figure. He had looked into the matter and found that the total cost of generation came out at 886d. per unit, the interest and sinking fund at ·671d., and depreciation at ·098d., making a total of 1·655d. per unit. He thought that a fixed price should not be made, but that the actual cost should be ascertained and charged. The cost of coal, etc., should be taken over the whole units supplied for power. It would very difficult to ascertain the percentage of coal to be put to standing charges.

Councillor IVEY, of West Ham, considered they could safely leave the allocation of cost to the electrical engineers. They had a combined committee in West Ham as well as a combined plant, and he believed in that. In fact, a one-man committee would be the most satisfactory of all.

Dr. PAXTON, of Bolton, said he had spent much paper and blacklead analysing the report of the Leeds tramway station. They supply 10 to 15 per cent. of their load for arc lighting at 5d. per unit, and hence claimed to produce the tramway units at ·6d. This figure was arrived at by deducting the arc lamp revenue from the total cost and then dividing by the units used on the tramways. At Bolton they charged 1½d., and he believed they made a profit.

Mr. R. C. QUIN, of Blackpool, had adopted the same method as the author when fixing the charges for energy to the Blackpool tramways some years ago, and found the results satisfactory. Up to 260,000 units per annum they charged 2d., and above that quantity 1¾d.

Councillor WORTHINGTON, of Wigan, said he was chairman of the combined Lighting and Tramway Committee, and he did not trouble at all on the matter. If they charged the tramways too much, it only meant that the money went from one pocket of the Corporation to another, and it did not affect the ratepayers a bit. In fact, just now, when the lighting load was not large enough to pay, they saved at least £200 a year in income tax by so doing.

Mr. TITTENSOR said he would reply in the *Proceedings*, adding that while figures never lied, l——s could figure.

Mr. A. L. C. Fell's paper on "Braking Apparatus for Electric Cars" was then taken as read. The following is the full text of the paper:

Braking Apparatus for Electric Cars.

BY A. L. C. FELL, TRAMWAY ENGINEER, SHEFFIELD CORPORATION.

The various methods of braking cars on electric tramways call for serious consideration owing to the comparatively high speed at which electric cars travel through crowded thoroughfares, and also that cars may be safely handled on steep gradients. On railways a fairly good rail can always be relied on, but in street tramway work the state of the rails is very unreliable. Car brakes may be classed under six different headings—viz. (1) hand brakes; (2) friction brakes; (3) slipper brakes; (4) pneumatic brakes; (5) electromagnetic brakes; (6) Newell electromagnetic brake.

Hand Brakes.—The best known of these is the link suspended type, the links being set at a slight angle so that gravity will tend to keep the shoes away from the wheels when they are not in operation. The shoe and head are usually of the well-known "Christie" pattern, the shoes being retained in the holders by means of a pin, which can be easily removed when the shoes require replacing. The brake beams and equalising brake beams are placed with their surfaces against each other, the power lever being the fulcrum at their centres. In the majority of cases the brake rods are made in one piece, thus avoiding unnecessary swivel joints. The link suspension is claimed to give much freer movement, as it does not become clogged with either mud or ice. In the writer's opinion, there is not any particular advantage to be gained by using one particular type as compared with another. The chief point in connection with all brakes is that reliable men should be employed to fit them on to the wheels of the cars, so as to ensure even pressure on the wheels. One very important matter concerning the adjustment of brake rods is not to employ locking nuts, as they cause serious delay when this work is necessary. The adjusting nut should be kept in position by a pivoted claw, which can be simply thrown back when it is necessary to move the nut. The writer has tested various types of brake shoes, and finds the "Corning" brake shoe is the best. This shoe, although somewhat more expensive in first cost, has been found to last several times the life of an ordinary cast-iron shoe without materially affecting the wear and tear on the wheels. The main body of the "Corning" shoe is of tough hard iron cast about a soft grey iron core. The body of the shoe has a chilled face. The combination of the chilled iron body and the soft iron inset makes the frictional quality almost equal to that of ordinary cast iron. The wearing qualities of this combination appear to give splendid results. A sample of one of these shoes is shown. This ran over 12,300 miles on a route where the gradients are very steep—viz., 1 in 11 and 1 in 12—and would easily have run another 1,000 miles before replacement would have been necessary. Ordinary hard cast-iron brake shoes on another car on the same route only ran for 6,000 miles before they were worn out. The difference in the diameters of the wheels under the two cars was inappreciable. Tests are now being made with various types of brake shoes on steel-tyred wheels, but at the time of writing comparative results cannot be given.

Friction Brakes.—On cable cars or on electric cars where only one motor is used, or where a broad gauge is in operation, a friction brake can be operated. This consists of a spool or boom upon which a chain is wound, the chain being attached to the brake lever and the spool or boom driven by two friction plates operated by the driver through the medium of a lever, a slight pressure on which applied by the hand or foot instantly applies a very effective brake. This type of brake acts very rapidly in the case of an emergency. It is simple in design, cheap to obtain and to operate, its only objection being the amount of room required to properly mount it on the axle. For this reason, on the majority of tramroads in this country, it could not be used.

Slipper Brakes.—This is the most useful type of brake at present in operation in England, and simply consists of wood blocks which are pressed down on to the rails by means o levers, as shown on Fig. 1. The levers are operated by means of a handwheel connected by a chain or worm gear at either end of the car. The operating handwheel is fixed on to a tube spindle, which is placed outside the solid hand-brake spindle. The two spindles are quite independent of one another, and separate ratchets and pawls are provided for locking them independently. It has been found in practice that it is advisable to design the slipper brake operating handwheel so that it is impossible to lift the car off the rails. The framework carrying the slipper-brake shafting, levers, and slides is fixed to the sides of the truck frames. On all gradients steeper than 1 in 20 it is advisable to use the slipper brake, and the best results have been obtained when the slipper brake is worked as an auxiliary to the hand or electric brake. On single lines with steep gradients the slipper brake is especially useful, as it not only retards the descending car, but also cleans the rails for the ascending cars.

Pneumatic Brakes.—On several systems in this country pneumatic brakes are fixed on the cars, but in the writer's opinion they are not satisfactory, since they are not always reliable. They require complicated and perfectly fitted mechanism to compress the air; the cost of maintenance is very high, and the conditions under which a street car has to work are unfavourable to success on account of the mud, dirt, and dust under the car. The air, which is compressed, has to be drawn in under very unfavourable conditions, and the dust rapidly cuts up the cylinder of the air-compressor. The difficulties in connection with driving the air-compressor, and keeping up a sufficient supply for frequent stoppages, are problems which have not yet been satisfactorily solved.

Electromagnetic Brakes.—One type of this brake consists of two cast-iron discs, one of which is fixed to the motor and has a coil of wire wrapped round it, the other is keyed to the axle,

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The motors are used as generators and gradually short-circuited through a rheostat and the disc coil above mentioned. The discs are thus magnetised and braking action is produced from three causes: (1) retardation due to converting motors into generators by driving them from the car axles on practically short-circuit; (2) drag due to eddy currents which are set up in brake disc as it revolves in the intense magnetic field of the brake shoe; (3) the mechanical friction between the brake disc and shoe. As the braking effect is so rapid, great care has to be exercised not to magnetise the discs too quickly, otherwise the wheels will at once be skidded unless a very plentiful supply of sand is used. On a good rail this type of brake can be used for taking a car down a gradient of 1 in 11, but it is always safer to use a slipper brake in conjunction with the electric brake. In practice it has been found advantageous to bring the slipper brake into operation at the top of a gradient and fix it; the speed can then be regulated by the hand or electric brake. In the writer's opinion, the hand brake should never be used in conjunction with the electric brake, but if the former is in use, it should be released before the electric brake is applied.

The Newell Electromagnetic Brake.—This is arranged to act as a magnetic slipper brake, the slipper being made of cast iron and having coils wound round it. The method of magnetising the slipper is similar to that employed to magnetise the disc brake described above, but in this case the slipper is drawn down on to the rail, whereby a strong braking action is set up. The writer has not had an opportunity of practically testing this brake on a roadway, but the experiments made at the Tramways Exhibition in London in 1900 were very satisfactory.

Brake Tests.—Tests have been made to ascertain the best methods of stopping cars under various conditions. Cars were run over a marked-off space on a practically level road. The speed was in each case carefully noted, and the brakes were applied at the same point in each case. The results have been tabulated, and from them and from previous experience it appears that for all-round general purposes the hand brake, worked in conjunction with the slipper brake, is the best and most reliable method of regulating the speed of a car. This is especially the case if the rails are greasy, because the wood block thoroughly cleans the rails. For emergencies the electro-magnetic disc brake is the most satisfactory, but it requires to be applied very carefully, as it is very liable to cause skidding. The constant use of electric brakes is not to be recommended, because (1) they are expensive items, and the wear and tear is very excessive; (2) when the gradients are very steep the life

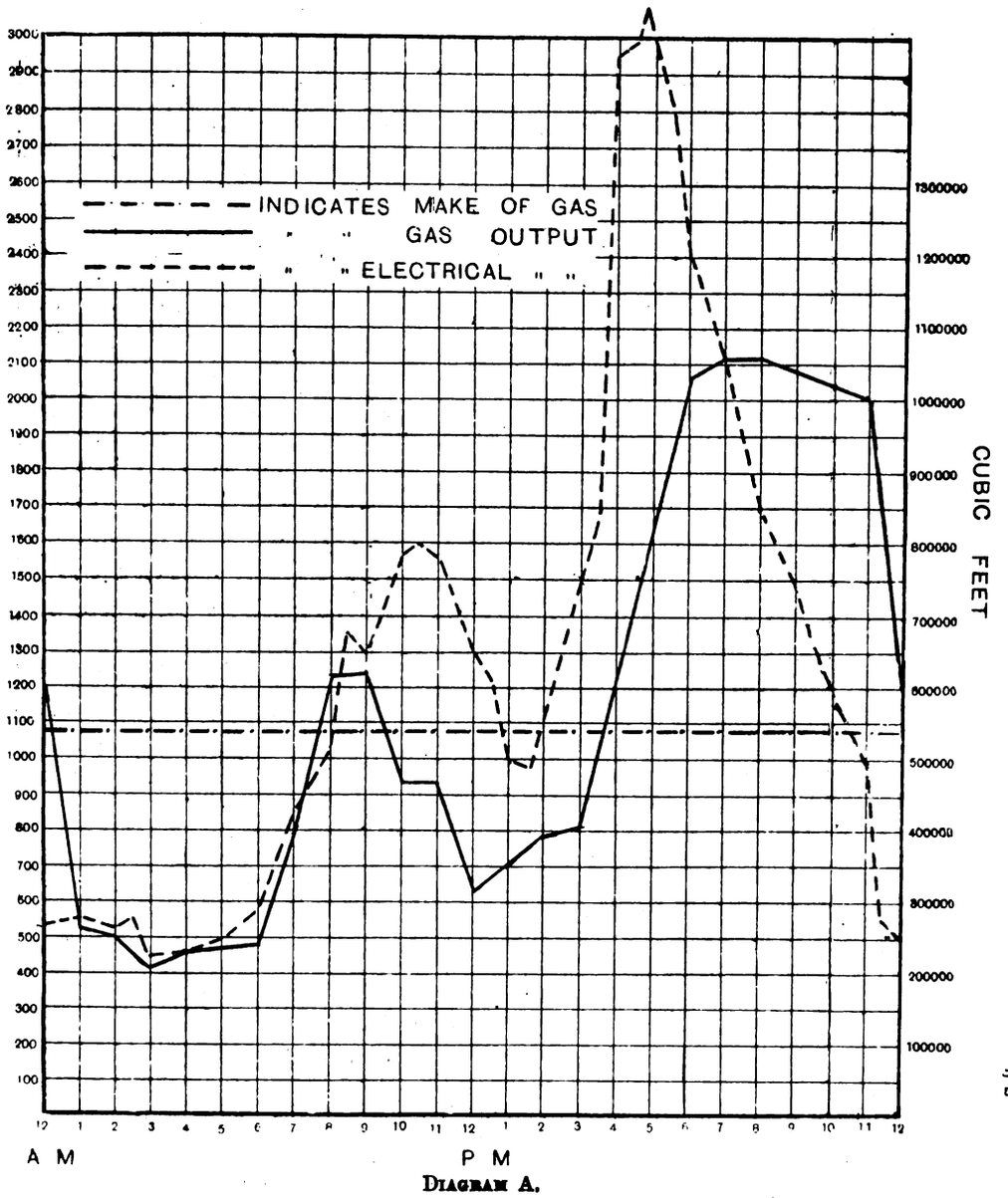

DIAGRAM A.

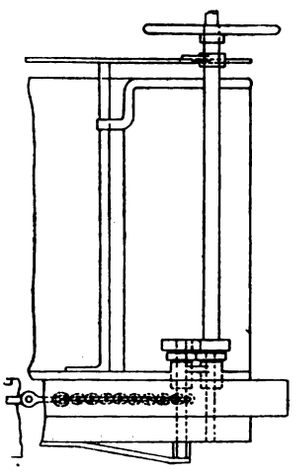

FIG. 1.

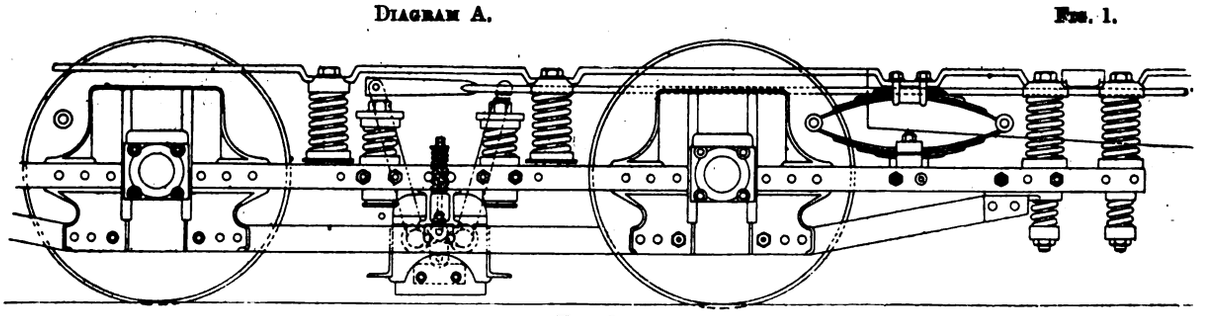

FIG. 1.

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of the motors will be appreciably shortened, as they will never get an opportunity to cool down.

Mr. COLLINGS BISHOP, of Wigan, complimented the author on his valuable paper, which was of great importance. He believed in the use of a hand brake for ordinary use, a slipper brake for heavy grades, and an electric brake for emergency. This latter should have a rheostatic control to avoid shocks to the passengers and apparatus.

Mr. J. F. C. SNELL, of Sunderland, advocated the members keeping logs of all repairs required, so that in time they might have at their disposal accurate comparative figures of the various costs of upkeep. It would be a good thing if manufacturers would combine an emergency sand-box with the emergency brake to avoid skidding of the wheels. He also advocated rheostatic control.

The meeting terminated by votes of thanks to the two authors for their papers.

The members were then entertained to lunch by the Corporation of Edinburgh. The Lord Provost was in the chair, and after the loyal toasts, proposed "The Municipal Electrical Association," to which Mr. W. A. Chamen replied.

(To be continued.)

Diagram A on the opposite page should have accompanied Mr. Chamen's presidential address given in our last issue. Reference to it will be found on p. 903.

THE VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO BERLIN.

(Continued from page 853.)

THE DYNAMO WORKS IN CHARLOTTENBURG.

The dynamo works of Messrs. Siemens and Halske Company are situated in Charlottenburg, on the Salzufer. The works were removed to this position in 1886, as the buildings available in the Markgrafenstrasse became too small. The site on the Salzufer, which at the time of purchase was covered with workshops for the construction of machines of another kind, was for a time occupied not only for the construction of dynamos, but also for the manufacture of cables. The further development of business led, in 1899, to the transfer of the cable works to a new site, and the whole buildings available on the Salzufer were occupied with dynamo work. These buildings, as shown in Fig. 1, were built according to the growing and increasing requirements of the manufacture.

The following work is now carried on at the dynamo works: (1) the building of generators, motors, and transformers; (2) the making of cut-outs, fuses, resistances, and lightning arresters, measuring instruments, etc.; (3) the manufacture of arc lamps; (4) the construction of rock-drilling machines. The driving of tools, machines, and lifting appliances is done by electromotors partly separately and partly in groups. The central station is placed near the middle of the works, and contains five steam dynamos furnishing direct currents of 2 by 110 volts. The dynamos are inner-pole machines, the armatures being developed as collectors. The pressure is divided by means of a storage battery; the battery is charged by two motor-generators.

The Building of Generators and Motors.—The building of generators and motors in the main is organised in such a manner, that in one building the erecting and mounting of the machines is carried on, so far as ironwork is concerned; on the other hand, the coils of the armature and the field magnet windings are made in a special building, called the armature hall. This separation of mechanical and electric parts of manufacture prevents an injury of the coil by mechanical influence, or a reduction of insulation by metallic dust. For the convenience of transport, the workshops, as well as the courts, are abundantly provided with tracks and electric travelling cranes. Besides, the machines are placed in the shops in such a way that the transport of pieces upon which work is to be done has been reduced to a minimum. Fig. 2 shows a view of the main workshops, and also gives an idea of the method of dealing with the manufacture. After the castings have been taken out of the foundry they are stored in the court ready for use. Further required work is done by machine tools separately driven by electromotors. Besides the stationary machines, movable tools are used provided with special electromotors, which are of small weight, easily transported by a crane to the worked part, and by means of a flexible cable connected as required. Fig. 3 shows the work upon the stator of a large rotary-current generator on a lathe. Fig. 4 shows a view of the stamping department. Here the sheet metal, of which the active parts of iron are constructed, is cut and stamped. Before being worked by means of a special machine, it is covered with fine paper. The stamping machines work in part with large stampers, which force the whole form with one action out of the sheet. In part the machines stamp the sheets tooth by tooth, as seen in the machines shown in Fig. 4. Single machines, whose models were exhibited in Paris, work entirely independent, taking the sheets from the machine table and giving them at one operation the necessary number of teeth. Then they release the parts, and the action is repeated.

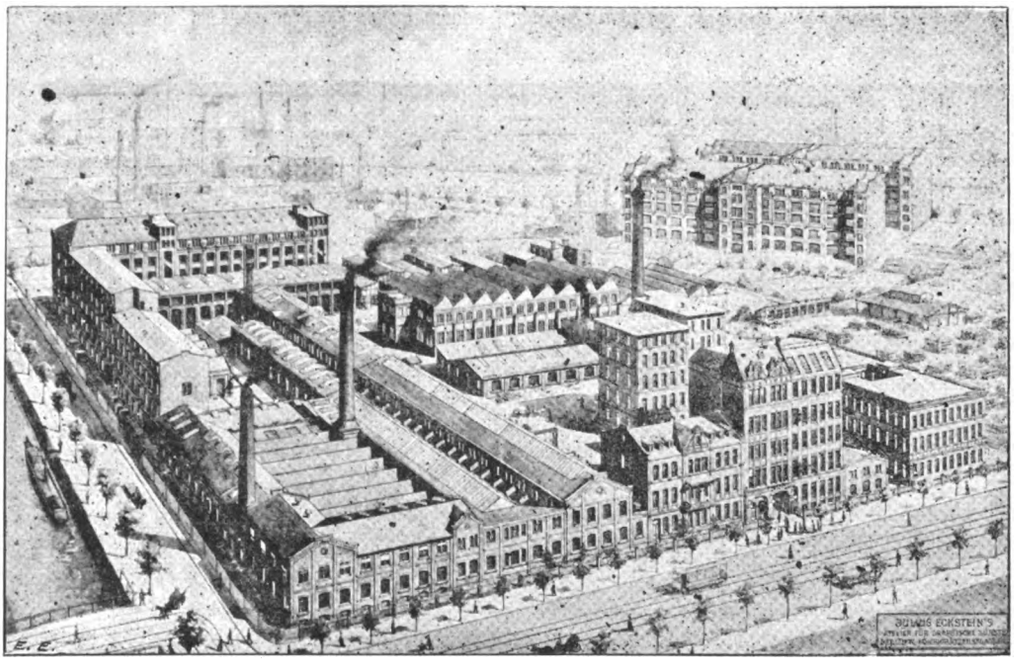

FIG. 1.—Bird's-eye View of the Dynamo Works.

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The castings and sheets being ready, the machines are fitted in the erecting shops. Fig. 5 shows the fitting of a rotary-current dynamo, the stator having a width of 6m. Next to the mounting-room of machines is the armature hall, devoted to the manufacture of armature and field-magnet winding and commutator building. The armatures, except in some special cases, are constructed on gauges in such a manner that the windings are perfectly

FIG. 2.—Machine Shop.

made, insulated, and so far as intended for the armature, embedded in the active iron. Fig. 6 shows in the foreground the manufacture of field-magnet coils for continuous-current dynamos; while in the background of the hall rotary-current armatures and inductors are wound. Of special interest is the manufacture of inductor coils out of flat copper, bent on special machines. In this part of the building also the connecting of the commutators with the armature is done. The armatures provided with the windings are carefully dried in special vacuum drying boxes in order to produce the best possible insulation. Owing to the expansion of business, special workshops have been constructed for the fitting of small electromotors and street car motors.

When the mounting is completed, a careful test of the machinery is made as to their mechanical and electric relations. Fig. 7 shows a part of the testing-room, in which a rotary-current generator of 13,500 volts is being tested for a pressure of 20,000 volts. The generators of this type, of which at the present time nine machines are under construction, are intended for direct coupling with a 1,000-h.p. turbine of 375 revolutions per minute. After the machines have stood the test they are completed in the motor workshop, and therefrom go the factory stockroom, if not, as it frequently happens with large machines, being at once shipped to their point of destination. For machines which are to be transported a long way, frequently even to countries across the ocean—for example, to the mines of East Asia and South Africa—the carpentry of the works furnishes the necessary and practical packing.

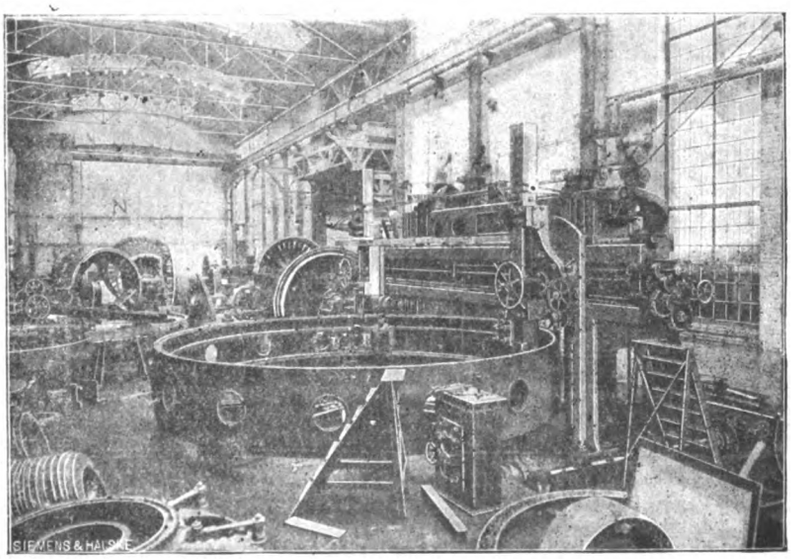

FIG. 3.—Stator of a Rotary-Current Generator on the Lathe.

THE BERLIN ELECTRICITY SUPPLY COMPANY.

The public supply of electrical energy in Berlin was commenced in the year 1885, when a small central station was laid down by the Allgemeine Elektricitäts-Gesellschaft, having as its commencing load some 3,000 incandescent lamps. The new illuminant coming rapidly into favour necessitated an increase in the capacity of the station, and soon the growing demand for electrical energy, not only for lighting but for power purposes, caused other stations to be built, and at the present date the Berlin Electricity Works possess six central stations in addition to numerous sub-stations, having a combined capacity, including the machinery now in construction, of nearly 150,000 h.p., all of which have been built and equipped by the Allgemeine Elektricitäts-Gesellschaft. The curves (Fig. 8) show graphically the increase in the load during the last 10 years, its most interesting feature being the rapid

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growth of the amount of energy supplied for power purposes and tramways, whereas the increase of energy supplied for public lighting is small, being due probably to the extensive use of the incandescent gas light in the streets of Berlin.

The various stations controlled by the company may be conveniently divided into three groups. The first group consists of the stations lying within the city boundaries, and located as follows: (1) Schiffbaurdamm-Luisenstrasse, 21,000 h.p.; (2) Spandauerstrasse-Rathausstrasse, 14,500 h.p.; (3) Mauerstrasse, 14,500 h.p.; (4) Markgrafenstrasse, 2,100 h.p.

With the exception of the Luisenstrasse station the above are the earlier stations of the company, and generate low-tension continuous-current, which is distributed on the three-wire system. As in other large towns, the heavy cost of ground space made it necessary for the company to build their new stations outside the city. These form the second group, being situated as follows: (1) Oberspree, 54,000 h.p.; (2) Moabit, 36,000 h.p. Both these stations generate high-tension three-phase current, which is brought by triple-cored, lead-covered, and armoured cables buried directly in the ground to various sub-stations in the city forming the third group, and located in the following streets: Mariannenstrasse, 7,500 h.p., and Pallisadenstrasse, 3,650 h.p., fed from Oberspree; Voltastrasse, 5,650 h.p., Konigin Augustastrasse, 5,650 h.p., and Wilhelmshavenerstrasse, 2,700 h.p., fed from Moabit.

The machines in the main and sub-stations in Berlin are arranged to feed two distinct networks—viz., the lighting and power and the tramway network. They are so connected up to the switchboards, however, that in case of necessity they can be interchanged and the stations interconnected, so that in the event of accident occurring at any station its load can be taken up by the others.

As stated above, the lighting of the town is carried out on the three-wire system, the pressure across the outers in the city itself being 220 volts, and in the outlying suburbs 440 volts. The pressure will, however, be gradually changed over to 440 volts throughout. The pressure of the tramway network is 550 volts. The smaller steam dynamos are wound to give a terminal E.M.F. of 110 volts, and are placed as balancing machines between the outers and the middle wire. The larger generators are wound for 220 to 260 volts, and are connected across the outers. In the sub-stations and also in the Luisenstrasse station separate

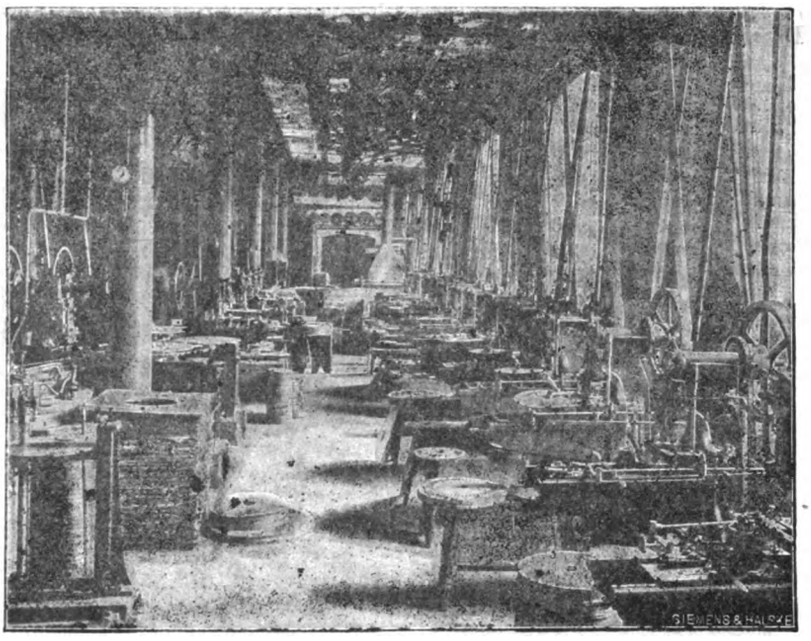

FIG. 4.—Stamping Department.

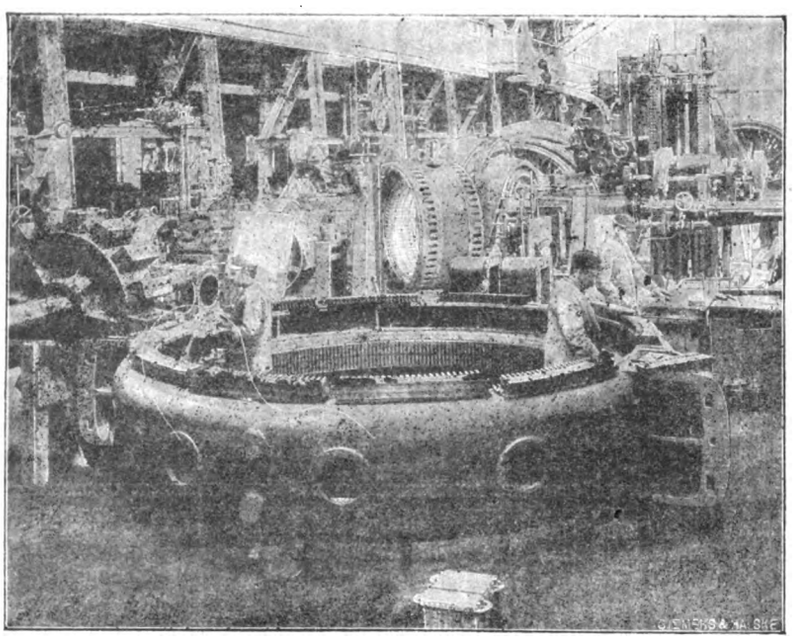

FIG. 5.—Fitting of a Rotary-Current Generator.

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buffer batteries are provided for the tramway and lighting networks, serving not only to take up the variations in the loads, and thus to reduce the strains on the generators, but also to bear the entire night load.

Preliminary Notice.

[BY OUR OWN CORRESPONDENT.]

By the time these lines appear in print a move should have been made to Dresden, but at present a great effort is being made by the members participating in the meeting to assimilate all the electrical knowledge of Berlin in the very limited time at their disposal. It will be unnecessary to recount the incidents of travel from London; suffice it to say that although the party which left Liverpool-street on Saturday evening last was not large enough to justify a special boat from Harwich, comfortable accommodation was provided by the Great Eastern Railway Company on their steamer, the "Amsterdam." It was coincidence which further provided an exceptionally smooth passage. Arrived at the Hook, the party boarded a special train for Hanover, and commenced their dusty journey through the monotonous country of Holland. In Hanover, which was reached about 4.30 p.m. on Sunday, the real fun commenced, but the first instalment was of an exasperating nature, being a muddle in the hotel arrangements. This prevented some of the members who had the comforts of their ladies to look after from participating in an intended visit to Messrs. Körting's works. However, a comparatively small contingent did eventually get to Körtingsdorf, where it was rewarded for its pains by the inspection, amongst other things, of some very fine gas-engines, including one of 1,000 h.p. in course of erection. Later in the evening the members were the guests of the city of Hanover to a banquet at the Kasten's Hotel, where a very hearty reception was accorded them by the Mayor.

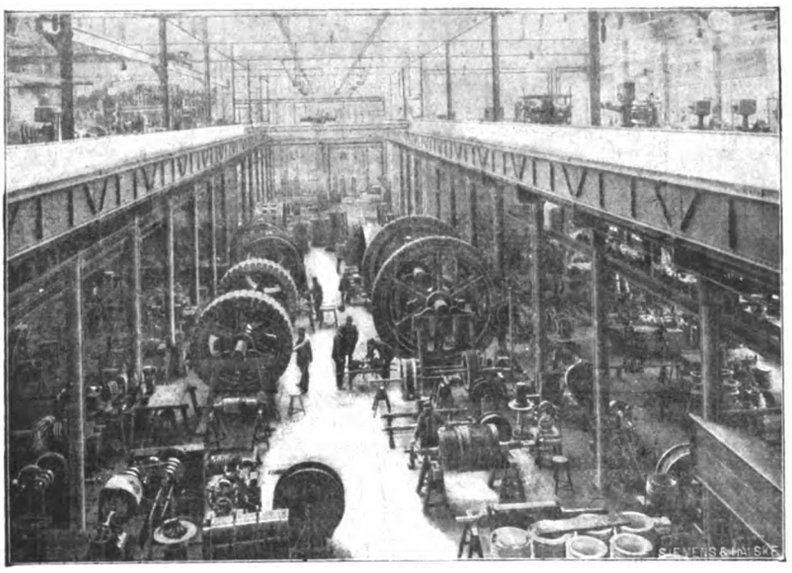

FIG. 6.—Manufacture of Coils and Windings.

The party arrived safely in Berlin on Monday morning, where they were received by Geheimrath Rathenau, the managing director of the Allgemeine Elektricitäts-Gesellschaft, at the company's rooms in the Luisenstrasse. A hundred Nernst lamps were used to illuminate the room in order to demonstrate the advantage of this apparatus. Herr Bussmann, head of the experimental department of the Allgemeine Elektricitäts-Gesellschaft, delivered an interesting lecture on the development of the Nernst lamp, which elicited frequent applause.

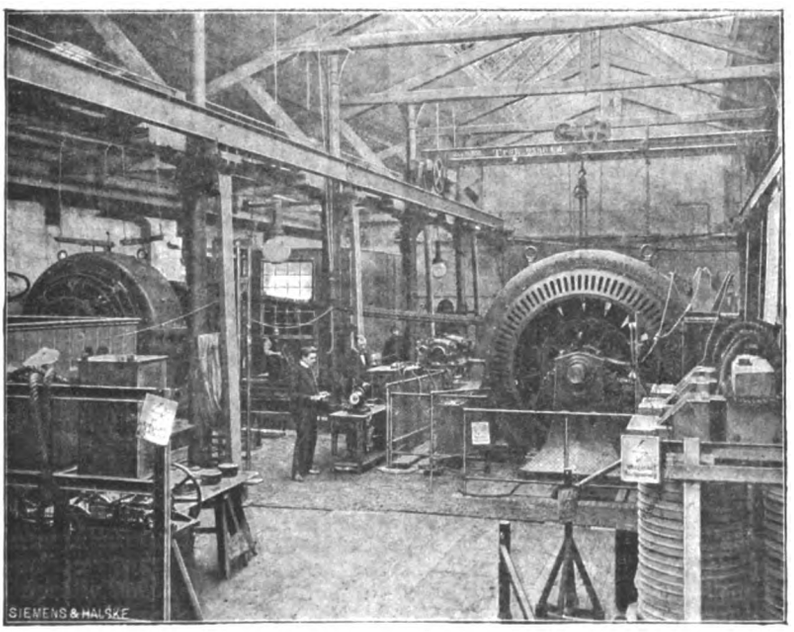

FIG. 7.—Test Room.

The first day was devoted to an inspection of the Allgemeine Elektricitäts-Gesellschaft and the electricity works erected in Berlin by this company. This visit commenced with the central station of the Berliner Elektricitäts-Werke in the Luisenstrasse. A visit to the high-tension station at Moabit, the most modern of the stations

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belonging to the Berliner Elektricitäts-Werke at which steam dynamos of not less than 4,000 h.p. are at work, and the sub-station in the Königin-Augustastrasse, concluded the day's work.

In the evening a reception took place in the exhibition for fire-prevention and life-saving appliances, where Herr Geheimrath Rathenau welcomed the guests in the name of the Allgemeine Elektricitäts-Gesellschaft and of Messrs. Siemens and Halske. We learn that the proceedings were protracted until the wee hours of the morning, and on

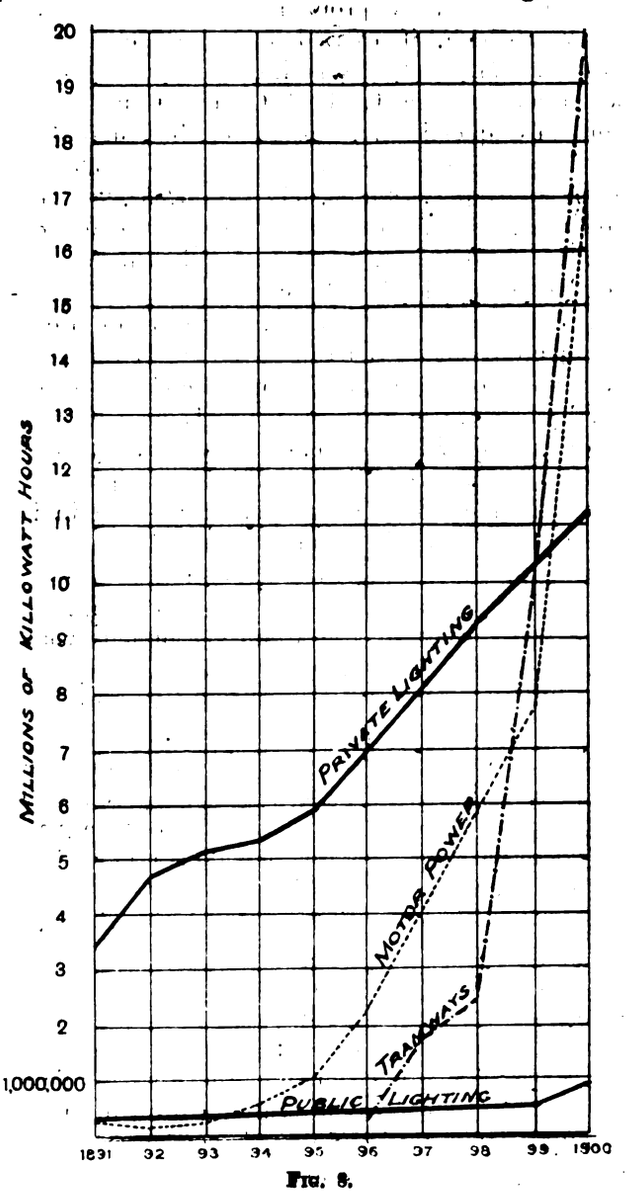

FIG. 8.

Tuesday the works of Messrs. Siemens and Halske were visited.

The following is a list of the members taking part:

Adam, J. H., Mauritius.
Addenbrooke, G. L., London.
Alabaster, H., London.
Allen, A. H., London.
Andrews, L., Hastings.
Atchison, A. F. T., Birmingham
Baily, F. G., Edinburgh.
Biggs, C. H., London.
Blackburn, A. B., Wolverhampton.
Blair, G. C., Glasgow.
Borns, H., London.
Boschan, A. von, Vienna.
Braulik, G, London.
Brown, W., London.
Bryn, K., Norway.
Chauvin, G. von, London.
Clirehugh, S. V., London.
Clothier, H. W., Manchester.
Clough, F. H., Berlin.
Coates, M. C., Newcastle-on-Tyne.
Collins, B. H., Liverpool,
Constable, A. D., London.
Cottam, G. H., London.
Cowan, E. W., Manchester.
Crampton, W. J., London.
Crawley, C. W. S, London.
Crompton, Col., R.E., London.
Davies, J. H, Johannesburg.
Dawson, P, London.
Day, C., Manchester.
Denham, J., Cape Town.
Dick, J. R., Brighton.
Digby, W. P., Berlin.
Dixon, W., Glasgow.
Dobbie, R. S., Whitby Bay.
Duddell, W., London.
Eck J., London.
Edgcumbe, K., London.
Edmunds, H., London.
Esson, W. B., London.
Eugene Brown, E, Newcastle-on-Tyne.
Eurich H. D, Bradford.
Fawcus, W. P. J., Manchester.
Ferranti, S. Z. de, London.
Foster, J. A., London.
Fowkes, F., Ambleside.
Foyster, A. H., Edinburgh.
Friedlander, P. R, Chelmsford.
Gee, W., Sale.
Gibbons, J., London.
Glegg, A., London.
Glover, F. A., London.
Graham, E. V., London.
Hadley, A. E., Manchester.
Hammond, R., London.
Hardy, W. E., London.
Harling, W., Lancaster.
Harris, A. F., London.
Hatton, R. J., London.
Hawkins, C. C., Bedford.
Hawkins, T., Manchester.
Heap, A. C., London.
Heaviside, A. W., Newcastle.
Heilborn, A., Stockholm.
Hirst, H., London.
Hodgkin, J. E., Darlington.
Jenkin, B. M., London.
Jenkin, C. F., London.
Laidler, W. C., Sunderland.
Leggat, J., Newcastle-on-Tyne.
Lind, E G., Mannheim.
Lord, F. A. B., London.
Lorrain, J. G., London.
Luke, P. V., C.I.E., London.
McCann, A. F., London.
McGeoch, W., Birmingham.
McMillan, W. G., London.
Madgen, W. L., London.
Mance, Sir H., C.I.E., London.
Marr, W. B., Sunderland.
Massey, W. H., London.
Mavor, H. A., Glasgow.
Mawdsley, H. St. H., Taunton.
Meares, J. W., Calcutta.
Melms G. J., Liege.
Miller. H. W., London.
Moll, O., Cologne.
Money-Kent, J. M. V., London.
Morris, Dr. D. K., Birmingham.
Morris, J. T., London.
Moul, H. E., London.
Mountain, W. C., Newcastle.
Neale, J. Stoke-on-Trent.
Nisbett, G. H., Prescot.
Nixon, C. B., Manchester.
O'Gorman, M., London.
Peake, A. H., Cambridge.
Perry, H. H., London.
Plumtree, J. S., Nottingham.
Preece, A. H., London.
Pyne, A. P., Gateshead.
Quin, R. C., Blackpool.
Ralph, G., Newcastle-on-Tyne.
Raphael, F. C., London.
Raworth, J. S., London.
Roberts, R. C., Berlin.
Robertson. R., Glasgow.
Roget, S. R., London.
Rolph. W. M., London.
Russell, S. A., London.
Sadler, A., Wolverhampton.
Sandberg, A. O. F., London.
Sankey. P. W., London.
Schultz. G., London.
Scott, E. K., London.
Seaman, A. G., London.
Sellon, R. P., London.
Sheardown, P. S., Dublin.
Short, S. H., London.
Siemens, A., London.
Sillar, A. M., London.
Smith. C. F., London.
Smith, R. H., London.
Snell, A. T., London.
Snelus, P. W., Mulheim.
Stansfield, H., Blackburn.
Steinitz, J. J., London.
Stottner, J., London.
Thompson, E., London.
Thompson, E. A., London.
Thompson, S. P., London.
Tischendörfer, F. W., Berlin.
Tomlinson, H. J., London.
Tree, R., London.
Turney, A. T., London.
Tweedy, R N., Brierley Hill.
Whalley. A., Helsby.
Whitlock, A A., London.
Wilkinson, G., London.
Williams, W., Berlin.
Williamson A. D, Sheffield.
Wilson, D., London.
Wilson, H. W., Liverpool.
Wilson, J. G., London.
Wood, A. P., Manchester.
Woolf, J., jun., Norfolk.
Wyld, W., Wednesbury.

(To be continued.)

COMPANIES' MEETINGS AND REPORTS.

GREENWOOD AND BATLEY.

The directors' report for the year ended March 31 shows that after providing for debenture interest and expenses of management, writing off £7,500 for depreciation, and making due provision for doubtful accounts, a profit of £35,627 remains, making with the amount brought forward £36,090. Of this sum the directors have allotted £5,000 towards the cost of completing the installation of electric power throughout the Albion Works, and £1,000 as a provision against contingencies. They have further appropriated £10,000 to the reserve fund, thereby increasing it to £20,000, and they recommend that dividends be declared at the rates of 7 per cent. per annum on the preference shares and of 5 per cent. per annum on the ordinary shares, leaving £4,474 to be carried forward. The buildings, plant, and machinery have been maintained in efficient working order and condition, £5,868 having been expended during the year on maintenance account and charged to revenue. The directors having secured a long lease of premises at Abbey Wood, near to Woolwich Arsenal, with full Government loading license under the Explosives Act, have agreed to terminate the tenancy of the Greenwich loading works and transfer the plant to these more convenient and suitable works. The demand for the De Laval patent steam-turbines, turbine dynamos and pumps, etc., for which this company has the sole right of sale in Great Britain, its colonies and dependencies, also for Egypt, China, and Japan, is steadily increasing.

Presentation.—At the Lincoln Corporation electricity works on Saturday, Mr. Russell, on behalf of the members of the staff, presented a handsome tobacco cabinet to their late chief engineer, Mr. C. S. Vesey Brown, A.M.I.C.E, who is leaving Lincoln to take up the position of general manager to the Northern Counties Electricity Supply Company, Limited. The usual complimentary speeches having been made, the pleasing ceremony concluded with cheers for Mr. and Mrs. Vesey Brown, and the singing of "He's a Jolly Good Fellow." A photograph of the employés has also been taken, and an enlarged copy in frame will be presented to Mr. Vesey Brown in due course.

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TO CORRESPONDENTS.

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TRAMWAYS IN LONDON.

Persistency in continuing in a wrong course is as discreditable as persistency in doing what is right is creditable. The London County Council is nothing if not persistent. It spends scores of thousands of pounds of the ratepayers' money in trying to rout the water companies. It has formulated tramway schemes which, if carried out, will cost millions of pounds, and is propounding other tramway schemes which, if carried out, will cost more millions. Most of the political papers condemn the action of the London County Council, not upon any question of principle, but upon the ground that such work is largely speculative and may not pay. Some, like the *Globe*, "do not know that, even if it can be shown that it can adopt the *rôle* without loss, its ambition in this respect ought to be gratified." Principle in modern legislation, whether imperial or local, is almost or quite an unknown quantity. Aristotle tells us of a kind of government or monarchy among the Greeks called an Æsymnety, and if that of the London County Council is not Æsymnetic, or an elective tyranny, we cannot otherwise define it. We are no opponents of electric traction in its proper place—and in its proper place there is room for many hundreds of miles within the shores of these islands—but we venture again to assert that in most of the districts wherein the County Council would construct tramways, and thus perpetuate a system of bad roads, the true solution of the problem lies in automobilism and perfect road surfaces. Our roads and streets, compared with those existing in other countries, are generally good, but compared with what perfect street surfaces should be are very bad. The problem for automobilists is rendered far more difficult with the existing road surfaces than it would be with perfect surfaces, and electric traction other than on tramways or railways is at a discount. If the Council is persistent in following a course we deem wrong, we must be as persistent in calling attention to it; and in this new scheme to spend between one and two millions upon further tramways, we think (throwing aside any question of underlying principle) that automobilism will have developed sufficiently far to render it doubtful if the scheme will pay upon business lines. The debt of London is becoming of enormous proportions. Its increasing ratable value is not elastic enough to diminish the rate per pound. Hence the great middle class is being constantly squeezed to provide something for its masters of the *oi poeloi*. The provision of the best form of street surface and the careful sanitation of the streets come within the purview of the local authority, while it has no right to determine or attempt to standardise any particular form of traction.

Heywood.—At a recent meeting of the Technical Instruction Committee Mr. William S. Johnston, clerk of works, electricity department, submitted a report as to the lighting of the technical school by electricity, and the substitution of an electric motor for the gas engine now in use; and it was resolved that Messrs Fryer and Co., Limited, the contractors for the supply of electrical fittings, etc., to the Corporation, be invited to submit a tender for the installation.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WALTHAMSTOW ISOLATION HOSPITAL.

SIR,—We notice in the issue of your paper dated June 7 an article appearing entitled "The Engineering Equipment of the New Isolation Hospital, Walthamstow." The whole of this article is written as if the British Westinghouse Company, Limited, had obtained and carried out the contract to which the article referred, which is not the case. We were the contractors for the *whole* of the work, and placed an order with the British Westinghouse Company for the gas-engines which they supplied to us. You will see, therefore, that the Westinghouse Company were merely sub contractors to us.

Further, we must call your serious attention to the fact that underneath the block showing a view of the generators the following line appears: "Westinghouse Generators, Isolation Hospital, Walthamstow." This statement is absolutely inaccurate. The generators are "Helios" generators, and were supplied by us as part of our contract.

We notice that the first paragraph of the article states that you obtained the description from the Westinghouse Company, and we are, of course, writing to them in the matter. We are quite sure that you yourself were quite ignorant of the unintentional injustice done to our company.—Yours, etc.,

FRANK SUTER AND CO., LIMITED.
(Harrington Wyman, Director.)

66, Berners-street, W., June 20, 1901.

GILBERT'S SELF-DRIVING WEIGHT OSCILLATING MOTOR.

SIR,—Mr. Arthur E. Gilbert, in his letter in your issue of 21st inst., has greatly moderated his claims for his wonderful motor. In his first letter he wrote, "I can show you something to go back and write upon for the enlightenment of those puzzling their brains over perpetual motion," but in his last asserts he has "nothing to do with perpetual motion," and that his "machine will work as long as a steam-engine." I know of engines which for months at a time are stopped for a few hours only once a week. But to be more accurate, a steam-engine in good order will work as long as it is supplied with energy in a proper manner, and provided Mr. Gilbert does not claim more for his machine, he will not be unreasonable.

It would be more satisfactory to have definite results of a test rather than vague statements, and if Mr. Gilbert will put his machine to drive, say, a dynamo giving an output of 5 kw. or 1 kw., the least that might be expected, in view of his extravagant claims, is that he should communicate the result to your columns.

Mr. Gilbert appears to be very unjust in at least two things. First, he seems indifferent to the fact that your efforts to dissuade him have been sincere, well meant, and based upon a knowledge of the fallacy of his ideas. In the second place, inasmuch as such a machine as he professes to have invented is regarded by the greatest scientists as a practical impossibility, he should not put forward statements he does not prove and reasons for which he does not give.

Perhaps it is well for your space and my time that this matter is to be ventilated in another paper. I hope the ventilation will be thorough.—Yours, etc., G. EVANS.

Aberdare, June 24, 1901.

BIRMINGHAM LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the last meeting of the session, held on the 22nd ult., at the University, Birmingham, Mr. J. C. Vaudrey in the chair, the Hon. Secretary read the following report of the committee:

The committee have to report that on receipt of a memorial signed by 78 local members of all classes, the Council of the Institution of Electrical Engineers granted powers at a meeting on June 25 last year for the formation of a local section of the Institution in Birmingham. At a preliminary meeting on Nov. 19, it was announced that Dr. Oliver Lodge had accepted the position of first chairman to the local section; and Mr. Henry Lea having been appointed vice-chairman, a committee was formed to manage the affairs of the section. At subsequent meetings of the committee the by-laws of the new local section were drawn up, and were approved at a general meeting on March 27. The area included by the local section was defined as consisting of the three counties of Warwick, Staffordshire, and Worcester, notices of meetings, however, being sent on application to any member residing within 50 miles of Birmingham. The committee have pleasure in reporting that the membership of the local section, which had already risen to 110 on Jan. 13, now stands at 123 members, the numbers in the different classes being as follows:

	Jan. 13.	May 22.	Change.
Members	20	21	+1
Associate members	22	34	+12
Associates	50	46	−4
Students	18	22	+4
Totals	110	123	+13

The general meetings of the section have been as follows: Feb. 27, inaugural meeting, address by the chairman, Dr. Oliver Lodge, F.R.S.; March 27, paper by Mr. W. Wyld, associate member, "Polyphase Equipment of Factories"; April 11, adjourned discussion on Mr. Wyld's paper and Mr. A. C. Eborall's paper on "Some Notes on Polyphase Sub-Station Machinery," given in abstract to the members present by Mr. Eborall himself; May 22, annual general meeting of section. These meetings have all been held in the buildings of the university through the kindness of the university council. The Council of the Institution has decided to include Mr. Wyld's paper and the discussion upon it in the *Journal* of the Institution. The committee invite offers of papers from members of the section for the coming session 1901-2, with a view to the formation of a complete programme in time for issue to members before the first meeting in November. They would remind members that the success of the section will be dependent largely upon the original papers received, and the members are therefore asked to realise the need of volunteering to contribute papers, not necessarily sufficiently original or important for inclusion in the *Journal* of the Institution, but with the object of promoting discussions on subjects of interest to members. At the meeting on Feb. 27, the committee at present in office was empowered to act for the next session. Mr. G. S. Ram resigned his place on the committee on March 19 on his transfer to London. The officers for the session 1901-2 are therefore as follows: Chairman: Oliver Lodge, D.Sc., F.R.S. Vice-chairman: Henry Lea, M.I.C.E. Committee: Fred. Brown; Alf. Coleman; Alf. Dickinson; W. E. Sumpner, D.Sc.; Prof. Threlfall; J. C. Vaudrey, M.I.C.E.; W. Wyld. Hon. secretary: D. K. Morris, Ph.D.

Mr. VAUDREY proposed the adoption of the report, and Mr. DICKINSON seconded the motion, which was carried *nem. con.*

Mr. VAUDREY then proposed a vote of thanks to the council of the university for the loan of the room in which all the meetings had been held. Mr. COLEMAN seconded the proposition, and the same was carried unanimously.

Mr. VAUDREY then called upon Mr. Taylor to open the discussion on Mr. Eborall's paper on "Some Notes on Polyphase Sub-Station Machinery."

Mr. Taylor said that, as the paper had already been discussed, he hoped the members would bear with him if he repeated anything that had already been said. He thought the paper was of very great practical value. Mr. Eborall had acted the part of judge, and collected the *pros* and *cons.* of the three classes of sub-station machinery, and had weeded out the first or asynchronous motor-generator, then left the synchronous motor-generator and the rotary converter, and impartially pitted them and then summed up. The members now had to act the part of the jury. He thought Mr. Eborall had not quite done justice to the rotary converter. He had given a short summary of the advantages of the synchronous motor-generator under four headings, and those of the rotary converter under five or more headings, as follows: The synchronous motor-generator—(1) it could be operated from any frequency; (2) simplicity of arrangements for control of pressure on the low-tension side, which was a great advantage, and very simply done; (3) the continuous-current pressure was independent of cyclic variations in the high-tension feeders, and those did not affect the low-tension pressure except when the pulsations were so great as to pull the machine up, which, of course, only happened when anything very serious occurred; (4) with the synchronous motor-generator, owing to any frequency being used, lighting could be done by alternating current, which was a great advantage. The advantages of the rotary converter, Mr. Taylor thought, were: (1) it had 10 per cent. better efficiency at half load than the motor-generator; (2) the overload capacity was 50 per cent. better in the larger

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machines; (3) the starting current was 40 per cent. less; (4) on removing the whole load on the continuous-current side the rise of pressure was 3 to 5 per cent. less than that of the motor-generator, and thus gave very good regulation; (5) rotary converters were 40 per cent. less in cost for small sizes up to 500 kw.; (6) rotary converters took up less floor space. Mr. Eborall had said the first point against a rotary was that it could not be easily regulated. Mr. Taylor thought that Mr. Eborall had not done justice to the rotary in saying that the simplicity of regulation was not so good as with the motor-generator. As to the third point against the rotary, that the continuous current was independent of cyclic variation in the high-tension feeder, Mr. Eborall gave the disease, and then immediately produced the remedy by saying that choking coils obviated that difficulty, as was shown by what had been done at Prague. As to the fourth point, Mr. Taylor held that both lighting and traction could be done from the rotary converter at any frequency, for he had seen rotaries working at 60 ∼, and the generators were driven by turbines; therefore it was obviously these cyclic variations which affected the running of the rotary at high frequencies, and he thought if we got a perfect engine of high speed—*i.e.*, something like the Parsons steam-turbine—whereby a small number of poles could be used, the cyclic variations would not be nearly so great as with the more commonly used slow-speed engine with a great number of poles, and if we could double the periodicity we would be able then to do both lighting and traction from rotaries as well as from motor-generators. On the Albany-Hudson Railroad, which was 36 miles long, trains were run at 50 miles an hour; there were three three-phase units of 750 kw. each and four sub-stations; and the three motor-carriages had each four motors of 75 h.p. A line like that, which was no toy, was operated with rotaries at this high frequency, and also did lighting as well. The Manhattan Railroad, N.Y., also had large units of rotary converters. These were started by the method of poly-phase-induction motor-generators to give continuous current to the sub-stations. At Glasgow the other thing was done. A small polyphase motor was attached to the end of the shaft of the rotary. Mr. Taylor concluded by saying he hoped he had done justice to the rotary converter, as this was not the case in the paper.

Mr. Dickinson said Mr. Taylor had referred to the high speeds used in this country, and asked what was the speed of the generators on the Albany line, and also what did Mr. Taylor consider high speed?

Mr. Taylor replied, and said he was only speaking comparatively, but that he had in his mind the Willans type of engine. He could not give the exact speed of the Albany generators.

Mr. Jones had nothing to say on the paper, but that probably what Mr. Taylor meant were quick-revolution engines, not quick speed—*i.e.*, not high piston speed engines.

Mr. McLean asked whether two-phase motors would start all right on a load? He had had some correspondence with a manufacturing firm making polyphase plant who had refused to guarantee their two-phase motors to start on a load and they had told him they would not start.

Mr. Wyld had had some little experience with the equipment of sub stations, although not polyphase. Some time since he had charge of the erection of several fairly large sub-stations equipped with synchronous motor-generators for converting single-phase high-tension alternating current to continuous current, and remembered the difficulty he had in getting them run up for the initial charge of the battery, for, of course, the high-tension current could not be put on to the motor until it was up to synchronous speed, and there was no continuous current available to run the low-tension side as a motor. In one case arrangements were made with a prospective consumer for power to drive a temporary dynamo from which current was taken through the mains to the sub-station, and the motor generator run up to speed and paralleled on to the high tension feeder. Mr. Wyld, therefore, agreed with Mr. Eborall in advocating the installing of a small asynchronous motor in the sub-station for running up the larger machines, as that was quite practical in a polyphase station, but, unfortunately, the usual motor-generators or converters were too large for single-phase motors to start up. With regard to the hunting of the motors, Mr. Wyld appreciated all Mr. Eborall had said in his paper on the matter, for he knew how the two or three motor-generators used to behave when they were all running in parallel, with perhaps two or three alternators at the generating station. When a "short" occurred on the mains, or a bad parallel at the generating station or any of the sub-stations, one of them would commence hunting, and that affected the others, and then possibly one or two of them would fall out of step—and, of course, blew their fuses—and these, going at 2 000 or 3,000 volts pressure, were not conducive to good regulation. These machines were worked at a periodicity of 75, and were single-phase, so that it was not to be expected that they would run so well as polyphase machines at a much lower periodicity. In reply to Mr. McLean's question *re* the two-phase motors starting on load, Mr. Wyld did not think he need fear much in that direction, for he (Mr. Wyld) had not as yet known any of his three phase motors to jib, and he did not see why the two-phase motors should.

Mr. Taylor said there was one thing he would like to mention, and that was that Mr. Eborall evidently did not think that continuous currents had to be varied, for his paper was entirely on the question of converting polyphase into continuous current, and a good deal had been heard just recently against continuous current. Perhaps some other speaker might have some further remarks to make on this point.

Mr. Wyld thought if Mr. Taylor referred to the last paragraph in Mr. Eborall's paper he would find that Mr. Eborall was by no means advocating continuous current, and, in fact, stated that although continuous-current sub-stations were necessary and advisable in certain cases, he was of the opinion that the best solution would be to distribute the polyphase current from ordinary transformer sub stations; and by that means the best results both from a technical and commercial point of view, would be obtained.

Mr. F. Brown asked what was the lowest periodicity that could be used for lighting work?

Mr. Taylor replied that he thought 30 ∼ was the minimum for incandescent lamps.

Mr. Vaudrey said he hardly felt in a position to sum up the debate, for, he said, he knew so little about polyphase work. One feature of the polyphase current was the engine power required. Only recently engineers had appreciated the high-speed engine, and he noticed that the high-speed engine was now being adapted to polyphase generators. He had recently had the opportunity of seeing a 1 200 h.p. Willans engine and Brown-Boveri three-phase alternator tested at the works of Messrs. Willans and Robinson. The power was absorbed in tanks 8ft. square by 6ft. deep, and the three leads were taken to the tanks and about 6in. or 8in. exposed in the water. The whole tank seemed on fire, and he thought this rather a novel way of absorbing 1,200 h.p. at 6,000 volts. Mr. Taylor had given 30 periodicity as a minimum for lighting purposes. Derby had 30, and it was an utter failure so far as arc lighting went, and was very little better for incandescent lighting. Fifty periodicity was about the lowest practically.

Mr. Taylor said that there was a difference whether 100 or 200 volt lamps were used, the effect of a low periodicity being marked on the 100 volt lamps.

Mr. Vaudrey, continuing, said Mr. Eborall had said that, to be a success, the generator ought to be fitted between the cranks of the engine. On the Willans it was at the side of the engine on the end of the shaft, and worked admirably. Mr. Eborall no doubt was thinking of the American slow-speed type of engine.

Mr. Vaudrey then explained an idea which had been suggested by Dr. Sumpner, that if at the meetings a paper was not forthcoming, some person should raise a subject for discussion. The first thing that had occurred to him was the question of "Boilers for Central Stations." Continuing, Mr. Vaudrey said the question of boilers was the very important one of steam generating plant, and his experience was that an electrical engineer without a really practical knowledge of engineering generally was only half an engineer. In a large generating station the generation of steam was most important. There were so many kinds of boilers now on the market that it was important to know which was good and which bad practice. The determining factor was that of the space available, then the value of land, and, perhaps, the actual cost of putting down the boiler had a great deal to do with it. The value of land had naturally brought the water-tube boiler into great use. No doubt if stations had been put outside great cities such as London, as was now being done, the Babcock and Wilcox boiler would not have been nearly so common. Then there were the Lancashire, dry-back, Babcock and Wilcox, Root (probably the Babcock and Wilcox was the outcome of the Root), Stirling, and Niclausse boilers. The Lancashire boilers which were long cylindrical boilers up to 30ft. long, with flues from end to end, with Galloway tubes across them, were now made for a working pressure up to 180lb. per square inch. The dry-back boiler, also cylindrical, had the advantage of being much shorter than the Lancashire, being only 11ft. long. Tubes were let through the boiler from front to back. The water-tube boilers were the Babcock and Wilcox, Root, Stirling, and Niclausse; the difference between these and the other class of boiler being that the water in these circulated through the tubes, whereas in the other class the water was outside the tubes. The question was which boiler to select. It was impossible to get a Lancashire boiler in such places as cellars and very confined places, therefore the water-tube class had to be used. There were, however, a great many Lancashire boilers in use; and why were there so many? The Lancashire boiler was so good for inspection and cleaning, and had a large storage for steam. Although its steam-raising power was not so rapid, it had some very good qualities. The dry-back boiler had much in common with the Lancashire, but the effects of expansion and contraction were not so serious, as the boiler was much shorter. It was a quick steam raiser, but the objection to it was the number of small tubes. The Babcock and Wilcox boilers were very quick steam raisers, and were very useful and convenient for confined places such as were to be found in towns, also for sending out to the Colonies, as they could be put together in their places, and they worked very well. The cost of cleaning, however, was very great, and unless the water used was very clear, the tubes gave trouble. More evils arose from bad water than from anything else. The Birmingham water was supposed to be good, but he had found it not so, and if he was putting down a new station he would put down a water-purifying plant. In one year the Birmingham water would deposit nearly an inch of incrustation, so the cost of purifying would soon pay for itself. The danger of incrustation was that the plates of the flues got burned. Further, the question of water was important in respect to the fittings and cocks, and on no account whatever should those so-called compounds for softening the water be used, as these often brought more trouble than the hardness of the water. Boiler fittings ought to be most carefully selected. He had once had some fittings supplied by a new firm making fittings, and these were to all appearances like those of a very well-known maker, but when they came to be used they did not last six months. Every maker did not seem to know the right mixture of metal, and, therefore, only fittings of the very best makers ought to be used.

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Mr. Jones thought the meeting ought to be grateful to the chairman for his remarks, and that all would agree with him in his remarks re the class of boiler to be used. Not only space, but safety was an important item in deciding upon what class of boiler to use, and he thought the water-tube much safer than the Lancashire. In the Babcock and Wilcox, as he understood it, owing to the rapid motion through the tubes all the deposit of scale was carried away. The Lancashire boiler plates were weakened by heating when the boilers became encrusted, but in the water-tube boiler that was not the case, so that even for bad water the water-tube was the one to adopt. In locomotive boilers he had found oak tan bark liquid answer very well indeed.

Mr. F. Brown said that circulation was supposed to take place in the tubes of the water-tube boiler, but he knew a place not very far from the room they were in where the tubes had got furred up entirely in a week. Birmingham Canal water was used.

Mr. McLean only put washing soda into his boilers, using Thames water, and it answered very well. Locomotive boilers he had found the worst to clean at the corners of the fire-boxes. In the old Grosvenor Gallery station, where the boilers were pressed very much, there was trouble with the London water, for the tubes got so badly furred that a lead pencil could not have been passed down the tube. There were four boilers, and they had each to be cleaned out once a month. With Lancashire boilers one could get inside and see what really was going on, and could make a very careful examination; in a locomotive boiler that could not be done. The fittings were very important, especially the blow-off cocks.

Mr. Vaudrey, in replying, said, with regard to Mr. Jones's remarks about blowing-off the boilers, he thought that a very crude method, and no doubt it would become a nuisance if done often in a large city such as Birmingham. At Liverpool he had seen scale ¼in. off a rivet head, and that was, of course, with lake water, but it turned out afterwards that there had been so much grumbling about the very soft water that part of the old supply from some part of Lancashire had been turned in with the new supply. He did not consider the Babcock and Wilcox boiler suitable for bad water, as it deposited even worse than the Lancashire boiler.

CATALOGUES RECEIVED.

Messrs. D. Bruce Peebles and Co. have forwarded to us their new catalogue, which has recently been issued, and which for general finish and arrangement will compare favourably with any other maker's list that we have had before us. It will be remembered that this firm manufacture "P. P. P." dynamos and motors, so called because the three gentlemen who practically are responsible for the work all have their surnames commencing with P. The firm, although it only commenced manufacturing dynamos and motors some few years ago, has already supplied some 50,000 e.h.p. of generating machinery, and its electric motors have found very large use in central-station work and in power distribution. In the catalogue there are reproduced a number of most interesting illustrations of the shops in which these electric motors and generators are made, and the specifications given afterwards of the motors themselves show the liberal margin which the firm allow in their goods. Farther on in the list, specifications are given of the dynamos, ranging in size up to 500 kw., and here again the details are such as will commend themselves to consulting engineers. The prices given in the list are also supplemented by the over-all dimensions of the various machines, so that the catalogue will be of great value to engineers when drawing up designs for new works.

Messrs. Richardsons, Westgarth, and Co., Limited, of Hartlepool, send us their list of "B. B." continuous-current machinery. We notice that the firm are making their dynamos and motors in a number of sizes ranging in voltage from 65 to 500 volts. From the specifications of the various machines given in this list, the dynamos and motors would appear to be manufactured on the best lines and with the finest materials.

A new pamphlet on the lubrication and formation of bearing surfaces, and also a revised price-list of the firm's pressure gauges, have just been issued by Messrs. Dewrance and Co., of Great Dover-street, London.

FORTHCOMING EVENTS.

FRIDAY, JUNE 28.

Physical Society.—At 5 p.m., ordinary meeting in the Wheatstone Laboratory, King's College. Papers: "The Effect of a High-Frequency Oscillatory Field on Electrical Resistance," by Mr. S. A. F. White; "The Spectrum of Cyanogen," by Mr. E. C. C. Baly and Dr. H. W. Syers.

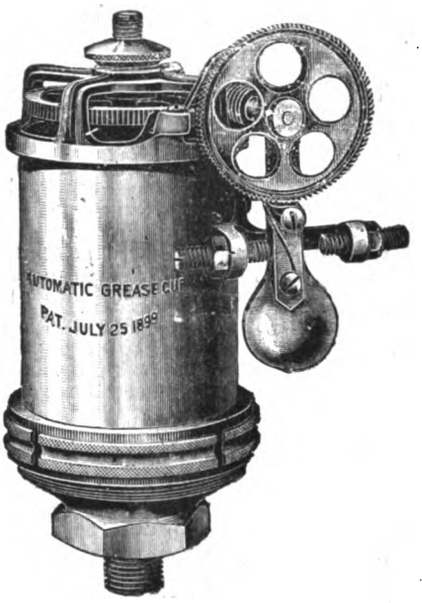
Society of Arts.—At 9 p.m., annual conversazione at the Royal Botanical Gardens.

THURSDAY, JULY 4.

Rontgen Society.—At 8.30 p.m., annual general meeting. Mr. G. Bowron will show an Oscillometer for Measuring the Current and Oscillations in the Secondary Circuit of an Induction Coil or similar apparatus.

"TIC-A-TOC" LUBRICATOR.

Messrs. Stern Bros., of 57, Gracechurch-street, E.C., have recently placed on the market a new automatic lubricator, which goes by the name of "Tic-a-Toc." It will be seen from the accompanying illustration that the design of this automatic grease-cup is exceptionally neat, and, what is of more importance, the mechanical construction is extremely simple. In action, too, simplicity is also a prominent feature. The throw of the crank-pin or eccentric of an engine operates the pendulum of the lubricator. This forces the plunger—fast or slow as required—through the grease-cup. It is claimed that the ordinary engine, running 10 hours a day at a speed of 150 revolutions a minute, will take 11¾ days to empty the pint cup. The



quantity of the lubricant, however, is easily regulated by increasing or diminishing the swing of the pendulum, and if desired, the lubricator can also be operated as a hand-compression cup while the engine is running. The stem of the plunger extending through the top of the cup indicates the amount of grease remaining in the cup. Messrs. Stern Bros. are making these lubricators in sizes ranging from 2in. to 3in. outside diameter. In the first size the extreme height of the lubricator when filled is only 7½in., while the largest size brings this figure up to 11¾in. The capacity of these two sizes is 4oz. and 18oz. of grease respectively. For use on eccentrics of engines which run continuously, or for a longer time than the cup will feed with one filling, special attachment is provided. We understand that the device has been patented in England, the United States, and other countries.

APPOINTMENTS VACANT.

Engineer in Charge of Station, Stepney Borough Council, must have had previous charge of plant consisting of water-tube boilers, high-speed engines, direct-current dynamos, etc., July 8. Details in our advertisement columns.

Shift Engineer, Huddersfield Corporation tramways, £100 per annum, July 1. Details in our advertisement columns.

Electrical Engineers, Dewsbury, £250 per annum, to be increased at the end of 12 months to £300, July 4; tramways, Council of the city of Wellington, New Zealand, July 20. Details in our advertisement columns.

Meter and General Testing Superintendent, Stepney Borough Council, July 8. Details in our advertisement columns.

Meter-Room Assistant, Stepney Borough Council, July 8. Details in our advertisement columns.

Canvasser, Ilford district, £2 per week. Applications must be delivered to Mr. W. J. Woodward, electrical engineer, 7, Cranbrook-road, Ilford, by July 3. Details in our advertisement columns.

Qualified Gentleman to take the position of head of the physics and electrical engineering department, £500 per annum, June 29. Details in our advertisement columns.

Clerk, Ealing District Council Electric Lighting Committee. Details in our advertisement columns.

Resident Electrical Engineer, borough of Swansea electricity works, July 11. Details in our advertisement columns.

Electrical Fitter, Grove Fever Hospital, Tooting-grove, Tooting Graveney, S.W., 30s. per week, July 4. Details in our advertisement columns.

Switchboard Attendant, Devonport Corporation electricity works. Details in our advertisement columns.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

389. A corporation with a continuous-current electricity supply are contemplating the hiring out of motors, and require a scheme to be fully worked out and submitted to them for approval. What are the essential points to be observed in the drawing up of this scheme, more particularly with regard to the borrowing and repayment of loan?—G.

390. A Thomson-Houston series circuit is burning with full load of 50 arc lamps, when earth faults suddenly develop, one on the positive main at the third lamp (counting from positive of dynamo), the other on negative main close to dynamo (after No. 50 lamp). The faults are very pronounced, but lamps Nos. 37 and 42 continue to burn, all the others, with exception of Nos. 1, 2, and 3, being out. Why should lamps Nos. 37 and 42 continue to burn?—F. C. J.

ANSWERS.

Question No. 383.—I have charge of an installation comprising gas-engine and shunt dynamo of about 8 kw., voltage 100. There is also a battery of 53 cells. I wish to charge up 20 new cells. What is the best means of obtaining a steady current at reduced voltage?

[The replies to Question No. 383 are neither so good nor so comprehensive as usual, and several are complementary of the other; so we give a large number of the answers, equalising the prizes.—ED *E. E.*]

Answer to No. 383 (*awarded* 5*s.*).—There must surely be a mistake in this question; the charging voltage for 53 cells should be 135 to 140 volts, not 100 as stated. In order to charge up 20 new cells, the E.M.F. required will vary between 40 and 55 volts. Now this will mean that the dynamo must work at one-third the usual voltage. This reduced E.M.F. could be obtained by either running at a lower speed, or by inserting a large external resistance in the shunt circuit. In either case the result is the same: the field flux is considerably diminished, and as the current output will be the same for the 20 cells as for the former 53, in all probability it will be impossible under such conditions to get sparkless commutation; and it may be that the armature reactions will be stronger than the forward induction, when most disastrous sparking will result.

Two simple methods are, however, open for adoption. The first is to run the dynamo at the usual speed and voltage, and put an additional glass box in series with the 20 cells to be charged; if this is filled with *slightly* acidulated water, and the charging current is passed through it from two lead plates, it will form a resistance in the main circuit which is variable at will, and which can be utilised to absorb the excess of voltage between that required for the 20 cells and that given off by the dynamo.

The second method is this: The writer assumes that the 20 new cells are required to replace that number which have worn out; this leaves 33 in good condition. If, now, the shunt coils, which were formerly probably in series, are connected to these 33 cells in parallel, but still through the regulating switch and resistance, the dynamo will now be a separately excited, in place of a shunt, machine, and the forward induction will be practically what it was before. It will now be an easy matter to get the 40 to 55 volts required, all that is necessary being to see that the armature is revolved at the requisite speed for this purpose. In this case it will be necessary to watch the charging very carefully, as a separately excited dynamo is not so suitable as a shunt machine for the purpose of charging cells.—M.

Answer to No. 383 (*awarded* 5*s.*).—The best method of charging up new cells is by means of a small booster, but since such is not included in the installation, the best method would be to charge these cells from the dynamo. This will best be accomplished by inserting in circuit with the cells some form of resistance to reduce the pressure of the dynamo to that required by the cells when fully charged. If we allow a pressure of 2·5 volts per cell when fully charged, then voltage required by battery = 2·5 × 20 = 50 volts, ∴ drop of pressure in resistance will be (pressure developed by dynamo) − (pressure required for cells)—*i.e.*, 100 − 50 = 50 volts.

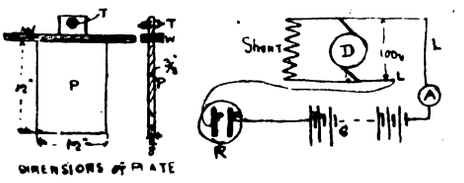

FIG. 1.

A cheap and effective resistance can be made by inserting in a small tub or tank, R (Fig. 1), two plates, P P, either of lead, iron, or carbon, these plates being held in position by means of two strips of wood, W W, placed across the mouth of the tub. To each plate is fastened a terminal, T. The tub is filled with sulphuric acid (5 per cent. solution). Fig. 1 represents the connections, L L are the leads from the dynamo, A an ammeter, C the cells to be charged, and R the liquid resistance. The great advantage of a liquid resistance is the perfectly gradual manner in which the current can be regulated. As the cells gradually become charged it will be noticed that the current gradually decreases. The current can be increased (*a*) by taking resistance out of the shunt, (*b*) by decreasing the distance between the plates, or the current can be decreased by increasing the distance between the plates.—L. B. H.

Answer to No. 383 (*awarded* 5*s.*).—The writer concludes that "A. P.," when he charges the cells, increases the speed of his dynamo to get the 53 × 1·6 volts = 138 volts. The 20 cells may be charged by doing the reverse—*i.e.*, decreasing the speed of the dynamo by putting a larger pulley on the dynamo or a smaller one on the engine, the speed of the engine could be altered, but it would not be found satisfactory. If the pulley on the dynamo was changed, the new one would have to be $\frac{138}{52} = 2{\cdot}6$, times larger (52 = 20 × 2·6). The expense would no doubt prohibit the use of a motor-generator or a "negative" booster (if the term may be used). The motor-generator would consist of a 100-volt motor, driven by the dynamo or accumulators (53 battery) coupled to a 52-volt dynamo. The "negative" booster would consist of the usual machines, motor and dynamo, the latter in series with the main generator, but in this case the dynamo side of the booster would be in opposition to the main voltage, so that the voltage of this dynamo would be 100 − 52 = 48 − less the C R loss in the armature.

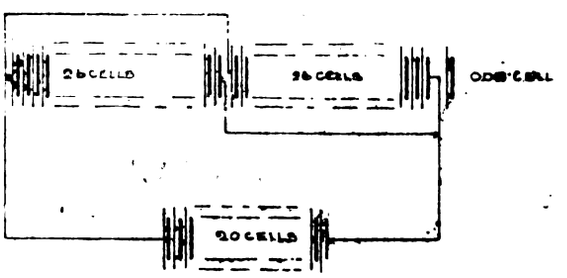

FIG. 1.

Yet another way, and by far the best from costs point of view, is to charge the 20-cell battery from the 53-cell battery. This may be done by cutting out the odd cell, cutting the remainder in two, and putting them in parallel

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(see Fig. 1). This would give a voltage of $\frac{52 \times 2}{2} = 52$, voltage necessary for charging 52; so this would be the best way, as the alteration only needs a few yards of wire and needing very little attendance. A more efficient way, however, is to put the 53 cell battery in parallel as above, and connect the 20-cell battery in series, charge with the dynamo (Fig. 2). You would have to run the dynamo a

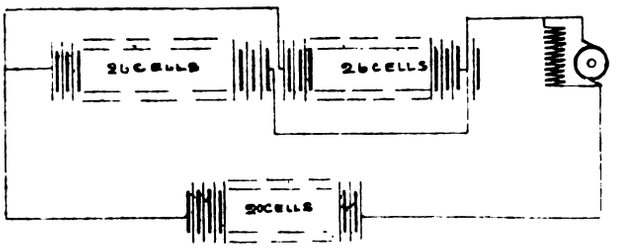

Fig. 2.

little slower $(20 \times 2{\cdot}6) + (2{\cdot}6 \times 2{\cdot}6) = 52 + 67 = 119$ volts needed. The difference in speed being so small, could be taken up by the gas-engine.—T. W. S. H.

Answer to No. 383 (*awarded* 5*s.*).—The most economical way to do this, if time and circumstances will permit, is to put one or more of the new cells in series with the 53. In most cases a good margin of adjustable resistance is provided in the shunt coils of the dynamo, so that its E.M.F. can be raised or lowered very considerably. It must also be borne in mind that a small charging current is much more beneficial to new cells than a large one. In many cases five new cells could be put in the charging circuit in this way quite easily, especially in summer, and they could be disconnected before starting the discharge. A few days of this treatment would charge all the 20 new cells a good deal better than hurrying them with the largest current they could take, for this is very apt to strain and disintegrate the plates. And again, this plan is economical, because it expends no more energy than is actually required for the work to be done. No work is done on useless resistance, and the little extra time employed in charging at a somewhat reduced current is well invested, and will show itself as an improvement in the condition of the battery and the light. If all the 20 new cells must be charged at once and as quickly as possible, and there is no adjustable resistance in the shunt coils of the dynamo, then it would be well to take this opportunity to add it. Its resistance should be sufficient to reduce the E.M.F. of the dynamo to about 50 volts, the amount required to charge 20 cells under normal conditions. If this cannot be done, then a suitable resistance coil must be added in the charging circuit to reduce the E.M.F. of this circuit at the terminals of the 20 cells to about 50 volts. It will be easy to calculate the resistance required, because the volts to be lost will be obtained by multiplying the current in amperes by the resistance in ohms—*e.g.*, suppose we have a current of 20 amperes, and wish to lose 50 volts, then $\frac{50}{20} = 2\frac{1}{2}$ ohms, or $2\frac{1}{2}$ ohms $\times$ 28 amperes = 50 volts. The question does not state the number of amperes used. Galvanised iron wire makes a good, cheap resistance coil, and it will safely carry 1,500 amperes per square inch of sectional area.—F. G. A.

Answer to No. 383 (*awarded* 5*s.*).—A simple way to charge up your new cells would be to connect up a water resistance in series with your cells. A water resistance may be made in the following way: Procure a fairly wide water-barrel with one end open and four pieces of wood about $2\frac{1}{2}$in. square and long enough to project a little way over the barrel at its greatest diameter. If two pieces of sheet lead about $\frac{1}{8}$in. thick are now got, all the material necessary for the water resistance is at hand. First connect up the sheet lead and wood as shown in section in Fig. 2; Fig. 4 being a side elevation. Splay the ends of the cables connected to the sheet lead as shown in Fig. 3. Slip the cables in adjacent to the sheet lead and screw up by bolts to ensure good contact. Put the countersunk nut on the inside, and do not put two nuts in the two top connections opposite each other—*i.e.*, stagger all countersunk nuts—so as to avoid any chance of short-circuiting.

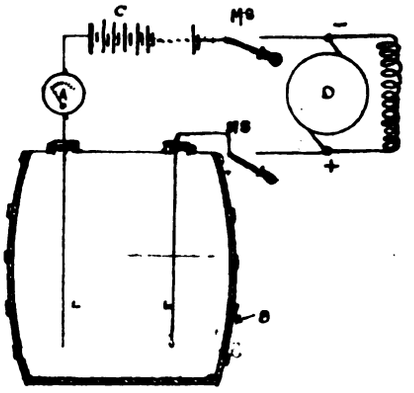

Fig. 1.—C, cells; M S, main switches; A ammeter; D, dynamo; L, lead plates.

The full connections for charging are shown in Fig. 1. Having filled the barrel with water, put the lead plates in the barrel as far apart as possible. Run up the dynamo to its normal voltage—100 volts. Put in all the switches necessary for charging. Advance the plates, L L, towards each other a little bit, but do not get them too near unless

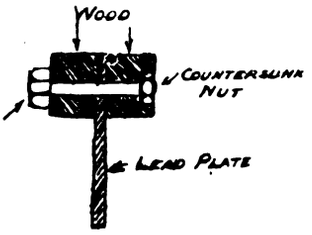

Fig. 2.

Fig. 3.

absolutely necessary. Keep them about a foot apart, and if the current is not by this time at the proper point, add a little sulphuric acid drop by drop, stirring well each time until the current gets to the proper plate, shown on ammeter, A (Fig. 1). It is not advisable to give new

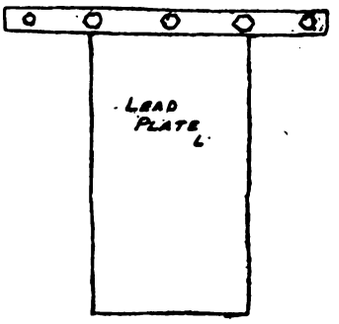

Fig. 4.

cells too much charging current or charge them too rapidly on a first charge, and about half the usual current given to the cells would be quite sufficient.—S. L.

Answer to No. 383 (*awarded* 5*s.*).—In order to pass the correct charging current through 20 new cells, the charging voltage will have to vary from a very low value, say 10 volts, at the commencement to about $2\frac{1}{2} \times 20 = 50$ volts at the end of the charge. These low voltages can be obtained without trouble from the 100-volt dynamo by reducing the exciting current sufficiently. In order to prevent the field becoming unstable at these low excitations, it will, however, be necessary to separately excite the magnet from some independent source—in this case from the whole or a part of the 53-cell battery. That this method of volt reduction is perfectly satisfactory in practice is evidenced by the wide use of the ordinary charging booster in battery stations. These boosters are, in the majority of cases, quite ordinary dynamos, separately

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excited, and giving volt variations quite as large as the above by variations in the exciting current alone without any sparking or other trouble. In our case the dynamo would be excited off about 20 or 30 of the 53 cells, and a large regulating resistance would be inserted in the field circuit at the commencement of the charge and gradually cut out as it proceeded. Or, in order to avoid the use of a specially large resistance, the number of cells used for exciting could be gradually increased as the charge proceeded, and in this way the shunt resistance, which is, no doubt, already in use with the dynamo, would be quite sufficient.

As an alternative method the 20 new cells could, of course, be connected direct to a certain number of the 53 cells, and this number could be gradually increased by means of the ordinary battery switch so as to maintain the charging current constant at its full value throughout. This method has, however, the disadvantage of leaving a certain number of the 53 cells partially discharged, and unless these are separately recharged they are liable to give trouble when the battery as a whole is next discharged.—Q.

Answer to No. 383 (*awarded* 5*s.*).—The question leads one to suppose that the 53 cells are either not charged in series, or, if they are, they are not the usual two-volt ones, or that the shunt dynamo in opposition to one's motions is capable of being pressed up to somewhere like 120 volts when charging the cells in series. As the dynamo has evidently been accustomed to charge these cells, we will leave speculating and pass on to the consideration of the best method of obtaining a steady current at reduced voltage to charge the 20 new cells, which, I take it, have to be charged separately from the 53.

There are two ways of altering the voltage of the dynamo: by reducing the speed of rotation; by weakening the field through placing a resistance in series with the coils of the field magnets. Further, the voltage between two points of the external circuit may be reduced by placing a suitable resistance in the remaining part of the circuit, while the voltage of the dynamo remains constant. Reducing the speed of dynamo we may at once dismiss, being unstable and uncertain in its effect. The introduction of a resistance into the external circuit, although very wasteful and uneconomical, requires the least disturbance of existing connections, and has simplicity to recommend it. I would suggest that "A. R." connect his 20 new cells in series, and put a voltmeter across the terminals to find their united E.M.F.—say it is 40 volts. Taking it as such, about 50 volts will be needed to charge the cells—that is to say, 40 volts will be absorbed in overcoming the back E.M.F. of the cells and 10 volts in forcing current through the cells. If the voltmeter were across the cells' terminals while charging was in progress, it would, when the above conditions held, show 10 volts. Now connect up dynamo and cells with the voltmeter across end cells, and leave a gap in the circuit. Close this gap with an adjustable resistance. Probably five ohms would do, but more at the start would be better. A water resistance is good if there are no other adjustable resistances handy. Make it by fastening to each end of the wire at gap a lead plate one square foot or more in area. Suspend the two plates in an oblong glass or lead-lined wooden box, taking precautions that there are no contacts anywhere. Fill with water until plates are fairly well immersed, then make the water conduct by adding a little acid by degrees. By shifting the plates nearer together the resistance may be adjusted further, only take care not to touch the plates. Adjust till 10 volts are shown on the voltmeter across cells, and you will be all right unless the water overheats, which requires watching while the charging progresses.

Now let us consider the effect of putting resistance in series with the field of dynamo, to weaken the field and so reduce the volts—a method which appears far more economical and better, although perhaps causing a little more trouble. As before, 50 volts are needed for charging the cells, and in this case the 50 volts are needed at the dynamo terminals. Disconnect one of the wires of the field magnets and close the gap so formed by means of an adjustable resistance of, say, rather greater value than the resistance of the shunt field; the resistance has not to carry any great current, and so need not be of very special make. Use a water resistance if it is convenient, but any adjustable resistance would answer. Now, while the dynamo is running at normal speed, adjust this resistance until the required 50 volts across the terminals are obtained on the dynamo. Then switch in the 20 cells, taking the ordinary precautions as to current being in right direction, and readjust the resistance, if necessary, until the required amount of 10 volts are shown on voltmeter. Things may then go on till the charging is finished. It is probable that the 100-volt meter will not give very correct readings at 10 volts, a matter which must be taken into consideration.

One other matter worth mentioning is the advisability of having an automatic cut-out acting when the current drops to a certain amount; it is easily arranged for, and prevents accidents and annoyance.—W. T. S. B.

Answer to No. 383 (*awarded* 5*s.*).—The fact that a gas-engine is employed in the case mentioned, introduces difficulties which would not be present if the plant was steam driven.

Now, the volts generated by any dynamo depend upon three factors: (1) the armature speed; (2) the field strength; (3) the number of turns in series on the armature. Now, in this case the number of turns is a constant quantity, and since a gas-engine does not allow of much regulation of speed, owing to the governing appliances used, and also to the fact that the full power is not developed except above a certain critical speed, there remains but one method—viz., to alter the field strength.

From the description given the apparatus appears to be a private lighting plant, and in such cases the shunt regulator, if such is provided, will not allow of any such reduction in pressure as the occasion demands. To charge 20 cells in series will need from 50 to 60 volts, and to get this pressure under the conditions may be done in various ways. A large additional resistance inserted in the shunt circuit would (if the magnets are ordinarily worked well round the saturation curve) meet the case. It could be a water resistance, or, better still, a few yards of iron wire wrapped round a board and immersed in a tub of water.

Another way would be to excite the machine separately from the main battery of cells or a portion of them through an adjustable resistance, made as before described, and adjusted until the field was sufficiently excited to cause the machine to generate the required voltage. This latter will probably be the most economical procedure, but any method will necessarily be wasteful, however, if (as the query leads one to suppose) the affair is only temorary, this will not matter so much. It might even be done by charging at 100 volts through an iron-wire resistance, but this would be most extravagant. Of course, the querist must remember that when the shunt is adjusted for the proper voltage for switching in, it will require strengthening until the amperes passing through the cells are correct, these depending on the type, number, and size of plates.—A. B. F.

Answer to No. 383 (*awarded* 5*s*).—From the fact that when the battery of 53 cells are fully charged the voltage would rise from 106 volts before charging to 132·5—that is, 2·5 volts per cell—I conclude from the question that "A. R." does not want the voltage of his dynamo to rise above this amount, or say 145 volts at the most, which would be the case if the 20 new cells were connected up in series with the battery. The best way to connect up the new ones for charging would be first of all to join them (the 20) in parallel by connecting all the positives together and all the negatives. Now, the voltage of the whole 20 when charged will be only that of one cell when charged, so that the new cells can now be put in to the main circuit to be charged up with the rest—that is to say, connect them up as if only a new cell were being put in. As the new cells would probably require a much longer charge than the old ones before being ready for working, and as it is not necessary to run on for the sake of the 20 new cells, the best way to join them to the main circuit for charging would be to connect them up to the first stop on the regulating switch (*charging* side), taking care that

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the discharge switch is not on the *same* stop at the time of doing so.

For the sake of simplicity, assume that the cable which comes to the first stop is joined to the positive end of a cell—in this case, the first cell. Then by disconnecting this cable from the positive end of the cell and joining it to the combined positive ends of the 20 new cells, also joining the combined negatives to the positive of the cell just disconnected, the 20 new cells will now be ready for charging. The advantage of joining the new cells to the first stop, as before mentioned, is that at the end of the day's charge these new cells can be cut out of circuit by means of the regulating switch without being discharged with the others. Of course, after two or three charges it will be found that the new cells will be ready for working; then they can be disconnected from the main circuit and joined up separately as required.—P. H.

NEW COMPANIES.

The following new companies have been registered during the past fortnight:

South American Syndicate, Limited.—Capital, £1,500. Object: to acquire real or personal property in South America or elsewhere, to acquire and operate any systems of tramways in South America, and to carry on the business of an electric light company, electricians, mechanical engineers, bankers, financiers, etc.

Tadcaster Electricity Company, Limited.—Capital, £6,000. Object: to adopt an agreement with Messrs. J. H. Ingleby, J. Bromett, and William Addinell, to establish stations and works, and to generate, purchase, and distribute electrical energy for the purposes of light, heat, motive power, and otherwise.

A. G. Beaver and Co., Limited.—Capital, £6,000. Object: to acquire the business carried on by W. E. Sotheby, at 151 to 157, Wardour-street, W., as A. G. Beaver and Co., to generate, produce, store, accumulate, and distribute electricity, and to carry on the business of electricians, mechanical engineers, manufacturers of electrical apparatus, metals, insulators, conductors, phonographs, bells, and other articles.

Hiram Maxim Lamp Company, Limited.—Capital, £70,000. Object: to adopt an agreement with C. M. Downie to carry on the business of electricians, mechanical engineers, producers and suppliers of electricity for the purposes of light, heat, or power, and manufacturers of and dealers in all apparatus and things required for and capable of being used in connection with the generation, distribution, supply, accumulation, and employment of electricity, and for the purposes of the company to erect and maintain any shops, stores, warehouses, or other conveniences.

Inverted Incandescent Lamp Syndicate, Limited.—Capital, £12,500. Object: to adopt agreements with the Sunlight and Safety Company, Limited, and to carry on the business of lamp, burner, and fittings manufacturers, makers of appliances for increasing illuminating power, gas manufacturers, electricians, suppliers of gas and electricity, manufacturers of electrical accessories, etc.

Auto Carriage Company, Limited.—Capital, £20,000. Object: to adopt an agreement with Messrs. L. Ruef and F. Lane, and to carry on the business of manufacturers, hirers, and letters to hire of motors, motorcars, cycles, bicycles, tricycles, and mechanically-propelled vehicles and carriages for use on roads, railways, tramways, etc.

Magnus Volk, Limited.—Capital, £10,000. Object: to acquire, undertake, and work the electrical tramways on the beach in the borough of Brighton, east of the west entrance of the aquarium, now worked by Magnus Volk under the sanction of the Brighton Town Council, and any additions to and extensions of the said tramways, to carry on the business of tramway proprietors, electrical and general engineers, etc., and to adopt an agreement with Magnus Volk.

B. Thompson and Co., Limited.—Capital, £3,000. Object: to acquire and carry on the business carried on at Frome, Somerset, by B. Thompson, of mechanical, electrical, ventilating and general engineers, machinists, etc.

Kington Ironfoundry, Limited.—Capital, £10 000. Object: to carry on the business of ironfounders, machinery and implement makers, suppliers of electricity for light, heat, motive power, or otherwise, mechanical, electrical engineers, etc.

T. C. Welding and Co., Limited.—Capital, £1,000. Object: to acquire and carry on the business of Messrs. T. C. Welding and Co., of Liverpool, manufacturers of and dealers in electric fittings, etc.

Motor Trust, Limited.—Capital, £3 000. Object: to adopt an agreement and to carry on the business of Messrs. G. F. Milnes and Co., Limited, as manufacturers of and dealers in motors and other carriages, boats and launches, cycle builders, carpenters, electricians, mechanical engineers, machinists, etc

Daimler Wagon Company.—Capital, £100. Object: to acquire any licenses, patents, and the like, and to carry on the business of manufacturers of and dealers in all kinds of vehicles (whether worked by animal traction or by steam, oil, electricity, or other mechanical power), etc.

HULL ELECTRICITY ACCOUNTS.

From the accounts of the Hull Corporation electricity department just issued, it appears that the total expenditure on capital account to March 31, 1901, amounts to £169,979. Abstracts of the revenue account and general balance-sheet are given herewith:

Dr. Revenue Account.	£	s.	d.
Generation of electricity: coal, or other fuel	6,080	2	5
Oil, waste, water, and engine-room stores	545	14	6
Wages	2,499	19	2
Repairs and maintenance of buildings and plant	681	19	6
	9,807	15	7
Distribution: wages to linesmen, etc., £597. 16s.; repairs, maintenance, etc., of mains, £317. 5s. 8d.; repairs, maintenance, etc., of transformers, etc., £74. 19s. 11d.	989	1	7
Rents, rates, and taxes	1,220	6	9
Management expenses	1,592	13	2
Special charges	125	6	8
	13,736	3	9
Balance carried to net revenue account	10,840	19	9
	£24,577	3	6

Cr.	£	s.	d.
Sale of current per meter at 5d., 5½d. and 2½d. for lighting, and 2½d. per B.T.U. for motors	23,713	7	2
Rental of meters and other apparatus	769	8	4
Service connections, testing installations) etc.	61	8	0
Premium improver	30	0	0
Deposits (forfeited)	3	0	0
	£24,577	3	6

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital—Loans raised by stock, £54,584. 15s. 11d.; Bank of England, £106,188. 16s. 8d.	159,773	12	7
Sundry depositors, deposits on supply of current	79	12	0
Sundry creditors	1 405	18	3
	161,259	2	10
Sinking fund	15,749	14	8
Reserve fund	11,323	17	3
	£188,332	14	9

Cr. Assets.	£	s.	d.
Capital expended on works and stores on hand	170.173	5	4
Less instalments written off meters	2.735	0	0
	167,438	5	4
Sinking fund investment	11,545	19	5
Stores on hand, March 31, 1901	354	6	5
Sundry debtors, current, materials, etc.	8,994	3	7
	£188,332	14	9

LEGAL INTELLIGENCE.

LIVERPOOL MORTGAGE INSURANCE COMPANY v. BRITISH ELECTRIC WORKS COMPANY.

In the Chancery Division of the High Court on Saturday Mr. Justice Cozens-Hardy heard an action brought by the Liverpool Mortgage Insurance Company against the British Electric Works Company, Limited, on a motion for judgment. It appeared that the action was brought by the trustee of a debenture trust deed, suing on behalf of himself and all other debenture holders in the company, which is a large Birmingham concern. The debentures had become enforceable by reason of the company having passed a resolution for the voluntary winding-up of the company and having failed to keep up the value of its cash in hand, book debts, and stock-in-trade to £30,000. The company, counsel stated, could not go on unless further funds were procured. Shortly after the action was commenced Mr. Justice Farwell appointed a receiver and manager, and no defence had been put in.

His **Lordship** said he was surprised that the company did not appear, and held that the plaintiffs were entitled to the order asked for. He accordingly granted the usual debenture holders' decree.

Mr. Eve, K.C., for the plaintiff, then said he had taken out a summons asking the Court's sanction to a conditional contract which had been entered into for the sale of the company's property to Vickers, Sons, and Maxim. The price to be paid was £60,000, and the purchasers undertook certain liabilities to the amount of £6,000. They acquired, amongst other things, the book debts and the cash. The summons also asked for payment of a commission of 2 per cent. to the late managing director of the company, who had negotiated the sale.

A liquidator of the company stated that at the meeting at which the voluntary winding-up was resolved on two liquidators were appointed, and they, although perfectly friendly, were unable to agree upon solicitors who should act for them. A

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meeting of shareholders had been called in Liverpool for the following Wednesday, and if the summons stood over no doubt counsel would be instructed.

Mr. Eve said he was anxious that the summons should be speedily heard, as to keep the works going it was necessary to tender for large Government orders. The purchase would be completed one month after the sanction of the Court to the contract, or, at the latest, by July 31.

Mr. Justice Cozens-Hardy adjourned the summons till to-day (Friday) and continued the appointment till August 10 of the receiver and manager.

BICKNELL v. KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION.

The case of Bicknell *v.* the Kalgoorlie Electric Power and Lighting Corporation has been heard before Mr. Justice Grantham and a special jury in the King's Bench Division of the High Court. The action was brought for the rectification of the defendant corporation's register of shareholders by removing plaintiff's name therefrom as the holder of 850 £1 shares, on the ground of alleged misrepresentation in the prospectus. Defendants denied misrepresentation, and counter-claimed for money alleged to be due in respect of calls.

Plaintiff's case was that certain important passages in the prospectus were untrue, particularly that to the effect that a valuable site for the installation of machinery and plant for power and electric lighting had been secured. It afterwards transpired, as alleged, that the only document the company could show was that they had 'secured a valuable right," and that was not granted until March, 1900, six months after plaintiff received the prospectus and bought the shares. It was said further by defendants that the Great Boulder Perseverance Gold Mining Company and the Great Boulder Main Reef had promised co operation, but it was found, according to the plaintiff's case, that they had, on the contrary, refused to co-operate. As a matter of fact, all that the companies in the district said was that if the defendant company could supply them with power at least 20 per cent. cheaper than was done at that time, and do so within a period of 18 months, they would give their support.

In the result, however, the jury found that the statements in the prospectus were true, and judgment was entered for the defendant company on the claim and counter-claim, with costs, application for a stay of execution being refused.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Taunton.—The Corporation invite tenders for free wiring. Tenders by July 1.

Manchester.—The Tramways Committee invite tenders for the supply of tramway rail bonds. Tenders by July 1. Details in our advertisement columns.

Kirkcaldy.—The Corporation invite tenders for feeders, mains, and roadwork and arc lamps. Tenders by July 20. Details in our advertisement columns.

Southwark.—The Electric Light Committee invite tenders for two additional panels to their main switchboard. Tenders by July 10. Details in our advertisement columns.

Amsterdam.—The Corporation invite tenders for tramcars for electric traction with overhead wire (perhaps 140). Tenders by Sept. 2. Details in our advertisement columns.

Dudley.—The Electric Light and Tramways Committee invite tenders for the supply and erection of a steam engine and dynamo. Tenders by July 6. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for steam and other pipework and paper-insulated cables, earthenware conduits, etc. Tenders by July 4. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of condensing plant, boiler feed pump, and steam and water piping, etc. Tenders by July 1. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for electric motors (enclosed type), of 4½ h.p., 7 h.p., and 10 h.p., for a period of 12 months commencing Nov. 1, 1901. Tenders by July 4. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of multiple-core lead-covered feeder and network cable and accessories for mains extensions. Tenders by July 2. Particulars in our advertisement columns.

Madrid.—The Public Works Department of the Department of Agriculture, Madrid, invite tenders for the construction and working for 60 years of an electric tramway from Santiario de la Yedra to Baiza. Tenders by July 26. Particulars at that office.

Pontypridd.—Tenders are invited by the Guardians for the lighting of the union workhouse, infirmary, and other buildings in connection therewith by electricity. Tenders must be received by Mr. William Spickett, clerk, Union Offices, Pontypridd, on or before July 23.

Glasgow.—The Corporation invite tenders for the supply of concentric and single main cables, insulated with paper or fibre impregnated with oil, bitumen, or other substance impervious to moisture, or with vulcanised bitumen. Tenders by July 9. Details in our advertisement columns.

Cleckheaton.—The Council invite tenders for Lancashire boilers, economiser, jet condenser, feed pumps, suction pumps, Meldrum's destructor furnaces, balancers and boosters, accumulators, cables, switchboards, and travelling crane. Tenders by July 6. Details in our advertisement columns.

Brighton.—The Town Council invite tenders for the supply and fixing of all the wiring and fittings necessary for the electric lighting of the new floral hall of the market. Specifications, etc., may be obtained at the office of the borough engineer and surveyor, Mr. Francis J. C. May, M.I.C.E. Tenders by July 26.

Manchester.—Tenders are invited by the Electricity Committee for the supply of the following stores during 12 months ending June 30, 1902—viz: brass and iron castings, coal slack, cement, cotton waste, flags, incandescent lamps, meters, oils, timber, etc. Particulars, etc., may be obtained from Mr. F. E. Hughes, secretary, Electricity Department. Tenders by July 2.

Birkenhead.—Tenders are invited by the Corporation for the construction, supply, and delivery of 15 electric tramcar bodies, complete electrical equipments for 15 cars, and trucks and trolleys complete for 15 cars. Specifications, etc., may be obtained on application to Mr. Arthur R. Fearnley, tramways manager, Sessions House, Brandon street, Birkenhead. Tenders by July 16.

Rio de Janeiro.—Tenders are invited by the Brazilian Government for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by July 8.

Manchester.—The Tramways Committee invite tenders for (a) 5 000 cast-iron bases; (b) 5.000 pairs of cast-iron collars; (c) 5,000 cast-iron finials; (d) 5,100 cast-iron plates; and (e) 400 rosettes (including clevises and lewis bolts). Specifications, etc., may be obtained on application to Mr. J. M. McElroy, general manager. Tramways Department, 55, Piccadilly, Manchester. Tenders by July 8.

London, N.E.—Tenders are invited for the erection and construction of mechanical coaling apparatus for the municipal electricity works, for the Electric Lighting Committee of the metropolitan borough of Hackney. Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W., on payment of £1. 1s. Tenders by 4 p.m. on July 4.

London, S.E.—The Borough Council invite tenders for the supply of electricity meters, demand indicators, and main fuses. Specifications, etc., can be obtained at the Town Hall, Spa-road, Bermondsey, on payment of a fee of £3. 3s., which will be returned on receipt of a bona fide tender. The specification may also be inspected (but not obtained) at the offices of the engineers, Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by noon on July 1.

Mansfield.—The Corporation invite tenders for the supply and erection of—boiler-house plant: three Lancashire boilers, mechanical stokers, steam pumps, economiser, and motor; engine-house plant: three 200-kw. high-speed steam generators, motor transformer, balancing motor transformer, and accessories; Korting condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains; public lighting: arc lamps, posts, and accessories; meters, and workshop equipment. Tenders by July 12. Details in our advertisement columns.

RESULTS OF TENDERS.

Stirling.—The Lighting Committee have accepted the tender of Messrs. Babcock and Wilcox, for the supply of steam-pipes, at £823.

Dundee.—The Council have accepted the tender of Messrs. Lowdon Bros., Dundee, for the overhead equipment in Seagate, at £2,010.

Hoylake.—The Electric Lighting Committee have accepted the tender of Brewer and Brunt, Hoylake, for the wiring of premises under the proposed system of deferred payments.

Hornsey.—The Council have accepted the tender of Braid, Pater, and Co., at £13,777, for the erection of the new electric lighting station. There were 11 tenders, the highest being £16,941.

Swansea.—The County Council have accepted the tender of the National Electric Wiring Company, Limited, 20, Wind-street, at £330, for wiring Guildhall and offices for purposes of electric lighting.

Thorpe (Norwich).—The Norfolk County Council have accepted the tender of N. C. Mann and Co., Redwell-street, at £4,000, for an installation of the electric lighting at the county lunatic asylum at Thorpe.

Poplar.—The Borough Council have accepted the tender of the Hart Accumulator Company, Limited, for the supply of a new storage battery, at £1,200, with an annual payment of £90 for five years in respect of maintenance.

Rochdale.—The Corporation have received tenders for six specimen electric tramcars from the British Thomson-Houston Company, 83, Cannon-street, E.C., and Messrs. Dick, Kerr, and Co., Prudential Buildings, 78, King-street, Manchester,

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Walsall.—The Town Council have accepted the tender of Thomas Parker, Limited, Wolverhampton, for supplying and erecting the new transformer required for the Freer-street sub-station, at £780, and for supplying a spare armature for such transformer at £226.

Whitehaven.—The Town Council have accepted the following tenders: British Thomson-Houston Company, Limited, supply of new switchboard at the electric lighting station; H. Kitchin, erection of a testing-box at the corner of Lowther-street and King-street; Electric Power Storage Company, supply of six storage cells.

Swansea.—The Electric Lighting and Tramways Committee recommend that the tender of the International Electric Company, Liege, at £1,470, be accepted subject to the engineer's approval of the switchboard they propose to supply and to satisfactory assurance being given that portions of the machinery necessary for replacement would be readily obtainable.

BUSINESS NOTES.

TRACTION.

Dundee.—The Seagate tramways have been extended to Peep-o'-Day-lane.

Chester.—The opposition to the Corporation Tramways Bill has been withdrawn.

Leeds.—A start has now been made with the electric equipment of the Wortley tram route.

Cape Electric Tramways.—The directors of this Company have declared an interim dividend of 6 per cent.

Paddington.—The Borough Council intend to petition against the Middlesex light railway scheme in Parliament.

Grimsby.—It is expected that the electric trams between Grimsby and Cleethorpes will be running in a day or two.

Baker-street and Waterloo Railway.—This company have called up a further £2 per share, making the shares £6 paid.

Brighton.—The Corporation have decided to order five additional tramcars from the British Westinghouse Company, Limited.

Hornsey.—The District Council have decided to present a petition against the Middlesex light railways scheme in Parliament.

Southend.—The electric tramcars have been tested over the whole of the lines, and the Board of Trade inspection will take place shortly.

Sunderland.—It is expected that at the close of the current year the profits on the working of the electric tramways will be between £12,000 and £15,000.

Cardiff.—It is stated that an agreement between the Corporation and the tramways company has practically been arrived at as to the measurement of the lines.

Personal.—Mr. J. C. Whiteley, late of Halifax, has been appointed chief assistant engineer to Mr. H. N. Thomas, the electrical engineer to the Corporation of Huddersfield.

Edinburgh.—The Mound and Tollcross Corporation electric tramway route will be opened for traffic in about three weeks. The Portobello route, on the other hand, is not likely to be opened till the autumn.

Perth.—The Town Council in committee have agreed to offer the Perth and District Tramway Company £20,000 for the tramway system in Perth, with a view to equipping the same for electric traction.

Birkdale.—The Bill promoted by the Urban District Council to authorize the construction and working of electric tramways in the township has passed the House of Lords Committee presided over by Lord Harris.

Isle of Thanet Tramways.—Major Pringle has held an enquiry on behalf of the Board of Trade into the causes of various accidents on this system, which, it is contended, have affected and may in future affect public safety.

Blackpool.—The Tramway Committee have decided to alter the position of the pillars along the centre of Lytham-road to the side of the roadway. The line from Talbot-square up the New-road to the cemetery is to be proceeded with.

Black Country Tramways.—It is reported that the British Electric Traction Company have intentions of constructing a line from Dudley through Rowley to Blackheath. The Rowley Regis District Council have decided not to join the scheme.

The Liverpool Accident.—Mr. A. P. Trotter, Board of Trade inspector, has now issued his report on the trolley wire accident on the Liverpool electric tramway system on Feb. 4 last, the main points of which have already been given in a previous issue of this journal.

Gravesend.—The National Electric Tramway Company have notified their intention to apply to the Board of Trade for consent to transfer the tramways order to a new company—the Gravesend and Northfleet Electric Tramway Company—in consideration of the sum of £16,664.

Halifax.—Good progress is being made with the tramway line to Hebden Bridge. The lines have now been laid nearly to Mytholmroyd, and the Board of Trade have been asked to send an inspector, with a view to the extension from Luddenden Foot to Brearley being opened at once for traffic.

Sedgley.—The British Electric Traction Company have commenced work on the new tramway line, which will bring about a connecting link between the Wolverhampton borough boundary and Sedgley. The whole track which is 2½ miles in length, will probably be finished within three months.

Oldham.—The Park road, Glodwick-road, and Lees-road sections of the Corporation tramways undertakings were formally declared open on Saturday. These lines are a part of the scheme for the construction of 25 miles of electric tramways within the borough, and the portions opened are 2¾ miles in length.

Swansea.—The Swansea and district light railways order as submitted to the Board of Trade for confirmation authorises the construction of new lines from Sketty to Port Tennant, the extension of the present tramways to Cockett and to Midland-terrace, Morriston, and the laying of extra lines in the town itself.

Private Bills.—In the House of Lords the Worcester Tramways Bill has been read a third time, and the London County Council (Tramways and Street Widenings) and the Metropolitan Railway Bills a second time. In the Commons the Manchester and Liverpool Electric Express Railway Bill has been read a second time.

Electric Tramways and Magnetic Observatories.—A special committee appointed by the Government of Bengal to consider this matter in Calcutta, have expressed "their inability to suggest any rule, or rules, which will protect magnetic observatories from disturbance where the overhead trolley system of electric traction is used."

London County Council Tramways.—The London County Council on Tuesday voted over £2 000,000 for tramways and street improvements. The expenditure of this sum, of course, is dependent on the sanction of Parliament in the session of 1902. A list of the proposed routes and improvements was given in our last issue.

Richmond.—It is stated that an arrangement has been made with the London United Tramways Company that the agreement between them and the Richmond Town Council shall not be prejudiced by the decision of the Parliamentary Committee in regard to the company's Extensions Bill, and that it shall be the basis of any new Bill they may promote.

Wolverhampton.—It is reported that the Lorain Steel Company have sent a cablegram stating that they are willing to accept the contract to lay down their surface-contact system in connection with the Wolverhampton Corporation tramways with certain "verbal alterations." A meeting of the Tramways Committee will shortly be held to consider the point.

Manchester-Liverpool Monorail.—The Cheshire Lines Committee have further petitioned against the Manchester and Liverpool Electric Express Railway Bill. The Committee of Selection in the Commons has appointed Thursday, July 4, for a select committee to sit and proceed with the consideration of the Bill, as already sanctioned by the House of Lords.

Huddersfield.—A public meeting has passed a resolution favouring the application of the Corporation tramway men for payment on Sundays at the rate of time and-a-half, which the Tramways Committee have refused to grant. The Corporation have decided that the tramlines at Chapel-hill and Lockwood-road be doubled forthwith, at an estimated cost of £3,578.

Musselburgh.—On the question of the electric tramway between Musselburgh and Edinburgh, the Musselburgh Town Council have decided to lay a statement before the Board of Trade in regard to the position of affairs, and to point out that the order for the tramway had been promoted by the National Electric Traction Company, and that the Council were most desirous that the tramway should be made.

Paris-Berlin Motor Race.—General and widespread interest is being shown in the international motorcar race from Paris to Berlin, and a hearty reception awaits those who, being lucky enough to escape accident *en route*, arrive in Berlin in good time. It is asserted that the German Emperor himself will give a welcome on his own car to the first arrivals in the German capital. England is represented in the race by a 50-h.p. Napier car.

West Cumberland Tramways Bill.—This Bill has complied with the Standing Orders of the House of Lords, and has been sent for second reading in the Upper Chamber. Petitions on behalf of the Cleator Moor Urban District Council, Whitehaven Hematite Iron and Steel Company, and the National Telephone Company, praying to be heard against the Bill when the committee stage be reached, have been deposited in the Private Bill Office of the House of Lords.

Folkestone.—The Corporation have sealed their agreement with Lord Radnor in connection with the proposed tramways. A resolution has also been adopted that if at any future time tramways are constructed outside the urban district of Folkestone to the boundary thereof, and there are tramways belonging to the Corporation inside the urban district to the boundary thereof at the same point, mutual running powers should be conceded upon terms to be agreed upon.

Preston.—The Tramways Committee have considered applications from the promoters of the Lytham Tramway Company and the Horwich and Preston Tramway Company asking the Corporation's approval of their respective applications to the Board of Trade for powers to construct and lay down tramways within the borough boundary. It was decided to recommend the Corporation to appear at the Board of Trade enquiries mainly with the object of protecting the interests of the borough and to obtain protective terms.

St. Marylebone.—The Tramways Committee are of opinion that the proposed West and South London Junction Railway is undesirable,

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inasmuch as the St. Marylebone portion would duplicate the lines of the already sanctioned North-West London Railway in Edgware-road, and, furthermore, the promoters of the West and South London Junction Railway propose constructing a station in close proximity to the intended station of the North-West London Railway near Marble Arch, at which point there already exists serious congestion of traffic.

Salford-Manchester Tramways.—Referring to our previous note on the subject, it has now been officially stated that the provisional agreement between the Manchester and Salford Corporations as to the working of the new electric tramway service over certain lines passing through the two districts has fallen through. The Salford Corporation have, therefore, decided to run their own cars entirely within their own boundary, and not to continue their service into Manchester. It is said, however, that there are hopes of a settlement in the near future.

Bath.—At the last Town Council meeting a formal resolution was passed empowering the authority to give notice to purchase the present tramway system. This step is in accordance with the agreement of the authority with the promoters of the electric railway, by whom the cost of the purchase will be borne. Mr. George S. Crisford has been retained to value the undertaking. The Chairman of the Tramways Committee stated that the conduit system was impossible owing to the arches in the city. The Clerk said that under the agreement they were pledged to the overhead system.

Glasgow.—The conductors and drivers belonging to the Coplawhill and Langside depôts of the Corporation tramways are agitating for payment on the same principle of daily pay as was formerly done and with an increase thereon of 2s. per week: to reduce the hours of labour to nine hours per day, or as near to that as could be conveniently arranged; and to pay "time-and-half" rate of wages for Sunday labour instead of, as at present, only the ordinary rate. An electric car driver has been fined a guinea for reckless driving in Eglinton-street on 11th inst., and another driver 10s. 6d. for a similar offence.

Metropolitan District Railway Bill.—This Bill, promoted by the railway company to carry out an agreement entered into with a company formed but not yet registered, called "The Metropolitan District Supply Company," came before the Select Committee of the House of Commons presided over by Sir John Kennaway on Tuesday. Mr. Pember, K.C., for the promoters, stated they had already power to apply electric traction, but the impecunious position of the company disabled them from going into the market to obtain the necessary capital to electrically equip the railway. Mr. Perks, M.P., a large shareholder, had entered into an agreement with Mr. Yerkes, a wealthy American financier, with the result that on favourable terms they had agreed to find a million of capital, to take up shares and to become practically partners in the working of the railway. Opposition was offered by the Metropolitan Railway Company and by the London and North-Western, who have running powers over the railway. It was stated that the objection of the former company was that the District Company by their Bill would require them to work on the section of the line common to both companies by the Yerkes system. If the Yerkes system were adopted, it would bar out the adoption of the Ganz system through the whole of the inner circle. It was obvious that there could be only one system in the circle. The question was which was the best.

London United Tramway Extensions.—The Select Committee of the House of Commons which has been considering the London United Tramways Bill has passed the preamble so far as it relates to 15 out of the 22 miles of new line proposed. The extensions granted comprise the whole of the company's proposals with regard to the group of lines in Kingston, Surbiton, Malden, and Esher, and also the Dittons and Molesey line, including the connections over the Kingston and Hampton Court Bridges, together with the company's authorised Middlesex tramways. The committee also passed the company's proposed electric tramway between Kew Bridge and Richmond, and the connection with Surrey from Hammersmith Broadway over Hammersmith Bridge. The chief proposal which has been rejected was to construct a line from Richmond to Putney, which would eventually join with the proposed London County Council system at the county boundary. The decision of the committee not to grant a license for this section, therefore, will prevent a through communication being established at this point, and leave a space of a mile or more between the termini of the two systems. This is to be regretted, inasmuch as great inconvenience to passengers and considerable waste of time must necessarily result therefrom. Another point worthy of note is that the committee decided that the existing Board of Trade provision gave gas and water companies sufficient protection against possible electrolytic action on their mains. The Bill now stands reported for third reading.

London Underground Railways.—On Friday Mr. Charles Booth gave some important evidence before the Joint Parliamentary Committee appointed to enquire into the routes proposed in various London underground railway schemes promoted in this session. He wished, he said, to see a complete system of tube communication in the area around London devised so that what was done locally might be brought into harmony with the whole. People might remove from a congested district to a longer or shorter distance if they had free scope for their choice, and gradually London would be expanded. There should be a gradual expansion in every direction, and by cheap and uniform fares people should be carried to any distance, just as in New York a five-cent fare would carry a passenger any distance up to 10 miles. Tramways should be worked by electricity in connection with, and extension of, tube railways, and they should also cover the ground now occupied by omnibuses. Colonel Yorke, chief inspecting officer for railways under the Board of Trade, also gave evidence founded on knowledge of the conditions of working traffic on the Central London, City and Waterloo, and South London underground railways. He supported, in the interests of economy and simplicity, the fixing of a uniform fare for each system. He was afraid that an all-night service would not be possible, because an interval of a few hours must be left for examination of the line and the work of repairs. On Tuesday the committee were occupied with the speeches of counsel in support of the several undertakings proposed, at the conclusion of which the room was cleared and the committee deliberated in private. On the readmission of the public, the chairman said the committee considered they had heard enough evidence, but if owners, lessees, and occupiers wished to say anything on the question of damage and the law on the point they would hear counsel, but not evidence. The committee then adjourned till Tuesday next.

LIGHTING AND GENERAL.

Yorkshire Electric Power Bill.—This Bill has been read a third time in the House of Commons.

Notting Hill Electric Lighting Bill.—This Bill has been read a second time in the House of Commons.

Pontypool.—The Guardians are investigating the question of lighting the workhouse with electricity.

Swansea.—Mr. J. H. Cawthra, electrical engineer to the Corporation, resigned his position on Monday.

Workington.—The Workington Electric Lighting Bill has been ordered to be reported for the second reading.

China.—It is said that a contract for the lighting of Pekin by electricity has been obtained by a German firm.

Bath.—An enquiry will be held shortly into an application to borrow £4,000 for the purposes of electric lighting.

Society of Arts.—Sir Frederick Bramwell has been elected to the presidency of the Society of Arts for the coming year.

Bedford.—A further sum of £3,000 is to be borrowed for electric lighting purposes at £3. 10s. per cent. per annum interest.

Beckenham.—Mr. M. K. North has held an enquiry into the application of the Council to borrow £20,000 for electric light extensions.

Glasgow.—The Corporation have decided to apply for a provisional order to supply electrical energy within the burgh of Kinning Park.

Heylake.—The contracts for the lighting of the town hall by electricity have been sanctioned by the Council, and the work will shortly be taken in hand.

Sligo.—Mr. Enright has advised the Corporation to summon a special meeting to give him authority to apply for an electric lighting provisional order.

Elland.—The report on the proposed electric lighting presented by Mr. Emmott, electrical engineer, of Halifax, is being circulated as private and confidential, and appears to be received favourably.

Factory Act.—Mr. Strachey, M.P. has consented to propose a clause in the Committee on the Factory Bill for the purpose of bringing Crown post offices under the operation of the Factory Acts.

Tadcaster.—The Guardians have granted sanction to the Tadcaster Electricity Company, Limited, to apply for a provisional order in pursuance of Section 4 of the Electric Lighting Act, 1882.

Sandgate.—The Council are urging the Hythe and Sandgate Electric Company to state definitely what they intended to do with regard to supplying Sandgate, as they have a number of applications.

Croydon.—Current for motive power is now to be supplied on the maximum-demand system. Sevenpence will be charged per unit for the first hour's average demand, and 1d. per unit for the remainder of the supply.

Falkirk.—A deputation of the Town Council is to visit Ayr, Edinburgh, Leith, and other places for the purpose of gaining information in regard to the working of the Council's electric lighting provisional order.

Electric Lighting in Wales.—The Bill to confirm provisional orders for electric lighting, which has passed the Examiner, and was reported for second reading in the Commons, contained provisions for Aberavon, Mountain Ash, Neath (rural), and Pontypridd.

Hornsey.—The Telephone Company having informed the Council that the telephone service would be resumed if the Council would allow a single pole to be erected at the corner of Hampstead-lane, the Council decided last week not to offer any opposition to this being done.

Institution of Junior Engineers.—The secretary (Mr. Walter T. Dunn) desires us to announce that the address of the institution on and after July 1 will be 39, Victoria-street, Westminster, rooms having been taken there on the first floor for offices, reading-room, library, etc.

Aberdeen Harbour Board.—At the last meeting of the Docks and Pilotage Committee of the Harbour Board the engineer reported that the electric lamps on the quay had now been fully equipped, and it was resolved to pay Mr. Bell, the electrical engineer, £50 for his services.

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Dungannon.—The Bill to confirm an electric lighting provisional order to authorise the Urban District Council of Dungannon to supply electricity within the limits of their area has been reported for second reading.

Ardsley.—Application is to be made for an electric lighting provisional order authorising the Urban District Council of Ardsley East and West to supply electricity for public and private purposes within their district.

Simla.—Mr. Meares's scheme for the establishment of works for the electric lighting of Simla is estimated to cost approximately Rs 9,71,275. This figure includes the pumping plant and the cost of house wiring at Rs.30 per light.—*Indian Engineering.*

Aberdeen.—The kirk session of the East Parish Church are willing to pay £75 towards the cost of the electric lighting of that church on condition that the work of introducing the installation be commenced at once, and that the lighting arrangements be finished by the end of August.

Preston.—The Tramways Committee have been considering the question of the purchase of the electric supply company's undertaking for the supply of electric power, but it is stated that, owing to the prohibitive price asked by the company, the committee cannot recommend the Corporation to purchase.

Wireless Telegraphy.—The steamer "Tyrian" has been dispatched to establish the first Canadian station for wireless telegraphy at West Point, Anticosti. The "Tyrian" will also lay for the Government a cable 22 miles in length connecting Belle Isle with the Government line to Quebec.

Clyde Valley Electrical Power Bill.—The Examiner of Standing Orders has reported non-compliance in the case of the Clyde Valley Electrical Power Bill, so that it will have to come before the Standing Orders Committee of the House of Lords who will no doubt suspend the Standing Orders to allow the Bill to proceed.

Berkhampstead.—A special meeting was held last week to consider the advisability of obtaining a provisional order for the supply of electric light in the parish, but no decision was arrived at. The chairman stated that he was at St. Albans recently, and the mayor had publicly stated that they were going in for electric light there, and were not going to charge the ratepayers a penny for it.

Panteg.—The Rhondda Urban District Council having entered into an agreement with the South Wales Electric Power Company, by which the value of the unit would be the minimum of 2d instead of the maximum of 3d., the Panteg Urban District Council are taking steps to come to a similar agreement, as it is to be proposed to put down a third generating station there at some future period.

Bermondsey.—A tender was recently accepted by which the National Electric Wiring Company undertook to wire the town hall for £408. 14s. The account certified was £662. 15s. 8d., subject to a reduction of £59. 10s., leaving a total expenditure of £603. 5s. 8d. to be met, owing to a number of alterations for the making of which it is said the General Purposes Committee, and not the Electric Lighting Committee, were responsible.

St. Pancras.—The London County Council have decided to advance £50,000, part of a loan of £77 111, applied for for electricity purposes, on condition that it is taken up at once and repaid with interest at the rate of £3. 10s. per cent. per annum within 42 years, the Borough Council paying the costs of the loan. A previous resolution of the Council sanctioning the expenditure of £29,390. 5s. 6d. for additional feeding mains has been rescinded.

Brighton Telephones.—The Corporation have asked Mr. Bennett to prepare a map showing an extension of the Brighton telephone area to embrace Haywards Heath and Cuckfield and the adjoining rural districts, including Lindfield and Wivelsfield. They have also decided to ask the Postmaster General if he would be prepared to extend the Brighton telephone area so as to include the urban districts of Haywards Heath and Cuckfield and the adjacent rural area.

London County Council.—The Council have agreed to lend the Hampstead Borough Council £12,500 for purchase of a site for electric light station, and the Islington Borough Council £3 236 and the Stepney Borough Council £26 507 for electric light installations. On May 2, 1899, the Council gave permission to the National Telephone Company to lay three mains in the southern pathway of Bow Bridge, and we are informed that the company have abandoned their application.

Dundee.—At a telephone meeting of the sub committe appointed in connection with the proposed municipal telephones for Dundee on Tuesday, a letter was read from the National Telephone Company, protesting against any interference with the wayleaves of the company, and stating that the company had expended a capital of £95,000 in Dundee. Without dealing with the letter, it was resolved to send a deputation to Glasgow to make enquiries regarding the cost and working of the municipal telephone system there. It was stated that the income of the electricity department for May amounted to £601, which is £465 more than for the corresponding month a year ago.

Glasgow Telephones.—The Corporation have issued a preliminary list of their telephone subscribers, who are continually on the increase, the number at present being 739. The Corporation have over 5,000 lines on order, and claim that neither subscribers nor operators can overhear what is not intended for them. Another improvement is in the case of trunk calls from Post Office call boxes in other towns, only a simple trunk fee having to be paid without any terminal charge. Special agreements provide also for telephone messages for transmission over the public telegraphs, telephone messages to be forwarded as letters by post, and call for Post Office messengers for express delivery of letters or parcels.

Melton Mowbray.—The Lighting Committee of the Urban District Council having come to the conclusion to treat both the gas and the electric companies in a fair and impartial manner, decided that a tender should be sent in from each company for a period of three years. Subsequently the electric lighting company submitted two alternative schemes, at £325 and £335 per annum. The tender from the gas company came to £334. 13s. 4d. per annum. The lowest tender has been accepted by six votes to two, and the Council as a whole will act as a committee to obtain specimens of lamps.

Blackpool.—According to the last report the revenue for the year amounted to £23,530. 18s. 10d., made up as follows: Private lighting, £14 658; tramway current, £3 120; public lighting, £5,656; sundries £96. The expenditure totalled £16,186, leaving a gross profit of £7 345, dealt with as follows: interest and sinking fund, £7,550, less deficiency supplied by general district rate, £205—total, £7,345. The units generated in the year to March, 1901, are 1 760 459 against 1 427 607 last year, being an increase of over 23 per cent. At March 31, 1901, there were 910 consumers and about 80 miles of electric lighting mains. Number of public arc lamps, 240; incandescent lamps, 290. The total electric lighting capital stood at £145,094 at March 31, and the sinking fund at £11 845.

Clifton.—Messrs. Rouch, Lambert, and Penny, of 6, St. Stephen-street, Bristol, have just completed an electric light installation in the parish church. On the centre main ceiling are placed two pendant fittings, with 10 25 c.p. lights on each, controlled by two switches to enable either the full power or half power to be used. The galleries are illuminated by 12 three-light pendants, suspended from the ceilings, and underneath the galleries are 23 single ceiling lights. All fittings to the ceilings are arranged so that the light may be raised and lowered as required. Fittings have also been placed in the vestries, lobbies, tower, organ pedals, and crypt. It is probable that two more of the Clifton churches will follow the example of the parish church.

Improved Electric Glow Lamp Co.—This Company, who have removed to 7, Great Newport-street, St. Martin's-lane, state that they have taken this step owing to their inability to renew the lease (now terminating) of their premises, and on account of the large increase of their business in street lighting and other departments which will make the concentration of their offices and works an advantage. The Company hope in the future to confine themselves exclusively to the trade, while continuing to make a speciality of their electric incandescent lamps as heretofore, and of street-lighting and all fittings and work in connection therewith. The firm promises in addition an extensive show of motors and other electrical accessories of all description. Several new lists will be issued shortly.

Fulham.—On Dec. 15 1897, the late Vestry entered into an agreement with the National Telephone Company, Limited, consenting to their laying under the streets ground wire and cables, inspection chambers etc., for the purpose of telephonic communication, the company paying to the Vestry a small rental for such permission. The company laid various pipes and tubes, and on July 30, 1900, the Vestry, in pursuance with provision contained in the agreement, served the company with notice to remove all wires and cables, etc., within 12 months. This notice has now been withdrawn and a fresh agreement entered into, the company undertaking to lay no additional wires, cables, appliances, etc., without entering into a new agreement, to be entirely separate from the agreement first mentioned.

Brierfield.—According to the *Nelson Chronicle*, it appears that the recent action of the Corporation of Colne will almost certainly lead to the total collapse of the Brierfield electrical scheme. It will be remembered that at the last meeting of the Brierfield Council, Mr. Cooper, the electrical engineer to the borough of Colne, was practically appointed electrical engineer to the urban district of Brierfield, and was instructed to proceed with the scheme of erecting an electrical supply station at Brierfield to cost £10,000. This arrangement was a capital one so far as Brierfield went, but it was a one-sided one in which Colne could rightly be expected to insist on having a say, as that authority employs Mr. Cooper at a large salary to carry out their own electrical enterprises to success. But the Colne Electrical Committee subsequently decided to take such steps as would withdraw the services of Mr. Cooper, their engineer from the service of Brierfield Council. This is a heavy blow to the Brierfield scheme, as very great expense will have to be incurred in order to fill the place which Mr. Cooper has been called upon to vacate.

Bray.—The town clerk having submitted a statement showing that, looked upon as a trading concern, the electric light works showed a loss on the year's trading to March 31, 1901, of £605. 2s. 9d., and the matter having been discussed at length, the Electric Light Committee concluded that, having regard to the fact that the Council had been selling electric current for less than the cost of production, a revision of charges should be made, and recommended to the Urban District Council on the 20th inst. that from July 1 prox. the price of current be increased 1d. per Board of Trade unit—viz., to 7d., reducing to 4½d. after 1½ hours' lighting at maximum demand. Further special concessions to larger consumers to be made at the following rates—viz: 2½ per cent. off all quarterly accounts of £5 and over; 5 per cent. off all accounts of £10 and over; 10 per cent. off all accounts of £25 and over, provided such accounts be paid within one month after being furnished. The consideration of matters *re* extensions, new plant, etc., was postponed. The Council thought it was inopportune

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to increase the price of cursent, and the report was sent back to the committee.

London Gazette.—A receiving order has been made out in the estate of C. A. Church (trading as H. Conolly and Co.), 120, Kentish Town-road and 12, Hampstead-road, London, on debtor's petition. The first meeting in the estate of the above was held on June 27 at 11 a.m. at Bankruptcy-buildings, Carey-street, W.C. The public examination will take place on July 24 at 11 a.m. at Bankruptcy-buildings, Carey-street, W.C.—The estate of A. G. Inrig (trading as the Globe Electrical Company), 46, Whitepost-lane, Victoria Park, has been released from trusteeship.—A receiving order has been made out in the estate of A. Sharp, lodging at Lane Head, Rastrick, Brighouse, Yorks, on debtor's petition. The first meeting in the estate of the above will be held to-day at Official Receiver's Offices, Town Hall-chambers, Halifax. The public examination will take place on July 15 at 2 p m. at County Court House, Prescott-street, Halifax.—The last day for receiving proofs in the estate of J. Brown, lately residing at 278, High-street, West Sunderland, is July 6. Mr. J A. Longden, official receiver, 25, John-street, Sunderland, is trustee.—The final meeting of the Premier Electric Lamp Syndicate Limited (in liquidation), will be held at the offices of Messrs. Wade, Chalmers, and Co., chartered accountants, 5, Fenwick-street, Liverpool, on Aug. 13 at 2 30 p.m.

Telephone Trunk-Line Exchange.—The new chief trunk line exchange at Franzosischeestrasse, Berlin, for the exclusive inter-urban and international telephone communication was opened on June 21. The system now in use means a considerable step forward in the development of telephony in Germany, for while up to now all trunk lines to Berlin terminated there, and could not be brought into connection with each other, the new trunk-line exchange enables the combining of any trunk-line wires, thereby providing the means of allowing telephonic intercommunication between not less than 17,000 towns all over Germany. This reorganisation naturally required an enormous amount of new and reconstruction, and the whole of the work connected therewith was laid into the hands of Messrs. Mix and Genest, Limited, of Berlin. This trunk-line exchange has been specially designed by the said firm, and has had a preliminary trial at the trunk telephone exchange at Chemnitz where during the short time of its introduction it has shown such reliability and such decided acceleration of service that the General Post Office decided upon its adoption on a larger scale for Berlin, and has now also ordered the trunk-line exchange at Magdeburg and Halle to be fitted up after the same plan. It is claimed that now the German Telephone Department possesses the most up-to date trunk-line exchange in existence.

British Thomson-Houston Co.—In view of the statements that have appeared in the daily Press, and in answer to numerous enquiries in regard to the same, the British Thomson-Houston Company inform us that the facts as reported are substantially correct. As is well known, the British Thomson-Houston Company own the patent rights for Great Britain of the General Electric Company of New York, the Thomson-Houston, and other companies, and, whilst the General Electric Company of New York have always been interested to a certain extent in the British Thomson-Houston Company, they have now increased that interest, and purchased British Thomson-Houston stock formerly held on the Continent. This does not affect the holdings in this country, and, in fact, the purchase meets with the approval of the British shareholders. The works now being built at Rugby will be pushed to completion, so that the manufacture of apparatus for the English market and export will be commenced as soon as possible. The Board of the British Thomson-Houston Company will be joined by Mr. C. A. Coffin, president, and General Eugene Griffin, first vice-president of the General Electric Company of New York, thus giving the General Electric Company of New York three directors out of a total of 13, Mr. W. J. Clark, the manager of the foreign department of the General Electric Company, already being a member.

W. P. Hartley, Bermondsey.—About 500 gentlemen assembled on Tuesday afternoon to witness the opening by Mr. H. C. Cust, M.P., of an extensive jam and marmalade factory at Green-walk Bermondsey New-road, S.E. The factory contains over 1,500,000 cubic feet, divided into seven or eight departments, as the largest building allowed by the London County Council must not exceed 250,000 cubic feet. Mr. Hartley comes from Aintree, Liverpool, where he has similar works, with a report of not only allowing his workpeople to share in his profits, but also of caring for their sanitation and comfort. The buildings are airy and substantial, and labour-saving appliances and electric fans abound. Five electric lifts have been fitted by Messrs. R. Waygood and Co., Falmouth-road, South Dover-street. They are of one-ton capacity each, the motors being of 17 h.p. Two Schuckert motors, of 10 h.p. each, are used for driving boxmaking and other machines. The 17 electric fans were made by Messrs. Matthews and Yates, Limited, and they vary from 18in. to 30in. diameter, the motors being of ¼ h.p. to 1½ h.p. The whole is lighted by about 700 16-c.p. lamps and 26 Thomson-Houston arcs of the enclosed type. The generating plant consists of two horizontal slow-speed engines made by the Burnley Ironworks Company, driving, by means of ropes, two A35 Schuckert multipolar dynamos, each having an output of 69 kw. at 220 volts. Space is provided in the engine-room for additional plant when extensions become necessary. Three 30ft. by 7ft. 6in. Lancashire boilers, made by T. Bellies and Son, Hyde Junction, constructed to carry a pressure of 150lb., supply the steam. Great attention is given to smoke prevention and smoke consumption. Mechanical stokers of the latest design are fitted, intended to minimise the escape of smoke to the greatest possible extent. The fine chimney stack is 130ft. high, with an unusually large internal flue, the diameter being 8ft. from bottom to top, with an outside base of over 16ft. across. The main switchboard is of white marble, and contains two dynamo panels fitted with ammeter, voltmeter, double-pole main switch, single-pole main fuse, automatic cut-out and shunt resistance for each machine, one spare dynamo panel for future machine, and two circuit panels for the various lighting and power circuits. The circuits are provided with throw-over switches, enabling them to be fed by either dynamo as required. The wiring is carried out on the distribution system, each floor having its own distributing switch and fuse board. The wires are, for the most part, run in wood casing, but in the boiling-rooms and other portions where steam and acid vapours are present, they are protected by insulated conduits. In the latter portions the fittings and distributing board cases are of watertight pattern. Mr. R. J. Wallis Jones, M.I E.E., of Great George-street, Westminster, was the consulting engineer. Mr. Fielden was the engineer for the contractors for the work, Messrs. Simpson Bros., of Hapton, near Burnley.

Kensington.—The Council are supporting the action of the London County Council with regard to the Notting Hill Electric Lighting Bill, and will ask the insertion of a clause providing that the powers under the provisions of the Electric Lighting Act, 1888, and of the Notting Hill Electric Lighting Orders, 1889 and 1895, of purchasing the undertaking of the company should extend to any lands acquired or works constructed by the company under the powers of the present Bill as if such land formed part of the undertaking; and they are of opinion that this course should be adopted, and that, if necessary, a petition should be lodged against the Bill in order to secure that the clause referred to be inserted. The lighting engineer has reported that he has been in communication with the several electric lighting companies in the borough in connection with the arrangements to be made for the lighting of Kensington High-street, Kensington-road, Brompton-road, Holland Park-avenue and High-street, Notting Hill, with electric arc lamps, and has ascertained from them that there will be no difficulty in getting a supply for the lamps, except on the north side of Kensington High-street and Kensington-road, in the area of the Notting Hill Electric Lighting Company. It appears, however, that this company would not object to the necessary current being obtained from the Brompton and Kensington Electricity Supply Company, who would light the south side of the road, and that the latter company are willing to supply the lamps from their mains on the south side of the thoroughfare. The Council are communicating with the two companies with a view to the difficulty being satisfactorily arranged.

New Issue.—The Urban Electric Supply Company, Limited, incorporated with a share capital of £500,000, divided into 50,000 5 per cent. cumulative preference share of £5 each (£250,000) and 50,000 ordinary shares of £5 each (£250,000), of which 4,000 ordinary shares have already been subscribed for by, and alloted to, Edmundson's Electricity Corporation, Limited, are issuing 30,000 5 per cent. cumulative preference shares of £5 each and 30,000 ordinary shares of £5 each. A dividend of 5 per cent. on the preference shares and a minimum dividend of 5 per cent. on the ordinary shares has been guaranteed until Dec. 31, 1910, by Edmundson's Electricity Corporation, Limited. The directors are Messrs. Francis Edward Gripper, M.I.E.E. (managing director Edmundson's Electricity Corporation, Limited), Clifton Villa, St. Margaret's-on-Thames (chairman); Edmund Charrington, A.M.I.C.E., Mayfield, Chislehurst, engineer; Herbert Brent Grotrian, Hare-court, Temple, E.C., barrister-at-law; William Page (director of the Brompton and Kensington Electricity Supply Company, Limited), Rickmansworth; John Cuthbert Wigham (director Woolwich District Electric Light Company, Limited), Coanwood, Surbiton. Mr. F. Hastings Medhurst M.I.E.E. (F. H. Medhurst and Lloyd), 13, Victoria-street, Westminster, S.W., is the consulting electrical engineer. This company was formed in 1898 for the purpose of obtaining powers to work electric light and tramway undertakings in various places in England and Scotland. Powers have been acquired either by this company or by others acting under its control for electric lighting in Camborne and Redruth, Glossop, Twickenham, Hawick, Grantham, Berwick-on-Tweed, Bishop Auckland, Godalming, Newton Abbot, Stamford, Dartmouth, and Weybridge, and for 3½ miles of electric tramways in Camborne and Redruth, and a provisional order for the 4½ miles of tramways at Glossop has been granted by the Board of Trade with the sanction and support of the Corporation of Glossop, and only awaits the usual confirmation by Act of Parliament. The construction of the works will be undertaken by Edmundson's Electricity Corporation, Limited, which provides, *inter alia*, for their profit being fixed by the consulting engineer of the company, or in case of difference by arbitration. They also undertake the supervision and general management of the various works until Dec. 31, 1910. Mr. Medhurst recently inspected all the towns for which the company hold electric lighting and tramway provisional orders. Regarding Twickenham, Grantham, Berwick-on-Tweed, Newton Abbot, Stamford, and Weybridge, he states that there is certain to be a good demand for electrical energy for lighting purposes in each of these towns, and that in each of them the price at which consumers will obtain electric light will compare very favourably with the present rates for gas-lighting. At Dartmouth the Government is erecting a great naval training college, and he understands that this institution will require electricity for some 3,000 lights from the company's Dartmouth central station. At Godalming the Charterhouse School will require a considerable supply of current in the coming winter. Mr. Medhurst considers the terms of the contract between the

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Urban Electric Supply Company, Limited, and Edmundson's Electricity Corporation, Limited, is in every respect most fair and reasonable, as all the shareholders of the Urban Electric Supply Company, Limited, are certain to receive 5 per cent. interest on their capital from the date of their subscriptions till the end of the year 1906. By the end of 1907 he estimates the capital expenditure will have increased to £650 000, and that the output and commercial results will be as follows: Net revenue, 1907—2,800,000 units at an average profit of 3d. (difference between 2½d., the cost of production, and 5½d., the price obtained), £35,000; 420,000 car miles at an average profit of 4d. (difference between 5½d. and 9½d.), £7,000—total, £42,000. He thinks the sum of £650,000 above mentioned might well be made up as follows, when the result would be: £150,000 debentures at 4 per cent. require £6,000; £200,000 5 per cent. preference shares require £10,000—total, £16,000; leaving for £300,000 ordinary shares, £26,000; which is equal to 8¾ per cent. In order to show the steady increase in net profit with every justifiable increase in capital expenditure, the following figures are given: Capital outlay in 1910, £1,000 000, made up as follows—£300,000 4 per cent. debentures, £350,000 5 per cent. preference shares, £350,000 ordinary shares. Net revenue, 1910: 5,800,000 units at an average profit of 3d. per unit, £72,500; 480,000 car miles at an average profit of 4d. per car mile, £8,000—total, £80 500; £300,000 4 per cent. debentures require £12,000; £350,000 5 per cent. preference shares require £17,500; 1½ per cent. depreciation requires £15,000—total, £44,500; leaving for 350,000 ordinary shares, say, £36,000 (which is equal to 10 per cent.). Full particulars will be found in another column.

PROVISIONAL PATENTS, 1901.

JUNE 17.

12329. Improvements in electric meters. Arthur O'Neill Fox, 46, Lincoln's-inn-fields, London. (Complete specification.)

12342. Improvements relating to electromagnetic winding mechanism for clocks. Theodor Schäffer, 11, Southampton-buildings, Chancery-lane, London.

12350. Improvements in revolving electric igniters. Anson Groves Ronan, 40, Chancery-lane, London.

JUNE 18.

12382. Improvements in portable electrically-driven drilling apparatus. George Frederick Campbell and Stanley Thomas Isherwood, 34, Castle-street, Liverpool.

12400. Trolley for electric cars. John Liddle, 154, St. Vincent-street, Glasgow. (Laclede Car Company, United States.) (Complete specification.)

12403. Improvements in bonding electric railway and tramway rail joints. John Stanley Holme, The Promenade, Egremont, *vid* Liverpool.

12408. Improvements in and relating to static rectifiers and other electrical apparatus for producing or maintaining continuous or unidirectional discharges. Thomas Burton Kinraide, 55, Chancery-lane, London. (Complete specification.)

12456. Improvements in or relating to trolleys for use in electric traction. John George Lister, 111, Hatton-garden, London.

12466. Improvements in apparatus for deriving continuous current from a source of alternating current. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

12468. Improvements in the manufacture and production of troughs or conduits specially intended for the reception of electric cables. Albert Harris Howard, 47, Lincoln's-inn-fields, London.

12469. An improved current transformer for telephones. Benoit Joseph Berthelon, 40, Chancery-lane, London.

JUNE 19.

12495. Seeing by electricity. Ludolph Fränckel and Richard Robert Harper, 5, South-grove, South Tottenham, London.

12502. Improvements in apparatus for deriving continuous current from a source of alternating current. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actiengesellschaft, Germany. (Complete specification.)

12509. Improvements in apparatus for deriving continuous current from a source of alternating current. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actiengesellschaft, Germany.) Complete specification.)

12514. Improvements in or connected with storage or secondary batteries. John Crisp Fuller and George Fuller, 33, Chancery-lane, London.

JUNE 20.

12551. Improvements in and relating to trolley pulleys for electric tramcars and the like. Robert Wylie, 96, Buchanan-street, Glasgow.

12562. Improvements in electric arc lamps. Crompton and Co., Limited, Arthur John Hodgson, and John William Ewart, The Arc Works, Chelmsford.

12587. Improvements in and relating to apparatus for lighting and heating by means of electric lamps. Richard Wade Boyd, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12607. Improvements in and relating to plates for electric batteries and methods for manufacturing the same. Edward Bennett Viles, 322, High Holborn, London.

12622. Improvements in electric instruments. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria street, London.

JUNE 21.

12685. An improved method of registering electric currents. Samuel Jevons and Edward William Bonson, 77, Colmore-row, Birmingham.

12691. Improvements in electric cloth-cutting machines. Robert Edward Leve, 6 Bream's-buildings, Chancery-lane, London. (Complete specification.)

12720. Improvements in or connected with electric cables for three-phase alternating current. William Beedie Esson, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

12721. Improved machine for use in the manufacture of electric fuses or cartridges. Hans Tirmann and Hugo Tirmann, 111, Hatton-garden, London. (Complete specification.)

JUNE 22.

12730. Improvements in cleats, ceiling roses, cut-outs, and the like for electrical purposes. Charles Cartwright Metcalfe, 50, Oldfield-road, Sale, Cheshire. (Harry Cecil Blackwell, Russia.)

12739. Improvements in electrically-driven centrifugal and similar machines Gideon Pott and Robert Williamson, 62, St. Vincent-street, Glasgow.

12755. Improvements in electric meters. Joseph Matthews and William Davies, 77, Colmore-row, Birmingham.

12773. Apparatus for automatically regulating the tension of electric currents. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Moritz Lindner, Austria.) (Complete specification.)

12773. Improvements in wattmeters. José Batlle and José Bueno, 322, High Holborn, London. (Complete specification.)

12774. Improvements in cell switching devices for electric accumulator batteries. Max Gehre, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on July 13.

1900.

5387. Apparatus for wireless telegraphy. Marconi.

11035. Electric apparatus for lifebuoys and lights to facilitate the rescue of persons from drowning and for other purposes. Binko.

11206. Electric switches and like apparatus for making and breaking electric circuits. Partridge and Elphinstone.

11283. Electric signalling apparatus. Warden-Stevens.

11727. Electric switches having intermittent or step-by-step motions. Kingsland.

11853. Flag or banner poles or for use in connection with arc lamps or for other like purposes. Grindrod.

15019. Recovery of tin and the simultaneous generation of electric energy. Gould.

15021. Manufacture of carbon electrodes for arc lamps. Alexandroff.

15363. Electro-deposition of metals upon articles of china, earthenware, and the like. George Cooke and Joseph Parr.

17765. Connecting the glow bodies of incandescent electric lamps to the leading-in wires. Scharf.

1901.

1994. Electrical meters. Fenny. (Allgemeine Elektricitäts-Gesellschaft.)

2009. Electric arc lamps. Fairburn-Hart. (General Electric Company.)

3002. Electrical insulators. Harloe.

3206. Equalising appliances for inner-connected polyphase currents. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

4868. Electric switches. Scott. (Date applied for under International Convention, Aug. 16, 1900.)

5596. Electrolysis of chlorides of metals of the alkalies and alkaline earths for the purpose of obtaining chlorine and apparatus therefor. Atkins.

6288. Coin-freed meters for gas or electricity. Smith and Smith.

6884. Protecting covers for steam-pipes, water-pipes, rods, chains, wire ropes, or electric wires for ship purposes. Hudson.

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5134. Conduits for electric cables and the like. Hultman.

9384. Electric arc lamps Johnson and Esson.

10623. Telephone apparatus. Nicholson and New Phonopore Telephone Company, Limited.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 22	727	711	+ 16	—	—
Birmingham Trams.	,, 22	4,537	4,559	- 22	107 118	—
Blackburn Corp'rat'n	,, 21	487	482	+ 5	11,583	10,542b
Blackpool Corporatn.	,, 20	775	762	+ 13	8,478	6,588
Blackpool-Fleetwood	,, 22	592	683	- 91	9 016	9 402
Bolton Corporation..	,, 23	1,311	1,260	+ 51	34,752	25,449
Bradford City Trams	,, 23	927	458	+ 469	17,045	10,350
Bristol Tramways Co.	,, 21	4,377	3,201	+1 176	—	—
Carlisle Tr'mw'ys Co	,, 22	184	—	—	3,623	—
Central London Ry.	,, 22	6 262	—	—	155,032	—
City & South London	,, 23	1,900	1,500	+ 400	48,971	32,235
Cork E. T. and L. Co.	,, 20	509	588	+ 21	10,391	9 063
Darwen Corporation	,, 21	191	151	+ 40	4,471	3,696
Dover Tramways ...	,, 22	225	216	+ 9	4,614	4,288
Dublin & Lucan E.R	,, 22	111	110	+ 1	2,341	2 209
Dublin U.T., elec. cars	,, 21	3,834	3,670	+ 164	—	—
Dublin S.D. Electric	,, 21	930	956	- 26	—	—
Dundee Tram Co. ...	—	—	—	—	—	—
Glasgow Corporation	,, 22 1	1,898	9,773	+2,125	—	—
Halifax Corporation	,, *22	2,049	1,592	+ 457	—	—
Huddersfield Corp'n.	,, 15	987	917	+ 270	10,640	7 845
Hull Corporat'n E.S.	,, 22	1,633	1 347	+ 286	76 310	40,018
Liverpool Corporat'n	,, 15	9,126	8,096	+1,029	202,839	174,029
Liverpool Overhead	,, 23	1,572	1,606	- 34	39,285	35,820
Oldh'm-Asht'n-Hyde	,, 14	487	595	- 108	11,435	11,015
Portsmouth Corpn...	,, 22	677	—	—	—	—
St. Helens Tramways.	—	—	—	—	—	—
Sheffield Corporation	—	—	—	—	—	—
Southampton Trams	,, 20	796	612	+ 183	—	—
Southport Corporat'n	—	—	—	—	—	—
Swansea Tramways..	—	—	—	—	—	—
Wolverhampt'n C'p'n	—	—	—	—	—	—

* Fortnightly. b Since April 1, 1900.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £98 decrease.

Barcelona Ensanche y Gracia, £69 decrease. Barcelona, £58 decrease.

Brisbane, £30 increase.

Buenos Ayres and Belgrano Electric, £673 increase.

Calcutta, £155 increase.

Cape Town (month of May), receipts, £12,700; expenditure, £6,070.

Mexico Electric (month of May), receipts, £18,500; expenditure, £10,600.

Perth Electric, £297 increase.

Port Elizabeth (month of May), receipts, £3,298; expenditure, £1,818.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter. 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	3-3½
—— Ordinary, 1-125,000	1 ..	½-¾
British Electric Works, Ordinary, 80,001-90,000	1 —	1/16-3/16
—— 6 per cent. Cum. Pref., 1-80,000	1 —	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 —	85-90
British Insulated Wire, Ord., 1-70,000	5 —	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 —	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 —	4½-5½
Brush Electrical Engineering, Ordinary	2 —	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2 —	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100 ..	103-106
—— 4½ per cent. 2nd Debenture Stock	100 —	101-104
Callender's Cable, Debentures	100 —	109-113
—— Ordinary	5 —	14-15
—— 5 per cent. Pref.	5 —	5½-6
Crompton and Co.	5 —	3½-4
—— 5 per cent. Debentures	— —	103-105
Edison and Swan United, Ordinary	5 —	1-1½
—— 5 per cent. Debentures	5 —	2-3
—— 4 per cent. Deb. Stock, Red.	100 —	87-89
—— 5 per cent. Second Deb. Stk., Prov. Certs.	— —	94-96
Electric Construction, Limited, Nos. 1 to 112,100	2 —	1½-2½
—— 7 per cent. Cumulative Pref.	2 —	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	103-106
General Electric Company (1900), 5 per cent. Cum. Pref...	10 —	9½-10 xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 —	15½-16½
—— 4½ per cent. Preference	5 —	5½-6
—— 4½ per cent. Debentures	100 —	107-111
India Rubber, Gutta Percha, and Telegraph Works	10 —	21-22 xd
—— 4 per cent. Debentures	100 —	101-104
Telegraph Construction and Maintenance	12 —	38-40
—— 5 per cent. Bonds	100 —	102-105
Telegraph Manufacturing, Ordinary	5 —	10-11
—— 5 per cent. Cum. Pref.	5 —	5½-6
Willans and Robinson, Ordinary, 1-80,000	5 —	10½-11½
—— 6 per cent. Cum. Pref., 80,001-90,000	5 —	6½-7
—— 4½ per cent. First Mortgage Debenture Stock. Red.	100 —	106-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 —	⅞-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	75 ..	70-75
Bournemouth and Poole, Ordinary	10 —	11½-12½
—— 4½ per cent. Cum. Pref.	10 —	10-11
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 —	7⅜-8½
—— 7 per cent. Preference	5 —	8½-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5 —	7-7½
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 —	5½-5¾
Chelsea Electricity Supply	5 —	5¾-6¼
—— 4½ per cent. Debentures	100 —	109-112
City of London, Ordinary	10 ..	8½-9½
—— 6 per cent. Cumulative Pref.	10 —	12½-13½
—— 5 per cent. Debenture Stock	100 —	133-137
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 —	102-104
County of London and Brush Provincial, Ordinary	10 —	8½-9½
—— 6 per cent. Cum. Pref.	10 —	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 —	108-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 —	5½-6¼
—— 6 per cent. Cum. Pref.	5 —	5½-5¾
—— 4½ per cent. First Mort. Deb.	100 —	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¾-5½
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5 —	5½-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 —	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11½-12½
—— 4 per cent. Debenture Stock, Red.	100 ..	102-105
Kensington and Knightsbridge and Notting Hill	100 —	103-105
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9½-10½
London Electric, Ordinary	2 —	1½-1¾
—— 6 per cent. Pref.	5 —	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	96-100 xd
Metropolitan, Ordinary	10 —	12½-14½
—— ,, 85,001-96,769	5 —	12½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 —	110-113
—— 3½ per cent. Mortgage Debenture, Red	100 —	96-99
Notting Hill Electric Lighting	10 —	15½-16½
Oriental, 1879	1 —	1½-1¾
—— £5 Shares	5 —	6¾-7¼
—— £4½ Shares, New	4½ —	5½-6
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 —	5½-6¼
River Plate Electric Light and Traction, Deb.	100 —	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	108 —	103-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 —	2-2½
—— 4 per cent. Debenture Stock	108 —	80-90
South London, Ordinary	5 —	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,060	5 —	15-16
—— 7 per cent. Pref.	5 —	9-10
—— 3½ per cent. Deb.	100 —	98-101
Westminster, Ordinary	5 —	12-13
Electric Railways.—		
Central London, Ordinary	10 —	9¾-9¾
—— Pref. Half-Shares	5 —	4¾-5¼
—— ,, ,, deferred	5 —	4¾-5¼
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	113-118
City and South London, Consolidated Ordinary	100 ..	55-57
—— Ordinary	10 —	5½-5¾
—— 4 per cent. Debenture Stock	100 —	111-116
—— 5 per cent. Pref. Stock '91	100 —	133-137
—— ,, ,, ,, '96	100 —	133-137
Liverpool Overhead, 5 per cent. Pref.	— —	12-13½
—— Ordinary, 1-50,000	— ..	7⅝-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,760	— ..	103-104
Waterloo and City, Ordinary	100 —	93-96
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4½-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 —	14-15
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-2¾
—— 5 per cent. Cum Pref., Nos. 1-75,000	5 ..	4¾-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	94-101 x d
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 —	6½-7
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250 of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 —	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 —	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	1½-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5½-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	5-5½
—— 5 per cent. Deb. Stock, Red.	100 —	103-105 xd
—— Prov. Cert., all paid	100 —	95-98
Cape Electric Tramways, Shares, Nos. 1-400,000	1 —	1¾-2
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-102
Imperial Tramways, Ordinary	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb. Stock	100 —	113-118
Kidderminster and District Lighting and Traction, Pref.	5 —	3½-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 —	103-106
New General Traction, Ordinary	5 —	3-3½
—— 6 per cent. Cum. Pref.	10 —	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 —	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	13-13
—— 5 per cent. Cum. Pref., 1-20,000	10 —	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-107
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £51,132 6 per cent. Preference	6s. —	5/16
—— £50,000 ,, ,,	1 —	1
—— £500,000 4½ per cent. Debenture Stock	80 p.c.	80 p.c.
Wolverhampton Tramways Company	— —	—
Telephones.—		
National Telephone, Ordinary	5 —	2-2½
—— 8 per cent. Cum. First Pref.	10 —	11-13
—— 6 per cent. Cum. Second Pref.	10 —	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 —	4-4½
—— 4 per cent. Deb. Stock, Red.	100 —	96-99
—— 3½ per cent. Deb. Stock, Red.	100 —	89-93
Oriental Telephone and Electric Company	1 —	3-1

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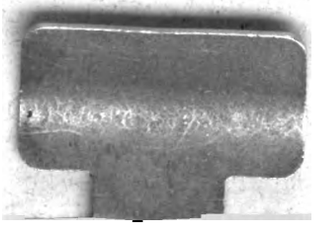

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